IT Resources and IT Capabilities as a Driver of Physical Infrastructure Projects Performance

By

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Abstract

This study evaluates how Information Technology (IT) creates value in the performance of physical infrastructure (PI) projects. The research model is based on the concept of the Business Value of Information Technology (BVIT) and relates the integration of IT resources with the development of IT capabilities to promote the performance of PI projects. The model is evaluated empirically from first-hand data collected from surveys in public and private organizations whose core is the development of PI projects in Colombia. The empirical test indicates there is a strong relationship between IT and PI performance when the effects of IT resources and capabilities are mediated through the underlying mechanisms composed by IT support for competitive strategies and core competencies. The strong correlation between predictor constructs and PI project performance is confirmed upon calculating the total effects, after which the empirical results shall confirm the theoretical basis. The study includes managerial traits like moderator variables and empirical results indicate there are no heterogeneity issues.

When countries achieve a foundational level of physical infrastructure, namely in basic services (i.e. water supply and sanitation), infrastructure for life and coexistence (i.e. housing, education, health, etc.) and ports and transport systems, they promote their national productivity and competitive edge, in turn increasing their social positions in relation to equity and sustainability. These transversal and relevant effects in the social context suggest to develop new studies in this field.

Dedication

I dedicate this achievement to my nuclear family, to my wife Zoraida and my sons Juan Francisco, Manuela, and Andrés, who have continually supported me and given me the courage to move forward on this lonely path. I hope the fidelity and effort materialized in this document is not only a minor contribution to knowledge, but also a contribution toward a better understanding that the only capital one can accumulate is derived from actions that further the development of society's welfare.

Oftentimes the existence of multiple dimensions has proved to be a distractor to overcoming this academic challenge. Therefore, I must also thank God for gifting me with the joy and inner strength to succeed.

I thank life for providing the opportunity to share this experience with my parents, siblings, extended family members, and friends that are sure to be filled with pride when this challenge has been conquered.

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Chapter 1: Introduction

Dynamism and globalization characterize the world's current interconnected environment, resulting in a global situation that challenges both governments and firms to increase their respective competitiveness to earn a spot in the international scope. Bertola and Ocampo (2012) analyzed how countries (i.e. Latin American countries) that base their development on commodities can affect other value-added economic sectors if high prices are not properly used to stay at the forefront. A key factor to include in this process is physical infrastructure (PI) given that it has a transverse incidence on social agents in terms of competitiveness, equality, and sustainability, and in which it has accumulated a gap of more than 40% (Perrotti & Sanchez, 2011). Although physical infrastructure is, to a great extent, already determined by accepted standards and specifications from exact sciences, it is essential to understand the underlying factors to deal with the aforementioned lags (D´Alessio, 2009; Morosini, 2015) and, in this way, propose new approaches to the development of PI projects. The main contribution of the research was to describe information technology (IT) as a driver of physical infrastructure project performance so that its intrinsic possibilities may add value to the field. In the academic literature reviewed there are no traces of studies related to the relationship between PI and IT. In the fourth industrial revolution, digital ecosystems have caused disruptive results in the social actor's articulations, achieving efficiency in the program's deployment, making results visible, optimizing budgets, and reducing the risk of unsustainable and negative practices.

The impact of IT support on physical infrastructure project performance was the focus of the research. It was based on theoretical concepts which postulate the existence of relationships between IT resources and capabilities with performance. The main concepts in this field are the theory of resources and capabilities (Barney, 1991), the theory of resource orchestration (Sirmon, 2007), the resource-based view (Spanos & Lioukas, 2001), the theory

of competitive strategy (Porter, 1980), and the widely accepted concepts of BVIT (Soh & Markus, 1995) and Firm Performance (Ravichandran & Lertwongsatien, 2005).

Research in information systems (IS) has identified resource orchestration as an efficient way to focus these investments on IT resources and for the subsequent consolidation of IT capabilities. This orchestration of IT resources is known as the Business Value of Information Technology (BVIT) and describes IT alignment with aims to enhance competitive advantages in strategic and operational planning and management (Ravichandran & Lertwongsatien, 2005), effectively promoting performance. Both IT resources and IT capabilities contribute to the improvement of the organization's performance (Ramachandran, Agarwal & Mishra, 2007).

Based on empirical studies, this research aimed to identify key aspects that are suitable for the improvement of PI development by means of proposing new administrative possibilities to strengthen current capacities and integrate efficient strategies and operations, altogether resulting in sustainable competitive advantages under the concept of New Public Management (NPM) (Pedersen & Hartley, 2008). In accord with this perspective, IT introduces a collaborative environment between firms and the government whereby the behavior of this network reaches the collective conscience (Kogut & Zander, 2003) so that, through cumulative and enhanced repetitions, the physical infrastructure gap may be closed, thus contributing to the development of valued-added economic sectors, i.e. South Korea and Singapore.

Background of the Problem

Government and firms (hereinafter referred to as "organizations") are exposed to dynamic environments, making them more complex and specialized and implying additional efforts in terms of coordination and communication between their teams and stakeholders. These complex relationships were referenced under the value chain concept (Porter, 1985;

Quinn, 1992), guiding the design of specialized functions and interactions (i.e. designs, production, control, etc.) so as to find models that maximize organizations' performance. Group relationships, as well as corporate learning, were the subjects of analysis to describe and propose methodologies to promote firm performance in accordance with market cycles, allowing firms to maintain sustainable competitive advantages. Kogut & Zander (1996) stated that organizations are social organizations that differ from prior theories. As transaction costs based on an individualized and egotistical vision, their evolution must aim to share and transfer knowledge among members (group, organization, or network) in a recurring and systematic manner to optimize results.

The dynamic environments and the organizations' specializations were factors that contributed to the establishment of new relationships such as joint ventures and hierarchical contractor forms, among others. Governments often adopt the hierarchical contractor form to develop physical infrastructure. In these situations, a contracting firm is entrusted with the performance of a specific project which is assigned with rules and restrictions on the scope, time, and cost of said project. Normally, these kinds of contracts are located at the core-periphery (Huber, 2011), but their results are crucial for national and governmental functions (Miles & Snow 1992). Depending on the performance of the contracting firm, the government may be affected in a positive or negative manner (Pedersen & Hartley, 2008). Hence, this relationship should be of higher interest given that PI transversely impacts society as a whole in three main aspects: (a) by producing a direct impact on society when the infrastructural works transpire, (b) by producing an improved performance platform for the productive entities, and (c) because physical infrastructure impacts competitiveness on both the local and national level. Under these circumstances, organizations are faced with the challenge of reviewing their management processes to improve PI project performance, more so in specific

countries (i.e. Latin Americans countries) where the PI gap is rounded at about 40% (Correa & Rozas, 2006).

In general, PI is realized by exact sciences such as physics, hydraulics, and chemistry, and there are sets of rules, procedures, optimal practices, regulations, etc., which are recognized and accepted worldwide by the Project Management Institute (PMI, 2008). If these guidelines were to be met, PI levels would not be expected to be where they are now. Hence, researchers focused on understanding other various factors that have been impacting PI development. Management theories based on verifiable resources (Barney, 1991; Penrose, 1959) indicated that gaps in an organization's performance are associated with their resource structuring levels and the establishment of their organizational capabilities such as the comprehensive development of people and groups, collective learning, replicability, information support for management processes, decision making, etc. In this sense, IS literature indicates that when an organization consistently incorporates, adjusts, and aligns its IT resources and capabilities, it develops favorable characteristics that further promote its performance (Ravichandran & Lertwongsatien, 2005). This cause-and-effect mechanism was described in the literature using the concept of the Business Value of Information Technology (BVIT) (Sambamurthy, Bharadwaj & Grover, 2003). The link between the BVIT concept and physical infrastructure development was the predominant topic of the research and aimed to understand both how organizations structure IT resources and develop IT capabilities into their business functions to support core competencies and competitive strategies and how these influence project performance (Ravichandran & Lertwongsatien, 2005).

IT resources and capabilities as key factors have been mentioned since Penrose (1959). Afterwards, the resources and capabilities theory (Barney, 1991), the theory of resource orchestration (Sirmon, et al., 2007), and the asset orchestration theory (Helfat et al., 2007) all came about. These theories coincided in describing the systematic accumulation of

resources and strategic asset management with the goal of promoting firm performance. Makadok (2001) complimented this by specifying that resource structuring should be performed in a dynamic context taking into consideration acquisition, development, and retirement (divest) coherently with the rapid rate of technological advancements.

Information System (IS) researchers indicated that IT resources are considered rigid and can impact firm performance when they align appropriately with the available capabilities (Nevo & Wade, 2010). IT human resources experts, considered to be the backbone of business activities, also conclude that these resources are not simply infrastructure (Bharadwaj, 2000; Karimi, Somers & Bhattacherjee, 2007; Powell & Dent-Micallef, 1997; Ravichandran & Lertwongsatien, 2005; Wade & Hulland, 2004; Zhu, 2004).

On the other hand, IT capabilities are considered to be the result of the development and display of IT resources. In other words, IT capabilities depend on the existence and availability of IT resources. They have a transversal effect on business functions, are integral to the critical success factors (CSF), and are the functional skills required to support core competencies and competitive strategies (Soh & Markus, 1995; Wade & Hulland, 2004). They were considered multidimensional factors (Wang, Liang, Zhong, Xue, & Xiao, 2012) that altogether improve the performance (Chan & Reich, 2007; Henderson & Venkatraman, 1993; Kearns & Sabherwal, 2006, 2007; Sabherwal & Chan, 2001).

The IS literature considered IT resources and capabilities as individual mechanisms; nonetheless, as cited, they are complimentary and reinforce one another to generate value (Wang, et.al 2012). According to the value creation model (Soh & Markus, 1995), IT resources and capabilities do not create value on their own. Rather, both must support competitive advantages along with the development and implementation of competitive strategies (Porter, 1980, 1991) and core competencies (Ravichandran & Lertwongsatien, 2005). The relationship between IT resources, IT capabilities, and their underlying

mechanisms (IT support for competitive strategies + IT support for core competencies) is what encourages IT to impact performance so remarkably. These complex relationships stressed the need to investigate and explain their incidence in the value creation process. Consequently, the study incorporated the BVIT framework in the construction sector, specifically in the development of PI projects. The analysis led to the understanding of the strength of the relationships, via mediation and moderator effects, between IT resources, capabilities, support for core competencies, and support for competitive strategies and their effects in PI project performance. It was necessary to measure the model's consistency, as well as its predictive capability, for which structured equation modelling (SEM) was the statics methodology used given its capacity to explain these multidimensional links that affect PI performance. The concepts, when applied, converge in the following thesis claim: When organizations promote both their IT resources and IT capabilities, appropriately aligning them with physical infrastructure project management, they positively impact performance and, in effect, contribute to the nation´s competitive edge.

Statement of the Problem

It is crucial for developing countries to close the physical infrastructure gap to be able to face challenges presented by international competition. This implies that government organizations and contracting firms must collectively align their resources and capabilities to improve PI performance. Taking into account that IT is decisive in the management processes of modern organizations, and based on the relevant literature (Makadok, 2001; Sirmon, et al., 2007; Wang et al., 2012), there does exist a significant relationship between IT resources, IT capabilities, and PI project performance. The corresponding research aimed at studying how such a significant relationship can exist among these elements. Hence, the statement of the problem revolved around the exploration as to whether the relationship between IT resources, IT capabilities, and PI project performance exist, as well as how its hypothesized relationship

correlates with the BVIT concept. Its corresponding results contribute to the concept of New Public Management (NPM) (Pedersen & Harley 2008).

Purpose of the Study

The purpose of this study was to analyze and understand how IT resources and capabilities impact the performance of PI projects developed by government organizations and contracting firms (Wang et al., 2012) in the construction sector. Infrastructure project performance is the object of this study for which data was obtained through surveys given to professionals and directors of government organizations and firms whose core objective is the development of roads, healthcare, education, housing, water treatment, and sewage-related infrastructure projects. The information was provided first-hand through the use of direct and electronic surveys about projects developed in Colombia. Because the research analysis concerns infrastructure projects, respondents were asked that the information provided be from the last infrastructure project completed at the time of the survey. (Muller & Turner, 2007).

Significance of the Problem

This research was significant for the following reasons: (a) because it integrated the alignment of the IT components that contribute to learning, replicability, cooperative work, information handling, and decision-making, as well as soft elements that foster performance (Teece, Pisano & Shuen, 1997), as critical management factors of PI; (b) because it contributed to the understanding of IT resource structuring and the establishment of IT capabilities as mechanisms that promote the projects' competitive strategies and performance. Various IS research studies highlight the ample amount of research possibilities associated with the BVIT concept and its underlying mechanisms (Wang et al., 2012). In the literature review, there were studies related to BVIT based around different concepts and orientations but there were no traces in the studies in which physical infrastructure was integrated; (c)

because it describes the strategic value of investing in technology and generating the guidelines necessary to empower them in government organizations and firms under a cost-benefit ratio provided by IT resources; (d) because it promotes the alignment of the organization's strategies with technological strategies, resulting in a multidimensional and transversal support system for the organizations to carry out their work; (e) because it promotes the dynamic capabilities of the organizations with respect to group learning (Andreu & Ciborra, 1996), the performance of strategic processes (Peppard & Ward, 2004), and the development, implementation, and use of IT resources that support competitive strategies and core competencies (Montealegre, 2002); and (f) because it encourages improved PI project management that will drive international competition, constituting replicable models oriented toward the concept of New Public Management (NPM) (Pedersen & Harley, 2008).

Nature of the Study

This research was quantitative and oriented to measure the correlation between IT resources and capabilities with PI project performance (Ravichandran & Lertwongsatien, 2005) in government organizations and contracting firms that maintain the development of physical infrastructure projects at their core. The nature of the study is deductive, using a Popperian epistemology. A theoretical analysis was initially proposed with the presentation of hypotheses which were validated by analyzing the information obtained by surveys given to management-level employees through convenience sampling. Given that the study was conducted in a defined period of time, it is considered cross-sectional. The survey corresponds to the study developed by Wang et al (2012), which included the academic stringency of peer review. For the current study, some adjustments were made to better reflect the orientation of the study. A pilot test was performed to validate the adjustments made.

The studies on the concept of BVIT have repeatedly aimed at investigating the way in which IT resources are mobilized and aligned with the organizations' functions. In the

literature review, there were no traces of BVIT-related studies associated with the countries' physical infrastructure projects. The research was considered unique because it is associated with a network derived from a contractor form typically located on the periphery of the government organizations with relatively little importance. When describing the government-firm relationship as a crucial aspect for society and national development, new management models may be established to strengthen replicability and improve upon the value chain for countries' physical infrastructure projects, and as a result enable capabilities that promote New Public Management (NPM) (Pedersen & Harley, 2008).

The study was based on a theoretical concept academically recognized as BVIT. To achieve the goals of the study, the design involved measuring the model's consistency, the strength of the relationships, and the mediation and moderator effects between constructs, for which PLS-SEM was the statistics methodology selected. Increasing data volume, in addition to formidable computer systems, permitted the development of next-generation analysis techniques such as structural equation modeling (SEM), a method formally recognized and accepted in recent decades by the social sciences. SEM is a multivariate technique that combines factor analysis and regression, enabling the examination of relationships between measured variables and latent variables, as well as between distinct latent variables. (Hair et al.,2014).

It is essential to highlight the specific methodological differences between CB-SEM and PLS-SEM. Statistics for CB-SEM are derived from the discrepancy between the empirical and the theoretical covariance matrix, while PLS-SEM focuses on the discrepancy between manifest variables or may be approximated in the case of latent variables. Hence, the evaluation of PLS-SEM builds on a set of nonparametric evaluation criteria and uses procedures such as bootstrapping and blindfolding to measure the model's predictive capabilities. Since PLS-SEM is nonparametric, it does not assume the data and normally

relies on a nonparametric bootstrap procedure (Davison & Hinkley, 1997; Efron & Tibshirani, 1986) to test coefficients for their significance. Others PLS-SEM features include achieving a high level of statistical power with small sample sizes, being capable of working with all scales of measurements, minimizing the amount of unexplained variance (i.e. maximizes the R^2values), and converging after a few iterations. Researchers indicate that PLS-SEM has some limitations with respect to categorical data from measuring endogenous constructs, but this kind of data is irrelevant to the scope of this research.

The development of physical infrastructure and related services is a determining factor for international competitiveness. For this reason, the main goal of this research is to achieve a better holistic understanding about the constructs' relations and interaction that promote performance. A wider range of knowledge in this field could contribute to the advancement of PI project performance, and, by a snowball effect, these findings could contribute to the ultimate closing of the countries' social gaps. From a systematic point-of-view, the study involved the component's psychometric quality, the model's consistency, the strength of the relationships, and the mediation and moderator effects as an integral analysis of the problem at hand. Thus, as will be indicated in Chapter 4, the study integrated three main measurement stages: the psychometric quality of constructs, the assessment of the PLS-SEM structural model, and the evaluation of the structural model results in terms of the Importance-Performance Matrix (IPMA) with heterogeneity as the mediator analysis (Hair, Hult, Ringle & Sarsted, 2014). This combination altogether provided consistent empirical evidence to assess the theoretical basis on which study is based.

Research Questions

The purpose of this research was to determine the impact of IT resources and IT capabilities in the performance of PI projects of organizations in the construction sector. The major research question (RQM) is related to whether a significant relationship does or does

not exist between IT resources, IT capabilities, and PI project performance. The minor research questions (RQm) were tailored to spell out how these hypothesized relationships take place through the mediating effects of IT support for core competencies and IT support for competitive strategies.

Both the research questions and hypotheses were related to the relations and interactions between constructs included in the research model from the theoretical framework based on the BVIT (Soh & Markus, 1995; Wade & Hulland, 2004). Taking into account the study type and its design, it was important to measure from a holistic view whether the research model would have the predictive capacity to describe PI project performance. In this sense, eight minor research questions (RQms) concerning the constructs' relationships were incorporated, which can be found together with the major research question (RQM) in Table 1. The following initial phrase is implicitly included with the research questions given below, after which the minor research questions may be added: "In organizations whose core is the development of physical infrastructure projects, is there…?"

Table 1

Research Questions List

No.	Research Questions
RQM	In organizations whose core is the development of physical infrastructure projects, is there a significant relationship between IT resources and IT capabilities with the PI projects performance?
RQm1	Is there a significant relationship between IT resources and IT capabilities?
RQm2	Is there a significant relationship between IT resources and IT support for competitive strategies?
RQm3	Is there a significant relationship between IT resources and IT support for core competencies?
RQm4	Is there a significant relationship between IT capabilities and IT support for competitive strategies?
RQm5	Is there a significant relationship between IT capabilities and IT support for core competences?
RQm6	Is there a significant relationship between IT support for core competences and IT support for competitive strategies?
RQm7	Is there a significant relationship between IT support for competitive strategies and the PI projects performance?
RQm8.	Is there a significant relationship between IT support for core competences and the PI projects performance?

The RQM aimed to measure the relationship between the incorporation and deployment of IT resources, the development of IT capabilities, and the performance of projects in organizations responsible for the development of physical infrastructure projects under the BVIT concept (Soh & Markus, 1995; Wade & Hulland, 2004). The IS literature stated that IT resources themselves are rigid and require an alignment with the organization so they may contribute to the organization's capabilities. The alignment process of these IT resources results in the production of IT capabilities (Nevo & Wade, 2010). Since IT capabilities depend on IT resources, the definition of the value creation boundary of these constructs has been the topic of numerous debates among the academic community. The research aimed at contributing to this discussion by individually describing the effects that IT resources and IT capabilities have on project performance (Wang et al., 2012). Given that there does exist a causal relationship between IT resources and IT capabilities, RQm1 was included with the purpose of confirming this link and determining how it contributes to the value creation mechanism (Pavlou & El Sawy, 2006).

Based on the competitive strategy theory and the RBV (Spanos & Lioukas, 2001), IT creates value when it promotes competitive advantages by means of the creation and implementation of competitive strategies (Clemons, Dewan, & Kauffman, 2004; Ramachandran et al., 2006) and the improvement of core competencies (Karimi, Gupta, & Somers, 1996; Porter & Millar, 1985; Rivard, Raymond, & Verreault, 2006). Under these premises, IS researchers affirmed that there does exist an underlying mechanism composed of IT support for both the competitive strategies (Rivard, et al., 2006) and the core competencies (Agarwal, 2006; Ravichandran & Lertwongsatien, 2005) that define BVIT (Wang et al., 2012). This mechanism mediates the effects that IT resources and capabilities have on PI project performance. RQm2, RQm3, RQm4, and RQm5 were included to describe the

relationships between IT resources and IT capabilities with the underlying mechanism integrated by IT support for competitive strategies and IT support for core competencies.

The core competencies theory suggested that, if the internal capabilities are rare, difficult to reproduce, and irreplaceable, competitive advantages will potentially be created. This statement supports RQm6, which links IT support for core competencies and IT support for competitive strategies (Hafeez, Zhang & Malak, 2002; Hamel, 1994; Prahalad & Hamel, 1990).

A wide range of authors agree that when IT resources align with the company's functions, IT capabilities are produced and support IT core competencies and competitive strategies. Altogether, these relationships generate a positive impact on firm performance and profitability (Chan & Reich, 2007; Henderson & Venkatraman, 1993; Kearns & Sabherwal, 2006, 2007; Sabherwal & Chan, 2001). According to Ravichandran and Lertwongsatien (2005), firm performance occurs in both the operational and market dimensions. Going off these conceptual bases, this study incorporated RQm7 and RQm8 to understand and measure how IT support for core competencies and IT support for competitive strategies play a role on the performance of PI projects. Due to the nature and focus of the study, PI project performance was only considered in the operational dimension.

Hypotheses

The research focused on gaining a better understanding on the effects of the predictor constructs, IT resources, IT capabilities, IT support for core competencies, IT support constructs for competitive strategies, and the PI project performance of the constructs. In this way, the model of predictive capacity described by the literature may be tested accurately. Links between constructs were associated with a set of null hypotheses (Ho) as indicated below in Table 2. The key authors that support each link are indicated further down in Figure 1. In the empirical test, the measurements represent the model's consistency and the strength

of the relations. The following initial phrase is implicitly included with the hypotheses given below, after which each individual null hypothesis may be added: “In organizations whose core is the development of physical infrastructure projects…?”

Table 2

Set of Hypotheses

No.	Nule Hypothesis
H1o	IT resources do not have a relationship with PI project performance.
H2o	IT capabilities do not have a relationship with PI project performance.
H3o	IT resources do not have a relationship with IT capabilities
H4o	IT resources do not have a relationship with IT support for competitive strategies.
H5o	IT resources do not have a relationship with IT support for core competences
H6o	IT capabilities do not have a relationship with IT support for competitive strategies
H7o	IT capabilities do not have a relationship with IT support for core competencies
H8o	IT support for core competencies does not have a relationship with IT support for competitive strategies
H9o	IT support for competitive strategies does not have a relationship with PI project performance
H10o	IT support for core competencies does not have a relationship with PI project performance.

H1o and H2o were supported in the theories aligned with a resource-based view, mainly BVIT and the theory of resource orchestration, which collectively coincide in describing value creation as the result of structuring IT resources and establishing IT capabilities that impact firm performance (Barney, 1991; Conner, 1991; Grantt, 1991; Liang, You, & Liu, 2010; Penrose 1959; Teece, et al., 1997; Wernerfelt, 1984).

H3o is based on Nevo and Wade (2010), two individuals who postulated that IT resources are considered rigid and impact firm performance when they align appropriately with their capabilities. Similarly, IT capabilities are considered the result of the display and development of IT resources, in other words, IT capabilities depend on the existence and availability of the necessary IT resources (Barney, 1991; Pavlou & El Sawy, 2006). H4o, H5o, H6o, and H7o were based on the transversal effects observed in various business functions by means of IT resources and IT capabilities, as well as how they support core competencies and competitive strategies (Nolan, 1994; Porter, 1991; Rivard et al.,2006;

Spanos & Lioukas, 2001; Soh & Markus, 1995; Wade & Hulland, 2004). H8o was based on the core competencies theory. This theory postulated that, when organizations are able to accumulate advantageous internal capacities that are differential and unique with respect to their competitors, they result in the establishment of competitive advantages. (Hamel, 1994; Hafeez et al., 2002; Prahalad & Hamel, 1990;). H9o and H10o were supported by the relationships concerning how IT resources and capabilities affect performance by means of the underlying mechanism observed in IT support for competitive strategies and IT support for core competencies. They were considered multidimensional factors (Soh & Markus, 1995; Wang et al., 2012) that collectively enhance performance (Barney,1991; Chan & Reich, 2007; Henderson & Venkatraman, 1993; Kearns & Sabherwal, 2006, 2007).

Theoretical Framework

The evolution of the firm's history has been influenced in recent decades by technological advances, especially by means of IT. The speed of change permanently generates an information deficit which gives IT a special strategic value in regard to firm performance (Wang et al., 2012). IS research has relied on management theories and research into the corresponding practices, mainly on the resources and capabilities theory (Barney, 1991), RBV (Spanos & Lioukas, 2001), resource orchestration research (Sirmon, et al., 2007), the competitive strategy theory (Porter, 1980, 1991), the core competencies theory (Hafeez et al., 2002; Hamel, 1994; Prahalad & Hamel, 1990), and the IT value creation model (Soh & Markus, 1995). Given that this research involved IT and project management, these main postulates were integrated as part of its conceptual base. The concept of the Business Value of Information Technology (BVIT) was among the primary functions included and acted as the theoretical foundation of the framework representing the relationship that the independent variables, IT resources and IT capabilities, have on the dependent variable, PI project performance.

The BVIT concept functions to describe how IT supports business management in diverse dynamic environments and how organizations must develop IT capabilities with adequate flexibility to adapt to changes in situational factors. These capabilities should be present both internally and externally to leverage current opportunities and branch out to explore and expand upon emerging markets (Sambamurthy, et al., 2003). This is precisely what Kogut and Zander (1992) described as dynamic capabilities linked to the creation of competitive advantages that occur in core competencies (Agarwal, 2006) and as strategic capabilities the internal-external exchange. These capabilities have been widely referenced in the RBV (Spanos & Lioukas, 2001) and in the studies by Porter (1980, 1981), Miller (1986), Ravichandran and Lertwongsatien, (2005), and Rivard, et al (2006). The theoretical framework, which was the conceptual foundation of the research, is shown in Figure 1 which illustrates and cites the main authors related to specific constructs and their relationships.

The conceptual base of IT resources is substantiated by the resources and capabilities theory (Barney, 1991), the resource orchestration theory (Sirmon, et al., 2007), and the orchestration of assets (Helfat, et al., 2007). These theories indicated that the coherent and timely accumulation of resources in organizations contributes to the development of competitive strategies and core competencies (Sambamurthy, et al., 2003; Wheeler, 2002). Different studies indicated that IT personnel should be included as part of the resources, whereas hardware, software, and databases are often considered to be on their own. The accumulation of the corresponding resources is not the only element essential to the production of the expected effects on firm performance. Research indicated that IT personnel generate the impact mechanism on firm performance through their support for the organization's functions, their fostering of communication among interacting groups, and their promotion of cross-competencies (Bharadwaj, 2000; Karimi, et al., 2007; Powell & Dent-Micallef, 1997; Ravichandran & Lertwongsatien, 2005; Wade & Hulland, 2004; Zhu,

2004). According to these conceptual bases, the research incorporated IT resources as a formative construct made up of: (a) IT infrastructure; (b) IT support personnel; (c) IT management personnel; and (d) IT personnel that connect IT functions with business operations (Wang et al., 2012).

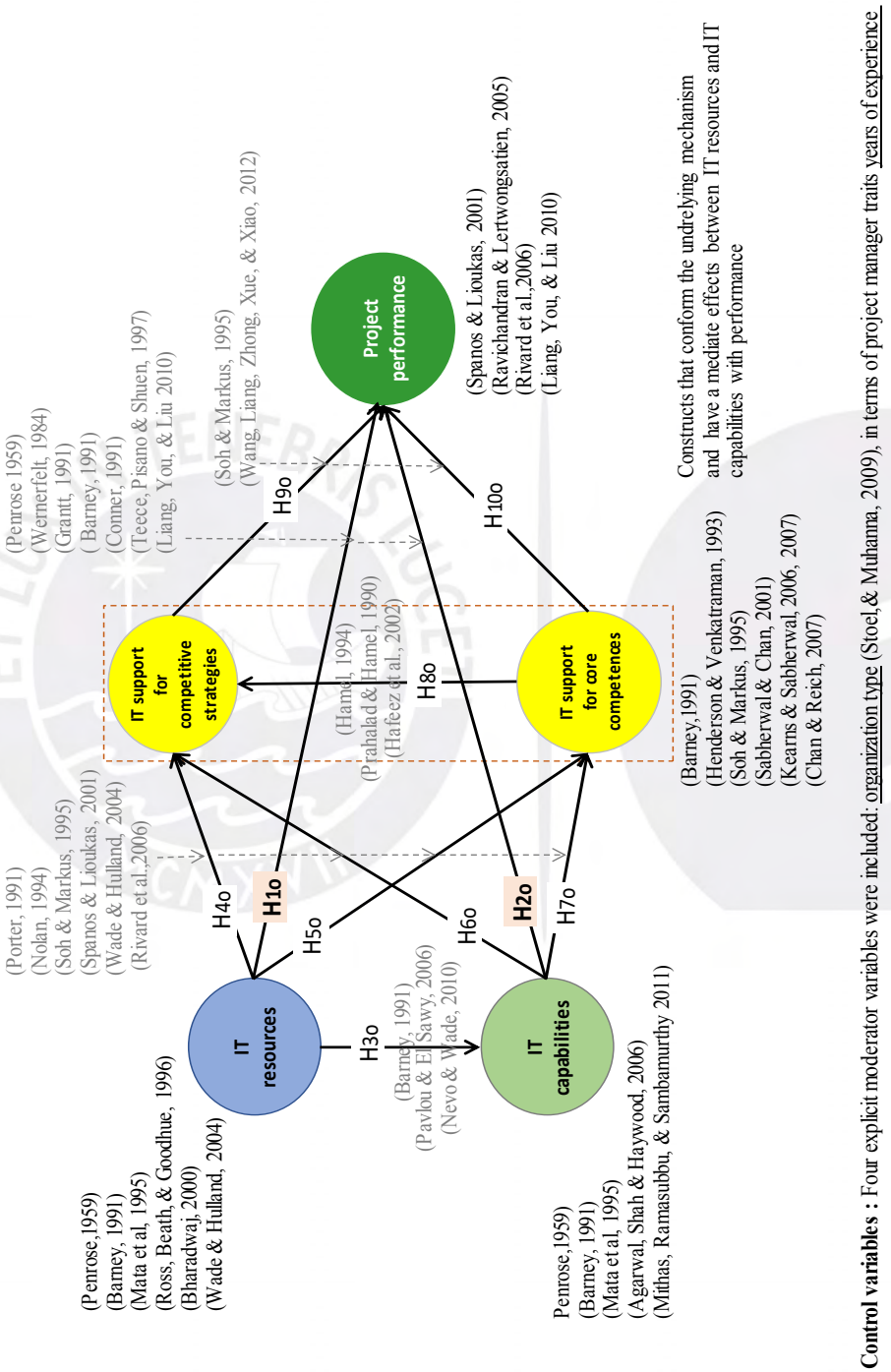


Figure 1. Theoretical framework (Based on Wang et al., 2012).

RBV (Spanos & Lioukas, 2001) stated that resources should correspond to specific, rare, non-duplicable, and irreplaceable assets that will permit the implementation of strategies that, in turn, generate profitable earnings. This statement generated numerous academic debates concerning the difference between IT resources and IT capabilities (Wang et al., 2012) given that both have a close relationship. Additionally, IT capabilities depend almost exclusively on the availability and deployment of IT resources. This research aims to enhance the understanding of the extent of IT resources and capabilities and nurture the academic debates with empirical evidence. IT capabilities are a key construct in establishing a direct link between IT and business functions because they integrate aspects such as idiosyncrasies (Saraf, Langdon, & Gosain, 2007), the routine's absorption and replicability (Liang, Saraf, Hu, & Xue, 2007), within an environment to support knowledge and learning, as well as the coordination and collaboration of the teams that work together to foster core competencies (Soh & Markus, 1995) and business strategies (Wade & Hulland, 2004).

The conceptual base of IT capabilities is equally substantiated by the resources and capabilities theory (Barney, 1991), the resource orchestration theory (Sirmon, et al., 2007), and the concepts by Pavlou and El Sawy (2006), who indicated that the deployment of IT capabilities streamlines the functional capabilities for the development of new goods and services and the development of competitive advantages. In this research, IT capabilities corresponded to a formative construct with four dimensions through which the organization mobilizes IT resources and efficiently leverages firm performance: (a) IT strategy planning as a capacity to align the organization's strategy with the IT strategy (Bharadwaj, Sambamurthy, & Zmud, 1999; Ravichandran & Lertwongsatien, 2005); (b) IT management as a capacity to align IT with business needs (Tiwana, Bharadwaj, & Sambamurthy, 2003); (c) the employment of IT as a capacity to generate awareness of IT functionalities so that all collaborators may integrate them into their activities (Pavlou & El Sawy, 2006); and (d) IT

development as a capacity to plan investments in technology, develop competent IT personnel, and expand its application to stakeholders (Wang et al., 2012).

According to Rivard, et al. (2006), the competitive strategy theory and the RBV are theories that collectively describe the existence of an underlying mechanism in the business value process that theoretically has a moderator effect on the relationship between IT resources, IT capabilities, and performance (Wang et al., 2012). Some of the main concepts that support the existence of this underlying mechanism are the following: (a) according to the IT value creation model (Soh & Markus, 1995), IT creates value when IT resources are deployed to strengthen IT capabilities, and, jointly, these mechanisms impact core competencies (Rivard et al., 2006); (b) improvements in organizational capabilities impact functions and stakeholders (Peppard & Ward, 2004; Peppard, Lambert, & Edwards, 2000; Piccoli & Ives, 2005); (c) the core competencies theory indicated that when internal capabilities are rare, difficult to copy, and irreplaceable, competitive advantages are created (Hafeez et al., 2002; Hamel, 1994); (d) the competitive strategy theory and subsequent studies by Porter (1980,1985,1996), Miller (1986) and Wang et al.(2012) indicated that the harmonization and alignment of IT resources and IT capabilities support the creation and implementation of competitive strategies and improve upon the core competencies that are closely linked to the BVIT concept and firm performance. Based on these concepts, the research's framework incorporated IT support for competitive strategies and IT support for core competencies as a linking mechanism between the relationships among IT resources, IT capabilities, and project performance (Wang et al., 2012).

The evolution of the conceptual base of IT support for competitive strategies is presented in the same manner as the strategy concept in that each orientation offers elements to describe the dimensions of this construct. Nolan (1994) stated that competitive advantages are based on market performance and business results. Porter (1980) referenced three generic

competitive strategies: differentiations in the market, low costs, and the overall focus. Miller (1986) described competitive strategies as innovative and differential strategies in the market. Based on these theories and taking into account the focus of the research, IT support for competitive strategies was determined by the project dimension denominated product success (Baccarini, 1999) in two distinct dimensions: (a) IT support for the integrity of completion as a strategy associated with product success in virtue of the absence of post-project hindrances, the quality of post-audit analysis, and the identification of technical problems during the project in conjunction with their solutions (Freeman & Beale, 1992); and (b) IT support for the stakeholders' satisfaction, a factor aimed at improving the effective coordination and relation patterns between project stakeholders during the project cycle (Baker, Murphy, & Fisher, 1988).

Following the core competencies theory and the statements made by Ravichandran and Lertwongsatien (2005), IT core competencies have a development potential when IT supports internal capabilities that impact firm performance in three dimensions: (a) IT support for market access, (b) IT support for integration of competencies, and (c) IT support for related functionality when IT is adapted to the business' critical processes. For the purposes of this research, IT support for core competencies included three dimensions focused on the project management process (Baccarini, 1999): (a) IT support for resource efficiency. Given that this support is oriented with the aim of anticipating all project requirements, having the sufficient amount of resources to meet project needs in a timely fashion and using these resources efficiently to accomplish the corresponding task is of vital importance to the processes (Tuman, 1986); (b) IT support for effective coordination between team projects to produce more efficient practices and processes, increase team morale, and promote participative decision-making (Baker et al., 1988); and (c) IT support for scope preservation

oriented at minimizing changes in the focus of the project by preventing potential disturbances to the organization's workflow and corporate culture (Kerzner, 1992).

In regard to the interacting constructs under the BVIT concept, various authors such as Chan and Reich (2007), Henderson and Venkatraman, (1993), Kearns and Sabherwal (2006-7), Sabherwal and Chan (2001) coincided in describing value creation as the result of structuring IT resources and establishing IT capabilities that impact firm performance, promoting and contributing to the underlying mechanism (IT support for competitive strategies + IT support for core competencies). According to Ravichandran and Lertwongsatien (2005), firm performance is determined by two dimensions: operational performance in terms of productivity, profitability, and financial indicators, and market performance in terms of access to emerging markets and the development of new products and services. Based on previous concepts and aligning with the research design, performance as an endogenous variable was evaluated under the effectiveness criteria with three formative items: (a) time, with respect to schedule compliance (McCoy, 1986; Morris & Hough, 1987; Pinto & Slevin, 1988; Turner, 1993); (b) cost, with respect to budget compliance (McCoy,1986; Morris & Hough, 1987; Pinto & Slevin, 1988; Turner 1993); and (c) quality, with respect to conformance with functional and technical specifications (Baker et al., 1988; Morris & Hough, 1987; Turner, 1993). In general, all items and constructs were associated with the survey questions and subsequently applied to the corresponding statistical process for which PLS-SEM was the statistics methodology selected to measure of model's consistency, the strength of the relationships, and the mediation and moderator effects between distinct constructs. The study incorporates managerial traits as moderator factors corresponding to heterogeneity analysis in terms of the statistical methodology.

Definition of Terms

Table 3 provides the main definitions of the terms and abbreviations incorporated in the research:

Table 3

Definition of Terms and Abbreviations

Terms/ Abbreviations	Definitions
American Society for Testing and Materials (ASTM)	One of the international norm development organizations in the world where producers, users, and consumers gather to create voluntary consensus norms guided by the principles of the World Trade Organization Technical Barriers to Trade Agreement. The norms are used in investigations and development projects, quality and systems testing, and commercial transactions around the world. These are some of the integral components of today's competitive commercial strategies. www.astm.org. (2014)
Business Value of Information Technology (BVIT)	BVIT is the extent to which the systemic use of IT improves the performance of the organization to achieve its objectives and gain a competitive advantage (Maoz, Fink, Pliskin, & Heart, 2007)
Competitive Advantage	Collection of routines, skills, and complementary assets that generate revenue and are difficult to imitate. (Teece, Pisano & Shuen, 1997, p. 524).
Competitive Strategy	Choosing a different set of activities to deliver a unique combination of value. Strategic positioning attempts to achieve sustainable competitive advantages by preserving what is distinctive about a company. This implies carrying out activities that are distinct from competitors or altering similar activities in advantageous ways. Porter (1980)
Core Competencies	"We define those competencies that define a firm's fundamental business as core. Core competencies must accordingly be derived by looking across the range of a firm's (and its competitors) products and services. The value of core competencies can be enhanced by combining the appropriate complementary assets. The degree to which a core competency is distinctive depends on how well endowed the firm is relative to its competitors, and on how difficult it is for competitors to replicate said competencies". (Teece, Pisano & Shuen, 1997, p. 516).
Country Competitiveness	Ability of a country to sustain and expand their participation in international goods and services simultaneously to increase the income of its population (President's Commission on Industrial Competitiveness USA) (Correa et al., 2006, p.36)
Critical Success Factors (CSF)	"Factors of a company that support or threaten the achievement of the objectives of the firm and its existence factors. They require special attention to avoid mishaps or missed opportunities. They can be internal or external and have either a positive or negative impact "(Ferguson, 1982, p.14).
Current Capabilities	"Social relationships that currently exist in a firm" (Kogut & Zander, 1992, p.1)
Dynamic Capabilities	"The firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments. Dynamic capabilities thus reflect an organization's ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions (Leonard-Barton, 1992)". (Teece, Pisano & Shuen, 1997, p. 516)

Firm Performance	Ravichandran and Lertwongsatien (2005) postulate firm performance is given in two dimensions, operational and market dimensions. Operational performance refers to productivity, profitability, and financial indicators, and market performance is defined as the success of the firm in entering an emerging market and bringing new products or services to the market.
Gap in Infrastructure	A gap in the vertical dimension with respect to internal factors in the country or region of analysis and corresponds to the difference between the evolution of the domestic supply and demand for infrastructure (Perrotti & Sanchez, 2011, p. 31)
Government Plans	Management tools that promote social development in a given location with the criteria to serve unsatisfied social needs to improve the quality of life of the citizens. *Departamento Nacional de Planeación* (DNP, 2006)
Hierarchical Contractor Form	"A traditional network organization in which the primary contractor forms a partnership or hires a subcontractor (which compose the periphery of the network and may have their own subcontractor organizations) to produce the required product". (Hubert, 2011, p.145).
IS	Information System
IT	Information Technology
IT Capabilities	Functional capabilities that support core competencies and competitive strategies (Soh & Markus, 1995; Wade & Hulland, 2004). They are the result of IT resource development and deployment and have a cross-effect on business functions. They are multidimensional factors (Wang, Liang, Zhong Xue, & Xiao, 2012) which improve firm performance (Chan & Reich, 2007; Henderson & Venkatraman, 1993; Kearns & Sabherwal, 2006, 2007; Sabherwal & Chan, 2001). They are the means of promotion and development of human resources and relations with stakeholders (Wang et al., 2012). IT capabilities are part of the critical success factors (CSF) that contribute to the alignment of business functions with IT to support routine and business processes. Chan & Reich (2007). They cannot be traded or endorsed and, therefore, serve as the fingerprint of the organization based on their specific, rare, inimitable, and irreplaceable assets to the organization (Lioukas & Spanos, 2001).
IT Resources	Specific, rare, inimitable, and irreplaceable assets that allow implemented strategies to generate revenue (Barney, 1991 Makadok (2001) complimented this by specifying that resource structuring should be performed in a dynamic context taking into consideration acquisition, development, and retirement (divest) coherently with the rapid rate of technological advancements. IT resources do not solely refer to infrastructure given that IT human resource experts are included to support and overlook the business' activities (Powell & Dent-Micallef, 1997; Bharadwaj, 2000; Wade & Hulland, 2004; Zhu, 2004; Ravichandran & Lertwongsatien, 2005; Karimi, Somers & Bhattacherjee, 2007; Spanos & Lioukas, 2001)
IT Support for Competitive Strategies	Corresponds to the support provided by IT to companies when designing new ways to outperform their competitors (Porter and Millar, 1985). Technology aids in the creation and exploitation of novel opportunities in an innovative manner (Clemons et al., 2004). According to Wang et al. (2012), IT support for competitive strategies has three dimensions: IT support for innovation differentiation strategies, IT support for the market differentiation strategies, and IT support for low-cost strategies (Rivard et al, 2006).
IT Support for Core Competencies	Defined as the degree to which competencies are improved and developed upon by IT (Wang et al., 2012). According to Ravichandran & Lertwongsatien (2005), IT support for core competencies has three dimensions: (a) IT support for market access competencies, (b) IT support for integration skills, and (c) IT support for functionality-related competencies.
New Public Management (NPM)	The convergence of national regimes from a global viewpoint models the dynamic range of processes and results. NPM refers to the renewal of the public sector by means of the limiting of state government hierarchically-organized systems that transcend the boundaries of public and private sector, third parties, and the different levels of government (Hartley & Pedersen, 2008, p.328).

Physical Infrastructure (PI)	Encompasses a set of engineering structures, equipment, facilities, and durability which provide the basis upon which the provision of services to the productive sectors and households occurs. It is classified according to its function in a) economic infrastructure (transport, energy, and telecommunications); b) social infrastructure (dams, irrigation canals, potable water, sanitation, education, and healthcare); c) environmental infrastructure, recreation, and leisure; and d) infrastructure related to the transmission of information and knowledge. It can also be classified according to its geographical coverage such as, for example, local and international reach. (Perrotti, Sanchez, 2011, p. 29)
Process	Set of interrelated, resource-consuming activities with a fixed-term that transform inputs into outputs and milestones that constitute control (PMI, 2008 p.)
Products	"Final goods and services produced by the firm based on utilizing the competencies that it possesses". (Teece, Pisano & Shuen, 1997, p. 516)
Project	Formally organized set of processes that have a clearly defined focus and must be carried out within the constraints of timeliness, economic factors, and quality (PMI, 2008.)
Project Management Success	This focuses on the process of the project. In particular, it emphasizes the successful accomplishment of cost-related, time-constrained, and quality-related objectives. It also considers the manner in which the project management process was conducted (PMI, 2008.)
Project Management Institute (PMI)	A nonprofit organization consisting of professionals with half a million active members in 180 countries that generates standards for project management and globally-recognized certifications www.pmi.org (PMI, 2008)
RBT	Resource-based theory
RBV	Resource-based view
Social/National Competitiveness	The ability of a country to sustain and expand their participation in the commerce of international goods and services simultaneously to increase the income of its population (President's Commission on Industrial Competitiveness USA (Correa & Rosas, 2006, p.36)
Value chain	The chain of processes that a firm operating in a specific industry performs to deliver a valuable product or service to the market. (Porter, 1985)

Assumptions

The following are assumptions on which the study was based:

- Survey data is considered reliable.
- The respondents' answers accurately correspond to the conditions of the organizations for which they work.
- Given that the study is based on the projects, respondents were asked to provide information regarding their participation in the most recent project completed at the time of the survey.
- Instruments used in the study are deemed appropriate to the Colombian environment.

Limitations

The study was limited to consultations with professionals and directors who, at the time of the survey, were working for government entities and contracting firms located in Colombia. They voluntarily agreed to participate in the research of a cross-sectional study. Subsequent studies may be longitudinal in that they will permit the evaluation of IT effects on performance in other fields and environments. Given the data collect was through surveys, subjective evaluations could occur with a relative degree of bias.

Delimitations

The study is aimed at professional and directors of government entities and contracting firms operating out of Bogotá, Colombia, that maintain as their core business objective the development of physical infrastructure projects such as roads, transportation, healthcare, education, and housing. The unit of analysis is focused on the physical infrastructure project. Organization type (government or firm) and project manager traits were considered as moderator research factors. Many of the survey questions were adjusted to adapt the study to the context of the Colombian environment. Firm segmentation by core businesses was performed in accordance with the *Departamento Administrativo Nacional de Estadística* (DANE, 2016) and with the *Clasificación Industrial Internacional Uniforme* CIIU -2016, further detailed in Chapter 3.

The surveys were aimed at directors and managers with responsibilities related to planning, control, and IT support of physical infrastructure projects. The manager type (non-IT or IT) moderated the analysis. The independent variables, IT resources and IT capabilities, are formative constructs. The theoretical underlying mechanism is composed of two additional formative constructs, IT support for competitive strategies and IT support for core competencies. The dependent variable is physical infrastructure project performance, a formative construct with three items: schedule compliance, budget compliance (McCoy,

1986; Morris & Hough,1987; Pinto & Slevin, 1988; Turner,1993), and conformance to functional and technical specifications.

Summary

In approximately one-third of countries in the world, there is a gap in PI which negatively impacts its population and economic agents (Perrotti & Sánchez, 2011). An adequate level of PI and related services is the productivity platform of the economic agents and increases their social positions in relation to equity and sustainability (Rozas & Sanchez, 2004). Government actions should be strategically aimed to close this gap, extending efforts to deploy consistent strategies that promote the player's core competencies in the development of physical infrastructure. For this reason, the research involved government organization and contracting firms to describe how IT correlates with their management functions and how it may impact PI project performance. In this study, BVIT is a focal concept which has been the subject of a number of investigations in managerial and IS research. However, in accordance with the literature review, there exists no evidence of the application of the topics of both BVIT and physical infrastructure in conjunction with one another.

The study is quantitative and correlates two exogenous variables, IT resources and IT capabilities, with PI project performance as the endogenous variable. BVIT literature referred to the existence of an underlying mechanism between IT resources, IT capabilities, and firm performance, which is composed of the constructs of IT support for competitive strategies and IT support for core competencies that are included in this study's framework (Wang et al., 2012). The study integrated as part of its objectives the development of more mutually collaborative actions between governments and contracting firms. This idea, aligned with the social view described by Kogut & Zander (2003), generates economic and social benefits for society as a whole.

The following chapter presents the literature review which includes the management theories that gave way to the BVIT concept, among which are the resources and capabilities theory (Barney, 1991), the theory of resource orchestration (Sirmon, et al., 2007), RBV (Spanos & Lioukas, 2001), the theory of competitive strategies (71), the theory of core competencies (Hafeez et al., 2002; Hamel, 1994; Prahalad & Hamel, 1990), and the definitions associated with firm performance (Ravichandran & Lertwongsatien, 2005).

Chapter 2: Literature Review

This chapter describes the literature upholding research predominantly focused on management from a strategic perspective as a mechanism promoting firm performance. Research studies pertaining to strategy have two main focuses, that of sector analysis (Porter 1980) and that of resources and capabilities (Barney, 1991). These visions converge in such a manner that considers the strategic aspect as the primary driver that generates profit. Porter (1980) defined his model with five competitive forces and key success factors, while the resources and capabilities approach on the other hand, known as the resource-based view (RBV), directs its claims towards sustainable competitive advantages supported by the incorporation and accumulation of resources and capacities that adjust to changes in dynamic environments (Spanos & Lioukas, 2001).

The study, however, was mainly oriented by the resource-based view (RBV). Integrated within the conceptual design and construct definitions are elements from the competitive strategy theory (Porter, 1980,1985,1996), given that they are complimentary rather than exclusive (Rivard, et al., 2006). The historical evolution of the concept of the RBV strategy was initially presented by Penrose (1959) as a reference to the social vision of the firm. In this historical context, the main theories supporting the framework and the RQs were described primarily based on the relationships and interactions of resources and capabilities as drivers of the competitive strategies and core competencies, as well as their impact on firm performance (Ravichandran & Lertwongsatien, 2005). The research included BVIT as a convergent theoretical concept in which IT resources and IT capabilities are constructs that describe the strategic value of modern organizations. There are many studies that relate the relationship between IT and diverse professional fields, including different characters and analytical scopes. The literature review, however, contained no traces regarding IT and PI

projects involving government entities and contracting firms, rendering the study unique in this sense.

Documentation

The review of the literature and documents consulted was realized through the following primary sources: databases from the Centrum Business School, EBSCOhost, ProQuest, JSTOR, and Emerald. The main key words used were as follows: theory of resources and capabilities, IT value creation, BVIT, competitive strategy, core competencies, and firm performance. The selection of keywords was determined after an extensive bibliographic review, effectively making it possible to focus the searches precisely. Based on the themes and theories selected, a historical review was carried out and efforts were focused on incorporating the most recent studies into the research model, given that the topic of IT is relatively dynamic and in constant fluctuation. Consulted research included books, seminars, and articles, among other sources, but the largest proportion of literature that served as the primary research foundation were peer-reviewed papers included in specialized journals.

Literature Review

The purpose of the literature review was to obtain integral background knowledge to accompany the research. The most relevant aspects included being the review of theories around which the business strategy concept is based, as well as its progressive evolution, the operational mechanism of resources, the capabilities to construct and deploy competitive advantages of modern organizations, the BVIT concept, and the pertinent impacts on firm performance.

The literature consulted and incorporated into the research was organized from a historical overview concerning the evolution of the concept of strategy. This overview permitted the inclusion of theories on which the research is based in terms of framework, variables, relations between variables, and the methodologies used for empirical testing. The

second aspect incorporated into this review was related to resources and capabilities since these are the central variables of resource-based theories such as RBV and BVIT and also constitute the central theme of the research at hand. Three key aspects, which are outlined below, were included to provide conceptual support to the relationships and interactions of these constructs within the research model: (a) resources and capabilities associated with the concept of strategy, (b) boundaries and coincidences between resources and capabilities, and (c) the connections resources and capabilities have in relation to firm performance. The main theories upon which the research is based were included and subsequently referenced to regarding the research questions, the hypotheses, and the structuring of the measurement model. Finally, the discussion and conceptual association of each one of the research variables were also included.

Evolution of the strategy concept

According to management researchers, the strategy concept had its origins in the military field with ancestral references such as the Art of the War of Sun Wu, dating back to the fourth-century BC. The evolution of the concept indicates that there is no concrete definition of strategy since it depends on both the context and the exact decisions at stake (Grantt, 1996). Associated with the resources and capabilities approach, Quinn (1980) indicated that strategy is an organizational model that must consistently integrate objectives, policies, and actions to the extent that there is alignment between the strategy and the deployment of actions. Resources may be uniquely incorporated to enhance competencies and ameliorate deficiencies that will allow organizations to better rival their competitors.

The definition of strategy in the academic community had its origins in economy and is subsequently associated with the management discipline, specifically strategic management. In the beginning, each academic community kept its distance from the emphasis placed on the term strategy for two reasons in particular: first, because in the context of

economy, strategy aims to achieve the common good, effectively going against the companies' interests (Porter, 1981), and second, in economic theories an abstract image of the company is presented in a generalist concept without reflecting the underlying mechanisms. Nonetheless, since the 1960s both disciplines have converged and developed structural theories of strategy such as Porter's theory (1980) and Barney's theory of resources and capabilities (1991). Therefore, the relevant academic evolution of the strategy concept was developed in the twentieth century (Fong, 2005) and is continually being influenced by the development of IT given that it is considered a strategic variable of modern organizations (Wang et al., 2012).

In the recent historical context following the industrial era, pertinent research warned about the need to modify the strategy based around line production keeping in mind a long-term vision, that is to say, the bigger picture. Statements by Chandler (1962), Tilles (1963), and Ansoff (1965) came about concerning the definition of long-term forecasts. Additionally, the firm was defined as a unit of analysis in these studies, ultimately giving rise to the term corporate strategy. With the oil crisis in 1974, the long-term vision was influenced by the concept of flexibility. The volatile effects of the crisis obligated organizations to prepare themselves to adapt to rapidly changing environmental situations. Beginning with Ansoff (1965) and basing his ideas off economic analyses, Porter (1980) developed the theory of competitive strategy and pointed out that firm performance depends on three basic competitive strategies: differentiation, low cost, and focus. In this sense, the relationship between internal and external forces, in addition to relative positioning (benchmarking), were incorporated as determining concepts to sectorial analysis. He declared a firm's offensive and defensive actions as a postulate for competitive strategy to create sustainable competitive advantages and register them in a sector with the five acting forces, effectively analyzing how these factors, as a whole, impact firm performance. Additionally, this theory incorporated the

concept of value chain to describe the complex relationships between the organizations' groups and the extensive resources required for effective communication and coordination.

Diverging from the competitive advantage theory laid out by Penrose (1959), Nelson and Winter (1982), Wernerfelt (1984), and subsequently Prahalad and Hamel (1990), Mhoney and Polovian (1992), and Peterfaf (1993), among others, Porter (1980) stated that the strategy should be based on the internal configuration of the organization, that is to say, based on the correlation of resources and capabilities as drivers of firm performance. This new conceptual base gave resources and capabilities a predominant role in achieving competitive advantages in various aspects such as innovation, core competencies, replicability, reputation, etc., a concept defined as dynamic capabilities (Teece et al. 1997).

Bueno (1985) described the evolution of the general strategy theory, exhibited in Figure 2. In it, the diverse conceptual foundation theories that researchers adopted or combined to perform their studies are illustrated. The conceptual model of this research was based on the combination of the resources and capabilities theory (Barney, 1991) and the theory of competitive strategy (Porter, 1980, 1991). According to Barney (1991), resources and capabilities are independent variables that, when accumulated and deployed, impact internal competencies and facilitate the formulation and development of competitive strategies that impact firm performance. This theory recognized the existence of an underlying mechanism derived from the structuring of resources and the establishment of capabilities that, in turn, gives rise to core competencies and competitive strategies. According to Rivard et al. (2006), Porter's theory (1980, 1985) and the theory of resources and capabilities (Barney, 1991) complemented each other in the mechanisms derived from competitive strategies and in core competencies such as leveraging of firm performance.

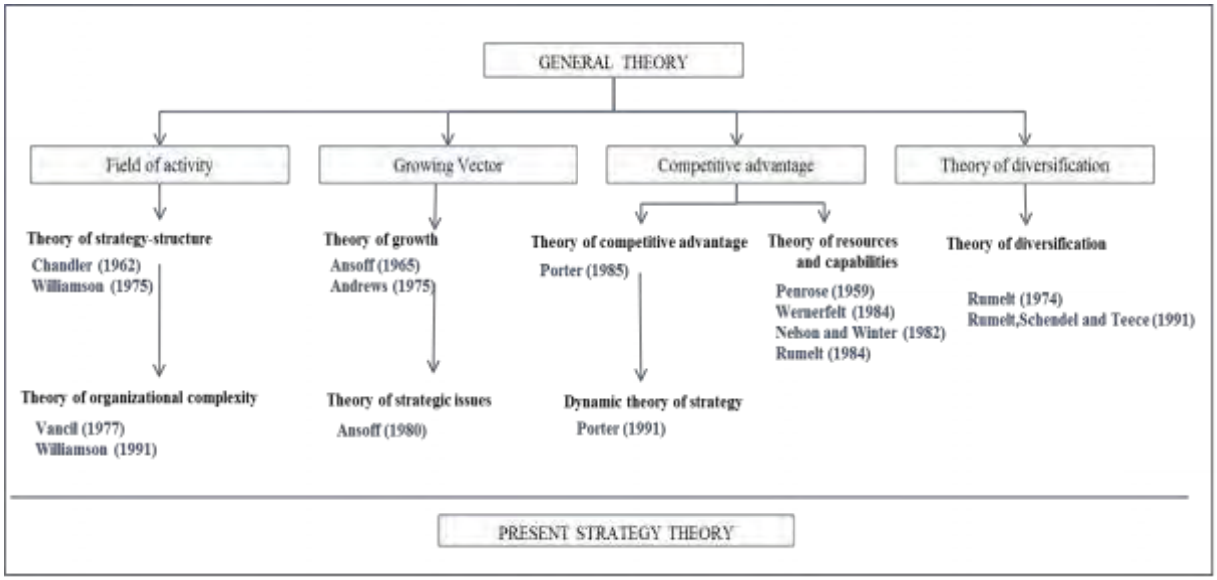


Figure 2. Evolution of strategy theory (Bueno, 1995).

Since resources and capabilities were the central elements of research, the academic evolution of these concepts and the way in which they integrate into the study is presented in the following sections

Resources and capabilities associated to strategy concept

Penrose (1959), a pioneer in the social and collaborative vision of organizations, is a reference in terms of the resources and capabilities theory with postulates that distance economic theories of the firm such as transaction costs (Coase, 1937). His contributions are still referenced to in current structure theories, mainly in the RBV, and highlight the following contributions:

- The physical resources accumulated by organizations, when interacting with competent individuals, develop into services that become productive operations. (In the context of Penrose's (1959) studies, the term "*services*" is interpreted as capabilities).
- Firms can be differentiated and are characterized by the heterogeneity of the resources they utilize.

- Criticizes the economic postulates of land, work, and capital, indicating that different combinations of non-explicit resources in the economy generate different types of resources.
- Defines the company as a collection of resources that generates income when acting under a normative and limited framework with efficient coordination.
- The accumulation of resources and the establishment of capabilities generate business capabilities that are visible in the organization's executives.

Based on the work by Selznick (1957), Andrews (1971) promoted the concept of core competencies, indicating that strategies can be deployed to generate internal competencies and competitive advantages when resources and capabilities are integrated in an effective and efficient manner. Furthermore, he defined resources as assets that are available and controllable by the organization and described the difference between physical, technological, human, and organizational assets, classifying them as either tangible or intangible. This converges with the theories of Penrose (1959) by indicating that resources and capabilities associated with core competencies define long-term strategies and are a dominant source of revenue.

Grantt (1991) criticized the competitive advantage theory (Porter, 1980) on the grounds of costs and differentiation, primarily due to three key features: (a) international competitiveness, (b) technological changes and advancements, and (c) changes in demand. First, Grantt (1991) indicated that the process of a firm's expansion is not performed within the same nuclear sector, but rather in distinct sectors. With this postulate, the competitive advantage theory is abandoned, leaving the diversification theory to become the aligning factor. Second, Grantt (1991) indicated that the competitive cost strategy is determined by the resources and capabilities theory given that the cost depends on the resources and their subsequent deployment. Third, Grantt (1991) indicated that the differentiation strategy

depends on capabilities such as culture, identity, cross-competencies, branding, technology, routines, client relationships, and distribution networks, among several others factors.

These arguments were equally associated with the postulates from the resource-based view RBV based on the heterogeneity of the firms. In this sense, each organization traces its results according to how it designs and implements the accumulation and deployment mechanisms of resources and the establishment of capabilities. To the extent that this orchestration is done in an organized and systematic way, organizations obtain irreplaceable internal capabilities that prove difficult to reproduce and become the source of creation for sustainable competitive advantages as well as superior performance (Barney, 1991; Conner, 1991; Wernerfelt, 1984). This vision recognized that the accumulation of resources does not suffice and that the role played by knowledge and technology is highlighted as transversal elements interacting in the strengthening mechanisms of core competencies and in the establishment and deployment of competitive strategies. When the organization is able to align its functional capabilities with IT, it may then understand, provide, synthesize, improve, and accelerate knowledge management to the interior of the organization and its stakeholders on a larger scale (Peppard & Ward, 2004; Wade & Hulland, 2004). In this respect, Teece et al. (1997) indicated that these competencies are the result of the accumulation and systematic combination of resources, routines, and knowledge that are conveniently transformed into collective learning capabilities and cross-competencies that are mainly in the dimension of intangible assets that must be flexible so as to rapidly accommodate to dynamic environments. A practical and summarized version of the role of resources and capabilities in strategic analysis was prepared by Grantt (1991) and is shown on Figure 3.

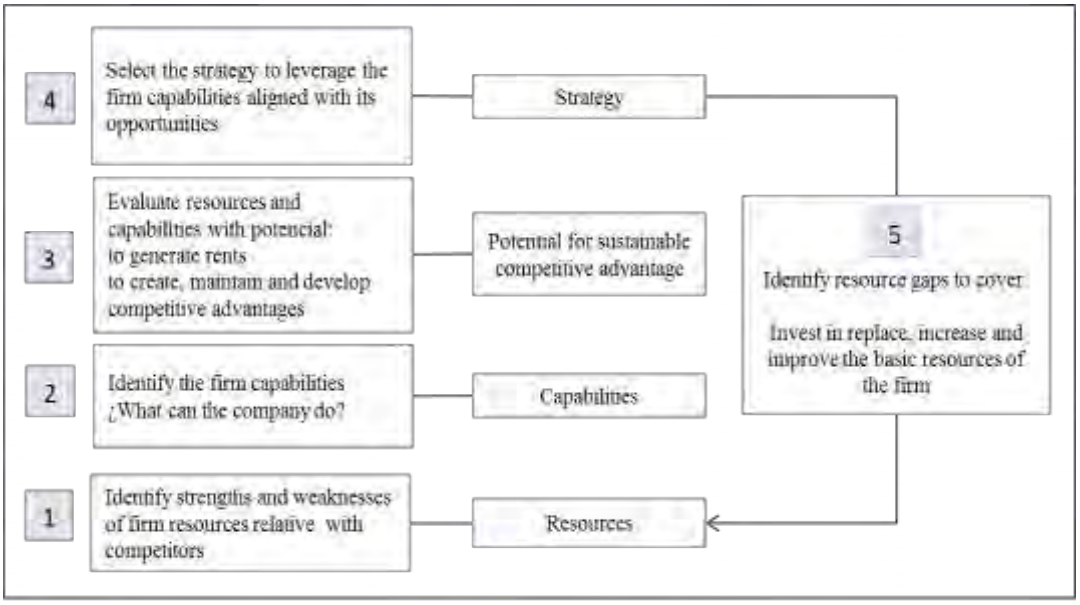


Figure 3. Theory of resources and capabilities - Practical framework (Grantt, 1991).

Within the research's framework, resources and capabilities are incorporated as independent constructs (Grantt, 1991) while recognizing that the literature warns of certain conceptual gaps in the determination of boundaries and relationships between resources and capabilities. These conceptual gaps will be the subject of the following section as an approximation to their coincidences and significant differences.

Boundaries and coincidences between resources and capabilities.

An ideal method of realizing the existence of strategic resources would be to consult the general statements. Unfortunately, these reports are centered on tradable assets that normally do not constitute themselves as being valuable, rare, and irreplaceable resources that contribute to core competencies and competitive strategies (Spanos & Lioukas, 2001). Therefore, this area of study only has a partial vision of the organization as a whole. Several authors such as Jacobson (1988), Hansen and Werrenfel (1989), Hall (1992), and Teece et al. (1997) included among these strategic assets personnel, branding, patents, reputation, client and supplier relationships, and the organization's overall culture. Faced with the difficulty of describing these aspects, the need for conceptual support arises. Following this need, the

following citations relate a conceptual benchmark between resources and capabilities with aims of describing these boundaries and coincidences. Concerning the relationship to resources, the literature indicated the following conclusions:

- Capabilities are associated with effectiveness and productivity. However, they are impossible to achieve without the necessary resources. (Dreirieck & Cool,1989).
- Resources can run out. In contrast, capabilities are built upon and further perfected through increased frequency in use (Dreirieck & Cool,1989).
- If capabilities depend on resources, that stands to reason that resources and capabilities collectively constitute the source of competitive advantage (Teece et al., 1997).
- The accumulation of physical resources by an organization develops into services that translate into productive operations when interacting with effective personnel (Penrose, 1959).
- Resources should be a cost-beneficial and flexible platform for the organization (Schwager, Byrd, & Turner, 2000).
- Resources should be adjusted to the business' needs (Peppard & Ward, 2004).
- Resources alone are rigid; their appropriate alignment is required to create or improve the firm's core competencies (Sabherwal & Chan, 2001).

Concerning capabilities as contributive elements to distinctive characteristics and competitive strategy, the literature indicated the following conclusions:

- Capabilities are provided by the aggregate of skills and organizational routines (Nelson & Winter, 1982).
- A distinct capability is based on the specific areas of an organization in which it outperforms its competitors (Selznic, 1957).

- A capability is determined by knowledge developed through replications (Kough & Zander). As Thomas A. Edison quoted, “Genius is 1% inspiration and 99% perspiration.”
- A capability is a set of relationships and connected interactions that contribute to an organization’s knowledge and learning capacity, from which the concept of memory firm is developed (Nelson & Winter 1982).

Given their own nature, resources and capabilities are considered in the literature as independent constructs. This definition coincided with the overall framework of the research. Some authors identified the grey area between resources and capabilities as a prominent source of inspiration for novel research (Wang et al., 2012). Nonetheless, the focal concern of the literature was to evaluate how resources and capabilities contributed to core competencies and competitive strategies, in turn generating revenue for the organization in question (Porter, 1980). Andrews (1971), based off the original work of Selznick (1957), included as part of his research the term core competencies to refer specifically to the interaction of resources and capabilities leading to the establishment and deployment of competitive strategies that impact firm performance. Several authors, referring to this construct and its implications on competitive strategies and firm performance, observed the following:

- The perfection of the use of resources and subsequent production of internal capabilities determines the competitive advantages denominated core competencies. Therefore, a gap in core competencies must be taken into account upon defining competitive strategies (Grantt, 1991).
- The integration of relevant knowledge, skills, and technology applied with the aim of successfully interconnecting resources and routines fosters the exchange of data and collective learning (Spanos & Lioukas, 2001).

- Capabilities should be measured through relative comparisons with companies in the corresponding sector to incorporate optimal practices and, in effect, create competitive advantages via their development (Porter, 1980).
- Skills and capabilities are considered resources that promote cooperation and coordination (Kough & Zander, 1992,1996,2003).
- Competitive advantages derived from core competencies depend on the degree of complexity of the relationships between resources and their interconnections. Competitive advantages will have a stronger possibility of being sustainable if these interconnections are more complex (Grantt, 1991).
- Competitive advantages are associated with the functional capability of producing new goods and services. (Pavlou & El Sawy, 2006).
- The integration of specialized IT personnel contributes to issue resolution, in turn having a positive effect on the strengthening and reinforcement of core competencies (Mata, Fuerst, & Barney, 1995).
- IT is an essential part of the critical success factors provided that it is aligned appropriately with the business and satisfies the firm's idiosyncrasy requirements (Chan & Reich, 2007).
- When IT capabilities are associated with the company's routines, they positively impact core competencies and competitive strategies (Garg, Walters, & Priem, 2003; Mithas, Ramasubbuand, & Sambamurthy, 2011; Willcocks, Feeny, & Olson, 2006).
- IT capabilities foster the learning process (Andreu & Ciborra, 1996; Montealegre, 2002).

One of the most powerful precepts of the RBV is that given by the relationship between competitive strategies and the other components of the model to achieve revenue.

The creation and deployment of competitive strategies must be associated with closing the organization's resource and capability gap, strengthening the existing core competencies, and establishing new core competencies that drive firm performance (Barney, 1991; Wang et al., 2012). The resources and capabilities theory (Barney, 1991) made explicit the relationships between firm performance and the construct of resources and capabilities by means of the underlying mechanism of core competencies and competitive strategies. This conceptual framework was preserved for the research model and becomes explicit in the both framework and the main research question.

Connection of resources and capabilities with firm performance.

According to the asset orchestration theory (Helfat, et al., 2007; Peteraf, 1993), the heterogeneity of organizations is evident in the respect that each one possesses different resources and capabilities and determines its own structuring of capability mechanisms. The impact on firm performance depends on the identification of the resources and capabilities that may have the potential of becoming competitive advantages, and in turn collectively promoting competitive core competencies. This gives competitive strategies a temporary dimension that considers whether to strengthen existing core competencies or generate new ones, ultimately proving beneficial in either situation. Core competencies have the potential of being more competitive when they are rare, difficult to reproduce, and irreplaceable (Hafeez et al., 2002; Hamel, 1994; Prahalad & Hamel, 1990). They are considered rare when they are unique, specialized, or non-transactional. They are considered difficult to reproduce when they are associated with complex relationships between resources, functions, multidimensional technologies, or depend on certain expert individuals in the organization. They are considered irreplaceable when they are completely immobile and associated with the organization's culture, idiosyncrasy, or crossed-competencies (Dietrich & Cool, 1989). The accumulation of these conditions in relation to resources, capabilities, and core competencies

can be leveraged with the deployment of strategies of competitive expansion toward new markets or the development of new products. (Teece et al., 1997). As Porter (1991) indicated, this implies a constant renovation of investments in resources and capabilities that allows covering the deficits generated in dynamic environments. To this end, Kough & Zander (1992, 1996) associated it with the knowledge creation and transference mechanism as the central axis of the organization's dynamic competencies. This specific consideration was what directed the current study to analyze the conceptual abstraction of the impact of IT on firm performance by means of IT resources and capabilities in such a way that said IT supports core competencies and competitive strategies, ultimately rendering IT as a source of sustainable advantages in modern organizations due to its knowledge development capabilities. When the organization is able to align its functional capabilities with IT, it may understand, provide, synthesize, improve, and accelerate knowledge management to the interior of the organization and its stakeholders on a greater scale (Wade & Hulland, 2004; Peppard & Ward, 2004; Prashant Kale, 2007).

Support theories

Using the references described in this first section of the literature review, it is crucial to refer to the RQ, "In organizations whose core is the development of physical infrastructure projects, is there a significant relationship between IT resources, IT capabilities, and project performance?", by means of comparison and application with relevant theories. The following sections consists of the main theories supporting this research, starting with the concept of IT value creation.

Business value of the information technology BVIT.

BVIT defines the degree to which the systematic use of IT improves the organization's performance in terms of achieving its objectives and obtaining a sustainable competitive advantage (Maoz, Fink, Pliskin, & Heart, 2007). BVIT is one of the key academic and

professional information systems (IS) (Kohli & Grover, 2008) to date. Academics have long recognized the existence of a consensus in which BVIT creates value and have determined several areas in which it may be manifested (Wang et al., 2012). Nonetheless, as indicated by Barney (1981), resources alone are static. Furthermore, in terms of IT, hardware and software by themselves do not create value. Regardless, both of these must constitute part of an organization's routines and mechanisms so they may collectively produce value (Melville, Kraemer, & Gurbaxani, 2004; Wade & Hulland, 2004). In a similar fashion, the existing BVIT mechanisms must be reinforced and renewed (Kohli & Grover, 2008). Figure 4 below illustrates the relationship between IT and a given value, exhibiting a sense of complementarity. IT, broken down into its constituent parts as hardware and software, cannot create value in isolation. On the contrary, they must constitute part of the value creation process for the business as well as other organizational factors that operate synergistically (Melville et al, 2004; Wade & Hulland, 2004).

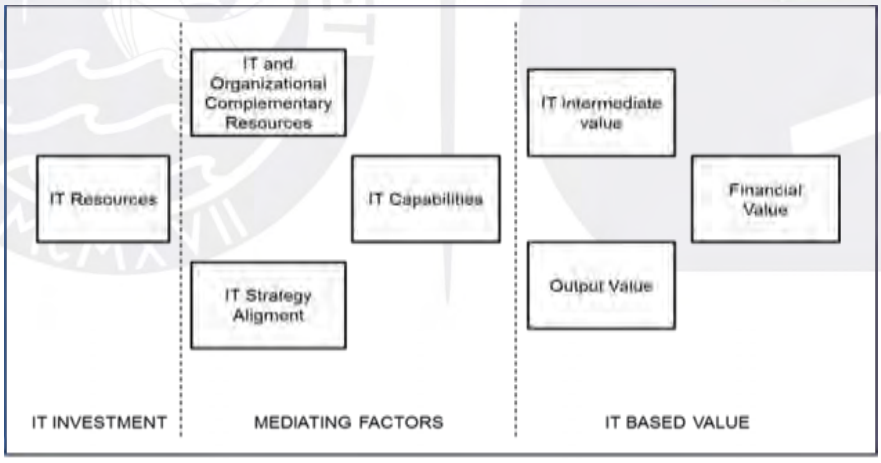


Figure 4. Model IT based value (Kohli & Grover, 2008).

Soh and Markus (1995), as illustrated in Figure 5, proposed a value creation model based on a theory of processes which describes IT impact as a foundation for the generation of additional value (Bharadwaj et al., 1999). In other words, the organization must have already achieved a state of intermediate profitability to move forward in this process. In order

for organizations to experience the corresponding impacts of IT, they must first verify the quality of their IT assets. Upon confirming this integral aspect, they must then place IT management in charge of properly converting IT expenditures into IT assets.

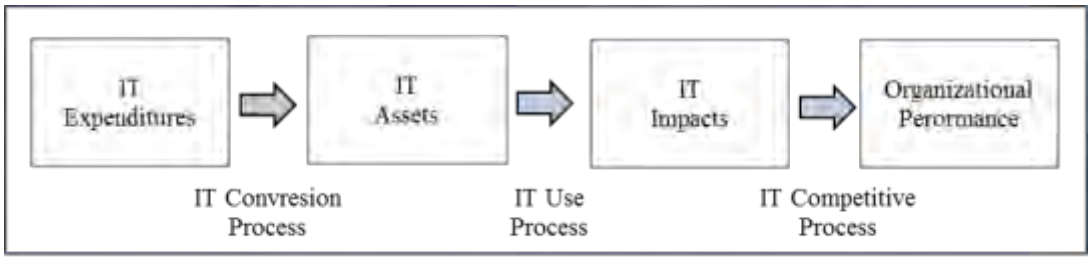


Figure 5. IT Creation business value model (Soh & Markus,1995).

IT investments interact with operational and strategic factors (e.g., organizational changes, additional resources, alignment, capabilities) to create value on different levels and in different types of organizational environments. Based on this concept, Henderson and Venkatraman (1993), as illustrated in Figure 6, proposed the strategic alignment model (SAM), describing the influences and effects observed between organizational strategy, IT strategy, organizational resources, IT resources, and their impacts on BVIT.

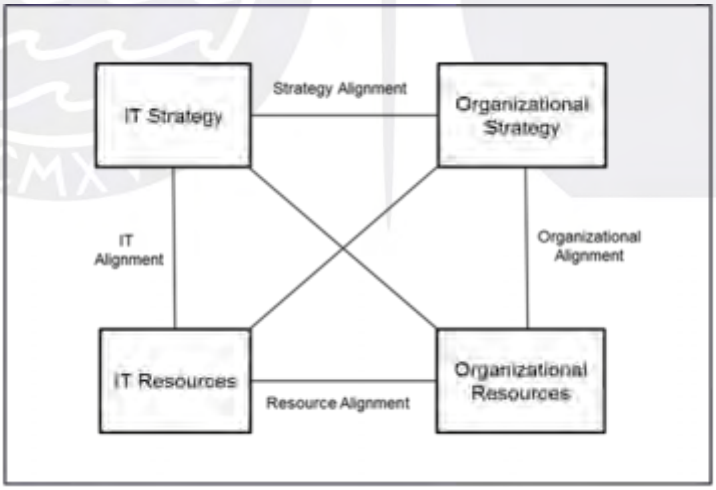


Figure 6. Strategic alignment model -SAM (Henderson & Venkatraman, 1993).

The Strategic Alignment Model's (SAM) framework facilitated the definition of BVIT through the analysis of multiple cause-and-effect relationships between organizational strategy, IT strategy, organizational resources, and IT resources. According to Wade and

Hulland (2004), the alignment of IT organization and feedback is a two-way process that is a mandatory prerequisite required to obtain and maintain BVIT.

Theory of resource orchestration.

Resource orchestration, a recent theoretical framework that integrates concepts of resource management, developed by Sirmon, et al. (2007), and the concept of the orchestration of assets, developed by Helfat et al. (2007), provided more precise knowledge on the role of managers in the structuring of resources for the company portfolio by grouping resources into capabilities and leveraging said capabilities to create value for customers (Sirmon, Hitt, Ireland, & Gilbert, 2010). The relevant corresponding components include managing resources, structuring the resource portfolio, pooling resources to build capacity, leveraging capabilities to create value for the customers, achieving a competitive advantage, and creating wealth for the proprietors (Sirmon et al., 2007).

The idea of asset orchestration derived from research on dynamic capabilities (Adner & Helfat, 2003) consisting of two main dimensions: search and selection followed by configuration and installation. A recent empirical study defines this logic as potentially promising (Sirmon et al., 2010). If capabilities depend on specialized assets, the relevant task at hand becomes more difficult with respect to coordination management. Management decisions should always take into account the optimal configuration of assets. Orchestration refers to two main principles: asset management research and the subsequent selection and configuration of resources and capabilities. The term orchestration is intended to convey that, given an optimal configuration of assets, the whole is more valuable than the sum of its individual parts (Teece et al., 2007).

Studies carried out on resource orchestration (Makadok, 2001) warned that the essence of resource structuring consists of more than just its collection, revealing the following key elements as crucial in this consideration: (a) acquisition, the process of buying resources from

strategic factor markets; (b) accumulation, the process of accruing internal resources; and (c) divestiture, the process of shedding the resources controlled by a firm (Sirmon et al., 2010).

Makadok (2001) provided two mechanisms efficient for creating economic income in organizations: the resource-picking mechanism and the capability-building mechanism. Under the resource-picking mechanism, administrators collect and analyze information to outsmart the rest of their competitors in the selection of resources. This is analogous to the way in which a mutual fund manager tries to outsmart market values in the selection of stocks. Under the capability-building mechanism, managers design and build organizational systems to improve the productivity of all the resources a company acquires. These two mechanisms related to the generation of income are not mutually exclusive and companies are likely to use both.

Resource based view – RBV.

This theory aims to explain performance differences among firms. At its base, the argument was that the creation of value through resources and capabilities is heterogeneously distributed among firms, opening the possibility of above-average returns. The distribution of resources and capabilities can remain heterogeneous due to flaws in the factor markets, the scarcity of resources, and the uncertainty of strategic duplicability (Barney, 1991). One of the key assumptions of the RBV is that the presence of strategic resources is sufficient to establish the potential for a competitive advantage since there is a direct relationship between resources and performance (Tywoniak, 2007).

The RBV theory, including both resources (or assets) and capabilities in its assessment, broadly defined specific assets as those which are rare, duplicable, and irreplaceable in the company. These assets allow a company to implement a value-creation strategy to generate income (Barney, 1991). On the contrary, according to Amit & Schoemaker (1993), tradable resources are classified as non-specific within a company's

assets. Capabilities are non-tradable and correspond to specific business skills with the aim of integrating, deploying, and efficiently using other resources within the company. In this sense, whereas resources are the input of the production process, capabilities refer to the ability to deploy these resources using the organization's methods and processes. The key feature of the capability-detached view of resources is that capabilities cannot easily be purchased in an external market, but are embedded within the organization's framework and must be developed upon over time (Wang et al., 2012).

Core competences theory.

The core competencies theory states that internal firm capabilities are valuable, rare, difficult to reproduce, and irreplaceable, constituting a potential source of competitive advantages (Wang et al., 2012). A company's core competencies are the primary source of sustainable competitive advantages and are usually the result of "collective learning," being manifested through activities and processes within the organization. The core competencies theory centers itself on the unique capacities that usually encompass multiple products or markets. In comparison with the theory of resources, this approach emphasized the development of long-term success strategies within the competitiveness of a company (Hafeez et al., 2002). A core competency provides potential access to a wide variety of markets while simultaneously being difficult to imitate by competitors due to the complexity of replicating individual technologies, production skills, and a similar organization of activities and value creation (Prahalad & Hamel, 1990).

Competitive strategy theory.

The competitive strategy theory indicated that external factors such as market structure play a central role in determining competitive advantage and business performance (Wang et al., 2012). Competitive strategy refers to the deliberate selection of a set of activities that effectively deliver a unique combination of value-generation. Strategic positioning seeks to

obtain sustainable competitive advantages by preserving what is distinctive and unique about a company. In this sense, it refers to performing different activities from its competitors or performing similar activities in novel ways. Additionally, Porter (1980) introduced the concept of generic strategies, also known as strategies of cost, a differentiation focused on representing the alternative strategic positions within an industry. Generic strategies remain useful to characterize strategic positions at the broadest level.

Variables

Based on the theoretical view, the research model included the following variables: two independent variables, IT resources and IT capabilities, and one dependent variable, project performance. Based on the RBV theories, the research study included the moderator effects of the underlying mechanism made up by two constructs, IT support for core competencies and IT support for competitive strategies, in the analysis. In the following sections, each variable is described in terms of their respective conceptual support.

IT resources.

IT resources are defined by Wang et al. (2012) as assets that are widely available and feasibly purchasable on the market. Pham and Jordan (2009) mentioned that the RBV has been widely discussed in literature and considered organizations as sets of resources and capabilities. Upon examining the link between the resources of a business and the preservation of competitive advantages, Barney (1991) formulated two general assumptions. First, that resources are heterogeneously distributed across competing firms. Second, that the resources of the firms are imperfectly mobile. Differences in firm performance are driven primarily by their unique resources and capabilities. According to the RBV theory, resources have been studied in the field of IT since the mid-1990s, though much of the research sought to identify and define a single IT resource or set of IT resources (Wade & Hulland, 2004). This view has been frequently studied in the field as IT resources and IT capabilities

(Bharadwaj, 2000; Mata et al, 1995; Ravinchandran & Lertwongsatien, 2005; Ross, Beath, & Goodhue, 1996).

According to Pham and Jordan (2009), there are three commonly discussed IT resources: (a) IT infrastructure (Bharadwaj, 2000; Bhatt & Grover, 2005; Mithas et al, 2008; Peppard & Ward, 2004; Ravinchandran & Lertwongsatien, 2005 Ross et al, 1996), (b) IT human resources (Bharadwaj, 2000; Bhatt & Grover, 2005; Mata et al., 1995, Peppard & Ward, 2004; Ravinchandran & Lertwongsatien, 2005; Ross et al, 1996); and (c) IT partnership (Bhatt & Grover, 2005; Feeny & Willcocks, 1998; Peppard & Ward, 2004; Ravinchandran & Lertwongsatien, 2005; Ross et al, 1996).

Based on previous studies, especially Wang et al. (2012), this study included IT resources as a formative construct with four main components that support core competencies and competitive strategies: (a) tangible resources, including IT infrastructure such as hardware, software, networks, and data, (b) human-related technical IT resources, (c) human-related managerial IT resources, and (d) relational IT resources.

IT capabilities.

IT capabilities correspond to the ability to run stable and repeatable patterns of IT management activities (Agarwal, Shah & Haywood, 2006). According to Mithas et al. (2011), IT capabilities can be classified into three main categories: (a) process integration capabilities such as entrepreneurial, operational, and renewal IT, (b) market orientation capabilities such as customer-oriented, vendor-oriented, and competitor-oriented IT, and (c) strategy and IT vision alignment capabilities.

IT-related capabilities in this study were defined as the capacities to effectively mobilize and deploy resources to develop strategic planning and effectively manage IS functioning and IT assets (Wang et al., 2012). IT capability is a multidimensional concept, and therefore stands out as a complex construction. Previous research highlighted four IT

capabilities: (a) IT strategic planning, (b) IT development, (c) the utilization of IT, and (d) IT management. These elements are unique in that they are non-tradable, which stands to reason that IT capabilities represent a strong footprint with specific and unique attributes in relation to a company's processes.

IT support for competitive strategies.

Companies must generate and develop new strategies using their IT resources for competitive reasons (Karimi et al., 1996). First, to create competitive advantage by providing companies with new ways to outperform their competitors (Porter & Millar, 1985). Information technology (IT) continued to play a key role in the creation and exploitation of opportunities for innovative competitive strategies (Clemons et al., 2004). Miles and Snow (1978) postulated that competing firms within an industry exhibit patterns of behavior representative of four basic competitive strategy types: (a) defenders, (b) prospectors, (c) analyzers, and (d) reactors (Karimi et al., 1996). Mithas et al., (2011) commented that, while a number of studies have supported the typology created by Miles and Snow (1978), some studies argued that it should be extended to permit the inclusion of new strategies that contemporary organizations would benefit from following. Thus, the analyzer and defender classifications have been divided into two respectively, resulting in the following additional classifications: low-cost defender, differential defender, innovative analyzer, and non-innovative analyzer.

IT support for competitive strategies is a second-order formative construct consisting of three first-order reflective constructs: (a) IT support for innovation strategy, (b) IT support for the strategy of market differentiation, and (c) IT support for low-cost strategy, whose measures were adapted from Rivard, Raymond, & Verreault (2006). According to Wang et al. (2012), IT support for competitive strategies have three distinct dimensions: (a) IT support for innovation differentiation strategy, (b) IT support for market differentiation strategy, and (c)

IT support for low-cost strategy (Rivard et al., 2006). The innovative differentiation dimension refers to the extent of IT use in improving the capability of new product development, shortening innovation cycles, and facilitating business process innovation. The market differentiation dimension refers to the extent to which IT is used to enrich marketing strategies, enhance sale capacity, and identify unfulfilled requirements. The low-cost dimension refers to the extent to which IS is used to decrease the cost of inventory, purchase expenses, and customer service (Wang et al., 2012).

Taking into account the aforementioned concepts along with the overall research focus, IT support for competitive strategies was determined by the project dimension denominated product success (Baccarini, 1999), corresponding with the following elements: (a) IT support for the integrity of completion as a strategy associated with product success in virtue of the absence of post-project hindrances, the quality of post-audit analysis, and the identification of technical problems during the project in conjunction with their solutions (Freeman & Beale, 1992); and (b) IT support for the stakeholders' satisfaction, a factor aimed at improving the effective coordination and relation patterns between project stakeholders during the project cycle (Baker, Murphy, & Fisher, 1988).

IT support for core competencies.

IT support for core competencies was defined as the degree to which IT was used to improve and develop core competencies (Wang et al., 2012). According to Ravichandran and Lertwongsatien (2005), IT support for core competencies has three dimensions: (a) IT support for market access competencies, (b) IT support for integration competencies, and (c) IT support for functionality-related competencies. Agarwal (2006) referred to the use of research, customer analysis, and the identification of a potential customer base as crucial elements to this process. Expanding on these elements, Amit and Schoemaker (1993) referred to the re-engineering of business processes, their improved flexibility, and support for the efficient

integration of the firm's supply chain. Anderson and Gerbing (1998) emphasized the resulting efficiency related to speeding up critical business processes. IT support for core competencies allows companies to maintain their market position and increase business earnings. Ravichandran and Lertwongsatien (2005) declared that the variation of IT impact on firm performance is determined by the degree to which IT is used to support and enhance core competencies, as illustrated by their model below in Figure 7. Firms that direct IS initiatives toward their core competencies are more likely to extract greater value from their IS assets than those that are less focused on IT deployment (Ravichandran & Lertwongsatien, 2005).

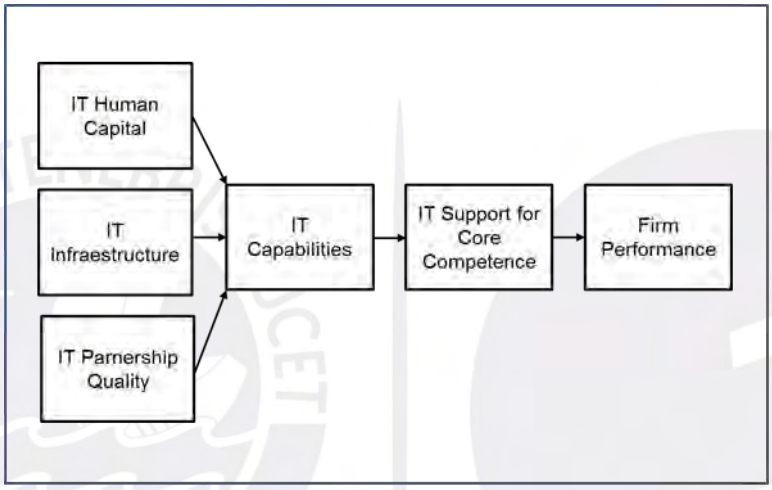


Figure 7. Ravichandran and Lertwongsatien model (2005).

IT can improve the efficiency and effectiveness of core competencies, expand their scale and overall scope, increase the cost and difficulty of imitation, and help realize the full potential of their strategic competitiveness. According to Ravichandran and Lertwongsatien (2005), it is possible to model the effect IT support for core competencies has on the improvement of firm performance based on IT capabilities.

Following the core competencies theory and the statements made by Ravichandran and Lertwongsatien (2005), IT core competencies have a strong development potential when IT supports internal capabilities that impact firm performance in three notable dimensions: (a) IT support for market access, (b) IT support for integration, referring specifically to the

integration of performed competencies, and (c) IT support for related-functionality, the act of adapting IT to the business' critical processes. For the purposes of this research, the construct referred to as IT support for core competencies included three dimensions focused on the project management process (Baccarini, 1999): (a) IT support for resource efficiency. As the elements oriented to anticipate all project requirements, having the sufficient amount of resources to meet project needs in a timely fashion, and using said resources efficiently to accomplish the relevant task at hand, is the most crucial factor of this dimension (Tuman, 1986); (b) IT support for effective coordination. This practice is aimed at the effective coordination between team projects to produce more efficient practices and processes, increase team spirit, and promote participative decision-making (Baker et al., 1988); and (c) IT support for scope preservation. This final dimension is oriented at minimizing scope changes by preventing potential disturbances to the organization's workflow and corporate culture.

Project performance.

The conceptual basis of project performance refers to a fundamental and integral dimension of firm performance. Ravichandran and Lertwongsatien (2005) postulated that firm performance can be described in two dimensions: (a) an operational dimension, and (b) a market dimension. Operational performance refers to productivity, profitability, and financial indicators, whereas market performance is defined as the capacity and subsequent success of a firm in entering new markets and producing new goods and services for the market. In the research carried out by Ravichandran and Lertwongsatien (2005), firm performance was measured by the respondent's assessment of the firm's performance during a three-year period ranging from 1997 to 1999 based on two distinct factors: (a) operational performance and (b) market-based performance. Operational performance was measured using a four-item scale that assessed the extent to which profitability, productivity, and financial performance

exceeded that of their competitors over the past three years (i.e., 1997-99). Market-based performance was measured using a three-item scale that assessed the success of the firm in entering new markets and producing new good and services for the market over the past three years.

Wang et al. (2012) made an adaptation of the model by Ravichandran and Lertwongsatien (2005) by measuring firm performance through perceptions or interpretations of the results. Through this, it has been noted that subjective performance measures are often highly correlated with objective performance measures, a methodology that has been used in previous studies and effectively applied to the strategic management of Information Systems (Capon, Farley, Lehmann, & Hulbert, 1992; Ravichandran & Lertwongsatien, 2005).

Between 1990 and 2009, Liang et al. (2010) reviewed 50 published studies on using RBV to investigate whether IT enhances firm performance using the model presented below in Figure 8. They discovered that the use of the resource-based model to investigate the relationship between IT and firm performance in IS research has been inconclusive when the research model does not include organizational capabilities. The indirect effect model, which describes organizational capabilities as mediators between organizational resources and firm performance, can better explain the value of IT than the direct effect RBV model, which does not include organizational capabilities in its framework. Furthermore, technological resources have been found to significantly improve organizational capabilities.

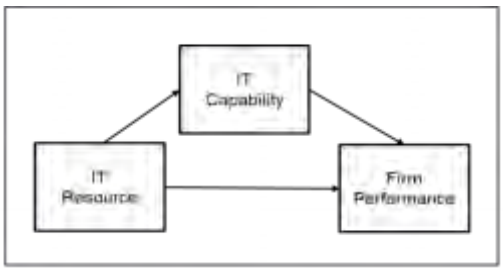


Figure 8. Framework for exploring resource-capability-performance relationship (Liang et al., 2010).

Further studies conducted to measure firm performance include those by Spanos and Lioukas (2001) and Rivard et al. (2006). Spanos and Lioukas (2001) revised the relative impact of industry and firm-specific factors on sustainable competitive advantages as illustrated below in Figure 9. The model used is compounded by the two following frameworks: Porter's framework of competitive strategy and the more recent resource-based view (RBV) of the firm. Empirical findings suggested that, although industry and firm-specific effects are essential, they each describe different dimensions of performance. Whereas industry-specific forces influence market performance and profitability, firm assets act upon accomplishments in the market arena (i.e., market performance), and thereby, on profitability. The study concluded with suggestions for future research that will seek to integrate both content and process-related aspects of firm behavior.

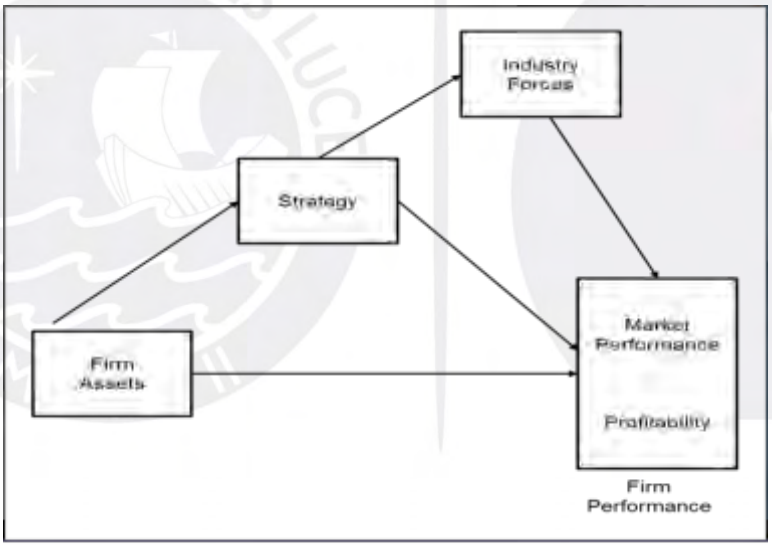


Figure 9. Spanos and Lioukas Framework.

The findings by Rivard et al. (2006) are based on the framework shown below in Figure 10, which has implications for both research and practice. In terms of research, the first implication is the importance of examining the contributions of IT to business performance by building upon the complementarity observed between the resource-based view of the firm and the competitive strategy view. Indeed, while researchers have examined the impact of IT

support on business strategy and of IT capabilities on business performance, this is the first study of its kind to include both effects.

This study is based on a model proposed by Spanos and Lioukas (2001), which comprises both a competitive strategy framework and the resource-based perspective, and is adapted to reflect the role played by IT. More precisely, the model encapsulates the effects of both IT support for business strategy and IT support for assets on firm performance (Figure 10).

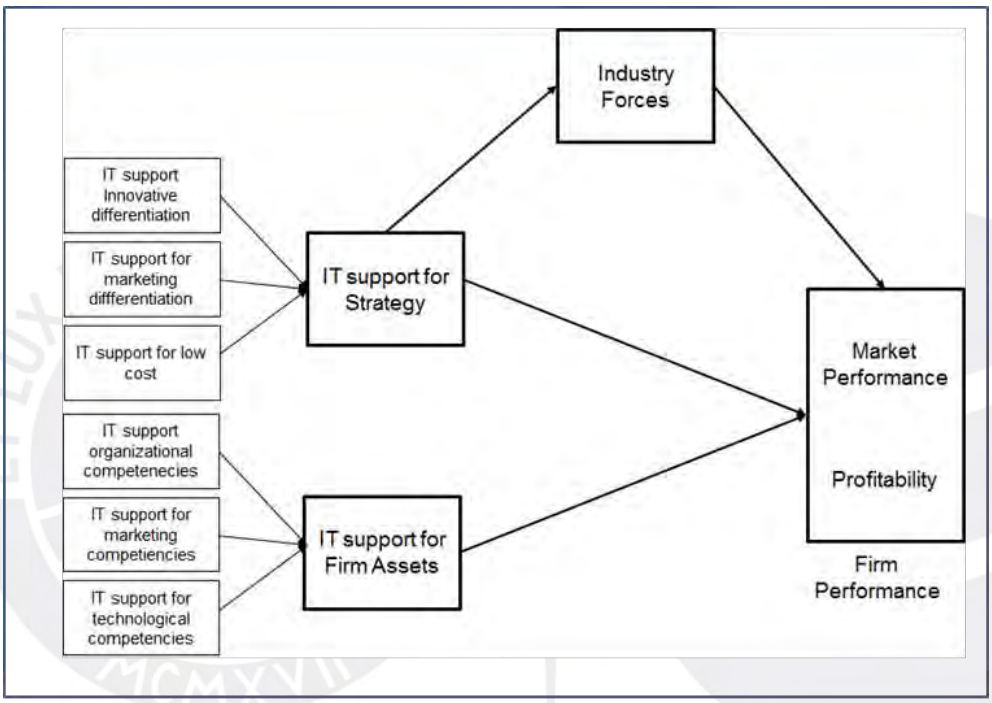


Figure 10. Rivard, Raymond and Verreault framework.

The results obtained in this study suggest this is a promising direction for the research in question. For practitioners, the results reinforced the strategic importance of the roles played by IT in explaining business performance. Not only can IT be used to implement competitive strategies, but they can also be used to support a firm's capabilities by contributing to the formulation and implementation of such strategies and directly contributing to a higher level of performance (Peppard & Ward, 2004).

Summary

The academic literature concerning corporate strategy has been linked with other sciences and disciplines and has seen its own development since the mid-twentieth century. These observations are reflected in the following strategy theories: the theory of competitive advantage, the theory of resources and capabilities, and the theory of diversification (Bueno, 1995). IT evolution has been refined by the globalization process and the increased rate of IT development. As a result of high volatility, the theory of resources and capabilities and the RBV are among the prevailing theories related to social vision. They include intangible assets such as the rudiments of core competencies and became key factors in the preservation of competitive advantages in dynamic environments. These concerns constituted the main conceptual background of this research.

Penrose (1959) stands out as one of the pioneers of RBV, along with Nelson and Winter (1982), Wernerfelt (1984), Kough & Zander (1992), and Teece et al. (1997), among others. A notable factor within the literature review was the academic convergence observed at the end of the 70s between the economy and management. This convergence gave place to the strategic structural theories, Porter's theory (1980), and the theory of resources and capabilities (Barney, 1991). These theories played an important role in academic background debates and contributed to the development of new strategy views such as resource orchestration (Sirmon et al., 2007), asset orchestration (Helfat et al., 2007), and the studies carried out by Spanos and Lioukas (2001).

The evolution of the strategy concept has been refined by IT development and is considered a high impact component in management processes. IS theoretical evolution had an analogous path with management due to combinations and links between IT resources and capabilities that were important components in the generation of revenue in modern organizations. The theoretical valuations of IT mechanisms that generate value were

incorporated in this study using the contributions by Ravichandran and Lertwongsatien (2005), Porter's postulates, the resource-based view described by Rivard et al. (2006), and the relationships between competitive strategies and firm performance formulated by Capon et al. (1992).

The conceptual basis of PI project performance was based on firm performance in the operational dimension (Ravichandran & Lertwongsatien, 2005) under the project management success dimension. This was defined by the literature by means of three integral variables: schedule compliance, budget compliance (McCoy, 1986; Morris & Hough,1987; Pinto & Slevin, 1988; Turner,1993), and conformance to functional and technical specifications (Baker et al., 1988; Morris & Hough, 1987; Turner, 1993).

Conclusions

The dynamic environment and consistent interconnection has rendered organizations more complex and specialized with growing needs for coordinated operations and communications (Teece et al., 1997). This competitive environment imposed on organizations the need to preserve competitive advantages and obligates them to incorporate permanent resources and develop special capabilities to effectively supply the deficits generated by this dynamic condition. In this context, one of the prevailing strategic theories was the resource-based view, which is closely linked to the resources and capabilities theory, resource orchestration (Sirmon et al., 2007), asset orchestration (Helfat et al., 2007), and the studies carried out by Spanos and Lioukas (2001). Given that the research was aligned with this vision, the literature review oriented its developmental strategy and the achievement of the following objectives:

1. To understand the coincidences between resource-based theories when they postulate when an organization systematically accumulates and deploys resources, generates capabilities, and when these resources and capabilities

impact firm performance. (Nelson & Winter,1982; Penrose, 1959; Peterfaf, 1993; Prahalad & Hamel, 1990; Wernerfelt, 1984). This concept permitted the structuring of the main research focus with the correlation between IT resources, IT capabilities, and PI project performance. The research questions and the design of the empirical test arose from these conceptual bases.

2. Different authors agree on the existence of an underlying mechanism which has a mediating effect on the relationship between IT resources, IT capabilities, and performance. From this concept, the constructs referred to as IT support for core competencies and IT support for competitive strategies were included in the research model to measure their direct and total effects on project performance (Barney,1991; Chan & Reich, 2007; Henderson & Venkatraman, 1993; Kearns & Sabherwal, 2006, Sabherwal & Chan, 2001; Soh & Markus, 1995).
3. To understand that the impact on performance is given from a holistic relationship between IT resources, IT capabilities, IT support for core competencies, and IT support for competitive strategies. (Soh & Markus, 1995; Wang, et al., 2012). This concept permitted the selection of the statistical methodology used, partial least square – structural equation modelling (PLS-SEM), which will be described in detail in Chapter 4. Its conceptual foundation is to determine the strength of the relationships between the constructs and the predictive capacity of the research model. (Hair et al.,2014).
4. To define a unit of analysis consistent with the research focus and the statistical methodology adopted. The literature review established the project as the prime unit of analysis. Given that the project is defined by a specific period of time, the research was considered cross-sectional.

5. To explore previous research postulates concerning the incomplete boundary between both resource and capabilities. The research lent a better understanding of the individual and collective effects of these two constructs in relation to PI project performance. (Saraf, Langdon, & Gosain, 2007).
6. To understand that IS researchers continue to support their studies in resource-based views such as BVIT, in spite of the consideration of the field of IS as being dynamic. The literature review also led to the understanding that the dynamic environment is described by the different ways in which organizations structure their resources and deploy their capabilities, in turn preserving the conceptual dimensions of IT value creation oriented by the BVIT concept.
7. To verify the best project management practices and recognize project management success as one of the main performance dimensions in terms of cost, time, and quality-based objectives. This was the conceptual base to define the components of the endogenous variable (Baccarini, 1999).
8. To identify any and all possibilities and potential benefits of future research projects.
9. To avoid repeating studies previously carried out by other researchers.

The literature review permitted the incorporation of a theoretical model that relates IT to the performance of PI projects by means of a quantitative methodology presented in further detail in the following chapter.

Chapter 3: Method

This is a quantitative and cross-sectional research study focused on measuring the relationship between IT resources and capabilities as independent constructs with project performance as the dependent construct with the aim of understanding how IT functions in terms of creating value in physical infrastructure (PI) project performance. The research was also oriented at understanding how the underlying mechanism functions and interacts with IT support for core competencies and IT support for competitive strategies in PI project performance and what effects it has on the structural model provided by the concept of BVIT (Barney, 1991; Wang et al., 2012). In order to systematically develop the study and direct it toward the fulfillment of the goals proposed, this chapter outlines the research design criteria, the instruments utilized, the procedures for data collection, the confidentiality conditions, the sample size criteria, the survey features, and an overview of the issues related to validity and reliability that may affect research.

Research Design

Previous research studies based on the concept of value creation from IT functions were carried out using quantitative methods. These investigations suggested preserving the same methodology and using the same instruments already developed and empirically tested for future studies. Taking into account the alignment of the research with the concept of BVIT, the quantitative methodology was preserved. This research specifically indicated that "Subjective measures have been found to be highly correlated with objective measures and have been used in many previous IS and strategic management studies" (Wang et al., 2012, pp. 339-340).

The data was collected first-hand through surveys (Wang et al., 2012) to achieve the academic protocols for peer review and was directed to professionals and directors who, at the time of the survey, were working in government entities and contracting firms located in

Bogota, Colombia, whose core business was the development of physical infrastructure projects.

According to Figueroa (2012), Karl Popper's epistemology was applied in conjunction with the alpha-beta method, which states that scientific knowledge is achieved through an inductive logic process by means of the collection and processing of information built on a conceptual framework. Based on this idea, a process diagram relating the exogenous variables with the endogenous variables is illustrated below in Figure 11. (Wang et al., 2012).

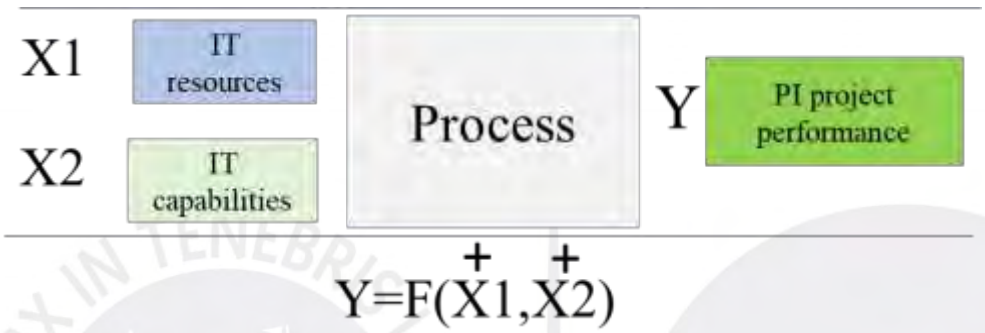


Figure 11. Research process diagram alpha-beta method (Figueroa, 2012).

According to the Popperian epistemology (Figueroa, 2012), the following sequence was used to associate the alpha and beta propositions present in the research study's development:

1. Alpha proposition for the diagram of the proposed process:

   α: "Organizations seek to improve their projects performance"

   This proposition is supported by the corporate strategy theories described in chapter 2. For the study's focus, it is based on Ravichandran and Lertwongsatien (2005), who indicated that firm performance is measured by the operational and market dimensions. Project performance corresponds to the operational dimension and is the endogenous variable.

2. From the alpha proposition, the following beta propositions were established:

   Based on the theory of resources and capabilities (Barney, 1991) the

exogenous variables (Wang et al., 2012), IT resources and IT capabilities, are linked with the endogenous variable, firm performance, as follows:

β1: "Structuring IT resources impact positively the PI projects performance"

β2: "Building IT capabilities impact positively the PI projects performance"

IT resources constitute a formative construct composed of IT infrastructure (Bharadwaj et al., 1999; Schwager, Byrd, & Turner, 2000), technical IT resources (Dehning & Stratopoulos, 2003), managerial IT resources (Ravichandran & Lertwongsatien, 2005), and relational IT resources (Bharadwaj et al., 1999; Ravichandran & Lertwongsatien, 2005). IT capabilities constitute a formative construct composed of strategic planning (Bharadwaj et al., 1999; Ravichandran & Lertwongsatien, 2005), IT development (Tiwana et al., 2003), IT use (Pavlou & El Sawy, 2006), and IT management (Tiwana et al., 2003).

The following propositions were derived from the variables contained within each construct:

β_{11}: "IT infrastructure impacts positively the PI project performance"

β_{12} : " Technical IT resource impacts positively the PI projects performance"

β_{24} : "IT management capability impacts positively the PI project performance"

3. Validation of the β propositions from the data observed:

According to the process diagram, the following expression arises:

Y= f (X1, X2); Where

Y= Project performance

X1= IT resources

X2= IT capabilities.

In terms of β propositions the expressions are:

≅y= βo1+β1 for the firm performance and IT Resources association; where

βo1: Means constant coefficient

β1: Coefficients

≅y= βo2+β2 for the firm performance and IT Capabilities association; where

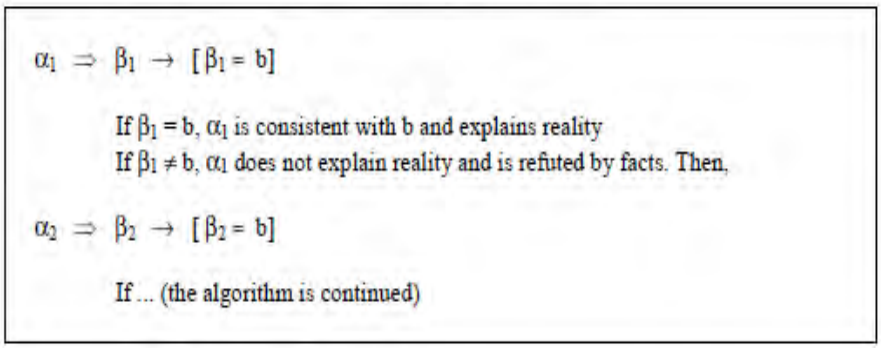
βo2: Means constant coefficient

β2: Coefficients

According to Figueroa (2012 p. 21), the application of the alpha-beta method is given by:

"The alpha-beta method is represented diagrammatically in Figure 2.2. From the set of alpha propositions α1, the set of beta propositions β1 is logically derived (indicated by the double arrow). The set β1 must then be subject to statistical testing (indicated by the single arrow). While the double arrow indicates logical inference, the single arrow indicates operational procedure, or the task to be performed. Statistical testing of the theory (indicated by the symbol ≈) implies seeking a statistical conformity between beta propositions and the available set of statistical relations or associations between endogenous and exogenous variables, the set **b**. If statistically (not mathematically) β1=**b**, then α1 is consistent with reality, and there is no reason to reject the theory at this stage of the research, so we may accept it provisionally until new empirical evidence or new theories arise. If β1≠**b**, then reality refutes the theory α1, and another theory α2 should be developed; thus, the algorithm is continued.1"

Figure 2.2 The Alpha-Beta Method



The exogenous and endogenous variables of the model are formative constructs detailed in the variables section. With the application of the alpha-beta method, the information obtained from the (b) surveys were compared to the β propositions. If the set of α propositions is consistent to b, then it may be deduced that β=b, and therefore explains reality. On the contrary, if β≠ b, the set of α propositions does not explain reality and is refuted by factual evidence.

4. The model was based on the following assumptions (a) the relationship between variables is linear, (b) the sample is obtained through a random mechanism.

Given that the research model incorporated interaction effects and formative constructs, *partial least square path modeling PLS-SEM* was applied for the data analysis due to its capacity to simultaneously estimate the dependencies and relationships of the constructs and sub-constructs (Hair, Black, Babin, Anderson, & Tatham, 2010).

Appropriateness of Design

This study was founded on the theory of resources and capabilities which provides a conceptual base used by authors in diverse fields of knowledge. The theoretical framework (Barney, 1991) and the framework of the study performed by Wang et al. (2012) were preserved. According to the process diagram (Figure 11) and based on the application of the alpha-beta method (Figueroa, 2012), IT resources and IT capabilities as exogenous constructs have a cause-and-effect relationship with project performance (dependent variable). Based on Wade and Hulland (2004), a static environment was not considered in this research study. These authors indicated that, independent of the performance environment, be it stable or dynamic, organizations must preserve efficiency in a dynamic manner with incremental resources and capabilities.

The literature indicates the existence of an underlying mechanism between firm performance and IT resources and capabilities composed of two constructs: IT support for competitive strategies and IT support for core competencies (Chan & Reich, 2007; Henderson & Venkatraman, 1993; Kearns & Sabherwal, 2006, 2007; Sabherwal & Chan, 2001). These constructs were considered as part of the key success factors given that they represent the level of alignment between resources and capabilities and the organization's functions and projections. (Hafeez et al., 2002; Hamel, 1994; Prahalad & Hamel, 1990; Wang et al., 2012). Similarly, the literature described a causal relationship between core competencies and competitive strategies, which is made evident in the framework. The design of the research was developed to understand to what extent performance is determined by the holistic relationship between IT resources, IT capabilities, IT support for core competencies, and IT support for competitive strategies. (Soh & Markus, 1995; Wang, et al., 2012). This concept permitted the establishment of the statistical methodology known as partial least square – structural equation modelling (PLS-SEM), which will be described further in Chapter 4. It was developed to determine the strength of relationships between constructs and the predictive capacity of the research model. (Hair et al.,2014).

Variables

The variables' conceptual base, composition, and relationships were supported by previous research studies (Pham & Jordan, 2009; Wang et al., 2012). IT resources, IT capabilities, IT support for competitive strategies, and IT for core competencies are second-order formative constructs consisting of several first-order reflective constructs. This variable structure (applied to constructs and sub-constructs) can be justified using the rules recommended by Jarvis, MacKenzie, and Podsakoff (2003), who pointed out that:

> (1) the causal direction is from the first-order construct to the second-order construct, that is, the former determines the latter; (2) the first-order constructs are not interchangeable with each other; (3) the first-order constructs do not need to be highly

correlated with each other; and (4) each first-order construct has its own backgrounds and consequences. (p.332)

IT resources represent the first exogenous variable defined as a formative construct integrated by four first-order reflective constructs indicated below in Figure 12. The conceptual relationships between IT resources and their reflective constructs are as follows: (a) IT infrastructure as a cost-effective and flexible platform for the organization (Schwager et al., 2000); (b) technical IT resources and managerial IT resources to interpret the business' needs and resolve issues (Mata et al., 1995); and (c) relational IT resources, with which there is constant interaction at all levels of the organization, supporting the creation of data for use in decision making and aligning IT with the business' needs (Chan & Reich, 2007; Kearns & Sabherwal, 2006, 2007; Luftman, Papp, & Brier, 1999 ; Sabherwal & Chan, 2001). Each reflective element was integrated in the survey questions.

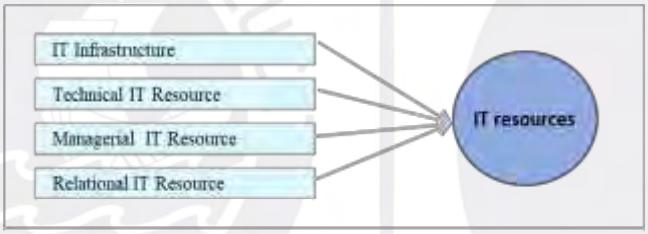


Figure 12. Construct IT resources (Wang, et al., 2012).

IT capabilities represent the second exogenous variable and is the drive that mobilizes resources within the conceptual model (Pavlou & El Sawy, 2006). Given that capabilities depend on the availability of resources, the framework incudes a causal relationship between these two constructs (Barney, 1991). IT capabilities was defined as a formative construct integrated by four first-order reflective constructs as indicated below in Figure 13. Each reflective element was integrated in the survey questions.

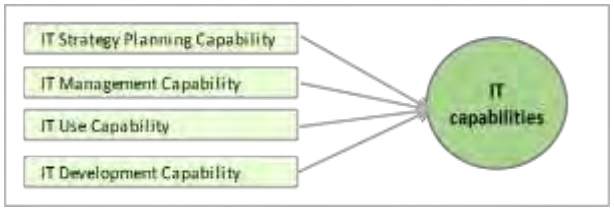


Figure 13. Construct IT capabilities (Wang, et al., 2012).

IT capabilities' conceptual relationships with its reflective constructs are as follows: (a) strategic planning, which contributes to the creation of competitive advantages based on planning methodologies aimed at aligning IT (Bharadwaj, et al., 1999; Ravichandran & Lertwongsatien, 2005); (b) IT management, which is associated with the aspect of IT development and planning that supplies the business' needs (Tiwana, et al., 2003); (c) the use of IT to introduce IT functionalities and apply them to the business; and (d) IT development to manage relationships with stakeholders (Wang et al., 2012).

Based on the theory of resources and capabilities (Barney, 1991) and various other authors (Chan & Reich, 2007; Henderson & Venkatraman, 1993; Kearns & Sabherwal, 2007; Sabherwal & Chan, 2001), the literature recognized the existence of an underlying mechanism as a driver for the creation of value and impact on firm performance associated with the BVIT concept (Soh & Markus, 1995). This mechanism describes the structuring of resource and the establishment of capabilities that foster competitive strategies and core competencies that, in turn, impact firm performance. In terms of IS and the study's framework, this mechanism was composed of two intermediate constructs: IT support for core competencies and IT support for competitive strategies. Both have a causal relationship with firm performance and depend on both IT resources and IT capabilities. These links were evident in the framework. According to Hair et al. (2014), IT support for core competencies and IT support for competitive strategies were considered as endogenous constructs within the *structural equation modeling SEM* methodology.

IT support for competitive strategies is a second-order formative construct composed of two first-order reflective constructs as indicated below in Figure 14. It has a causal relationship with IT resources and IT capabilities. Each reflective element was integrated in the survey questions.

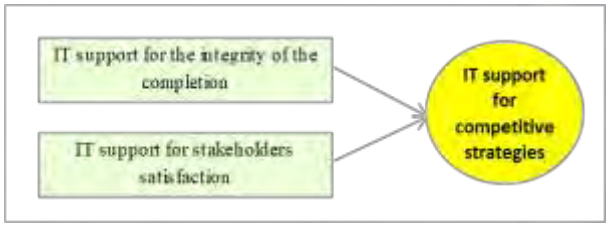


Figure 14. Construct IT support for competitive strategies (Baccarini, 1999).

The conceptual relationships of the IT support for competitive strategies construct is associated with the theory of competitive strategy (Nolan, 1994; Porter, 1981) and the RBV (Spanos & Lioukas, 2001). Rivard et al. (2006) stated that these two theories are not exclusive, but complimentary for the development of competitive strategies. Based on these concepts and considering the research focus, the definitions associated with each subconstruct were determined by the project management strategy dimension denominated product success (Baccarini, 1999) as well as the following: (a) IT support for the integrity of completion as a strategy associated with product success in virtue of the absence of post-project hindrances, the quality of post-audit analysis, and the identification of technical problems during the project in conjunction with their solutions (Freeman & Beale, 1992); and (b) IT support for stakeholders' satisfaction, a factor aimed at improving the effective coordination and relation patterns between stakeholders during the project cycle (Baker, Murphy, & Fisher, 1988).

IT support for core competencies is a second-order formative construct composed of three first-order reflective constructs. Likewise, this construct has a causal relationship with IT resources and capabilities. According to the literature, core competencies are present when resources have been structured and capabilities have been established with the view of

enhancing internal capabilities, and thereby constitute competitive advantages (Hafeez et al., 2002; Hamel, 1994; Prahalad & Hamel, 1990). For the purposes of this research, this construct included three dimensions focused on the project management process known as project core, illustrated below in Figure 15 (Baccarini, 1999): (a) IT support for resource efficiency. Given that this support is oriented with the aim of anticipating all project requirements, having the sufficient amount of resources to meet project needs in a timely fashion and using these resources efficiently to accomplish the corresponding task is of vital importance to the processes (Tuman, 1986); (b) IT support for effective coordination between team projects to produce more efficient practices and processes, increase team morale, and promote participative decision-making (Baker et al., 1988); and (c) IT support for scope preservation oriented at minimizing changes in the focus of the project by preventing potential disturbances to the organization's workflow and corporate culture (Kerzner, 1992). Each reflective element was integrated in the survey questions.

Figure 15. Construct IT support for core competences (Bacarini, 1999).

According to Ravichandran and Lertwongsatien (2005), the concept of PI project performance was only oriented in the operational dimension. For the research, project performance was a second-order formative construct with three items corresponding to the dimension of project management success: cost, time, and quality-related objectives, as illustrated below in Figure 16 (Baccarini, 1999).

Figure 16. Construct Project performance (Baccarini, 1999).

Cost-success was measured in terms of meeting the budget requirements (McCoy 1986; Morris & Houg 1987; Pinto & Slevin 1988; Turner, 1993), time-success was measured in terms of meeting the schedule requirements (McCoy 1986; Morris & Houg 1987; Pinto & Slevin 1988; Turner 1993), and quality-success was measured in terms of conformance with the functional and technical specifications (Baker et al., 1998; Morris & Hough, 1997; Turner, 1993). According to a previous study, the measurement of project performance was realized first-hand as part of the survey. This research specifically indicated that, "Subjective measures of firm performance have been found to be highly correlated with objective measures and have been used in many previous IS and strategic management studies" (Wang et al., 2012, pp. 339-340).

Research Questions

The following were the research questions incorporated in the study with which the relationships between IT resources, IT capabilities, and PI project performance for diverse physical infrastructure projects developed in Colombia were assessed. The questions were associated with relationships between the constructs and were based on the theories and concepts incorporated in the research framework.

1. RQM**:** Is there a significant relationship between IT resources and IT capabilities with the PI projects performance?
2. RQm1. Is there a significant relationship between IT resources and IT capabilities?

3. RQm2. Is there a significant relationship between the IT resources and IT support for competitive strategies?
4. RQm3. Is there a significant relationship between the IT resources and IT support for core competences?
5. RQm4. Is there a significant relationship between the IT capabilities and IT support for competitive strategies?
6. RQm5. Is there a significant relationship between the IT capabilities and IT support for core competences?
7. RQm6. Is there a significant relationship between IT support for core competences and IT support for competitive strategies?
8. RQm7. Is there a significant relationship between IT support for competitive strategies with PI projects performance?
9. RQm8. Is there a significant relationship between IT support for core competences with PI projects performance?

Population

The sample was oriented for convenience and, therefore, was not random, given that the respondents were expected to possess specific capacities or conditions as defined by the research design. Considering that infrastructure project development involved government institutions and contracting firms, both were included in the survey sample. Hence, all the respondents were officials who worked for these corresponding government institutions or contracting firms at the time of the survey. Consistent with these considerations, the type of organization, be it governmental or a firm, was included as a model moderator factor (Wang et al., 2012). Since PI project performance was the unit of analysis, surveys were aimed at professionals with responsibilities related to the planning, control, and/or support of PI projects and related services in Colombia.

Informed Consent

The surveys were answered by professionals and directors with responsibilities pertaining to the development of physical infrastructure. They were informed that their participation contributed to the enhancement of their organization's development given that the structured information of current competencies may result in the deployment of strategies that better promote a performance platform for the company and their productive entities. Appendix A includes the survey format, the research objectives, its aforementioned benefits, the respondent's profile, the information confidentiality agreement, and proof of informed consent to answer the survey.

Sampling Frame

According to Hair et al., (2014) and Cohen (1992), there is an optimal set of parameters to use in the determination of sample size when the statistical methodology used is *partial least squared - structural equation modeling PLS-SEM*. For this study, the parameters for the statistical model design were as follows: the minimum *determination level* R^2 in all endogenous constructs was .25, the *model significance level* was 5%, the *statistical power* was 80%, the level of complexity given by the maximum number of arrows pointing at a construct in the path model was four, and the maximum number of independent constructs was two. Based on these parameters, the minimum sample size recommended was 52 cases. Since the sample size used in the study was 128, this requirement was feasibly met (Cohen, 1992). The criteria for excluding the questionnaires included missing data, suspicious response patterns, or outlier effects.

Confidentiality

The first part of survey included the respondents' traits, which were used as research moderator factors. In general, all the information was treated as confidential with emphasis on the respondent's identities. To ensure confidentiality the raw data was kept in secure

lockboxes in the researcher's office, the data files were password-protected, and the respondents' names were not recorded on any of the instruments administered. For data processing purposes, each survey was allocated with a numeric code to keep track of its identity.

Geographic Location

The study was geographically administered to government institutions and contracting firms whose core was the development of physical infrastructure projects and services related to education, healthcare, housing, transportation, water supply, and sanitation, with operations in Bogota, Colombia. The research was supported by CENTRUM, Escuela de Negocios de la Pontificia Universidad Católica del Perú (PUCP), and by the Maastricht School of Management in the Netherlands (MSM).

Instrumentation

The research data was collected first-hand using the peer-reviewed Likert survey, 7-point scale, developed by Wang et al. (2012). It was applied by making slight adjustments to adapt to the Colombian context and research focus. The survey was originally written in English and later translated into Spanish, maintaining the academic back-translation standards (Usunier, 2011).

The survey provided the respondents' traits, which were included as moderator factors in the assessment of the data. Based on Wang et al. (2012), the measurement of firm performance was carried out first-hand using information and data collected from the surveys. There was a pilot test for the survey aimed at guaranteeing comprehension on the part of the respondents regarding what was established by Hair et al. (2010). For the purposes of this research, the measurement instruments were deemed suitable and, taking into account the respondents' knowledge and experience, the data collected from the

surveys was assumed to correspond to the best options. The consent for use of survey data, used by Wang et al. (2012), is included in Appendix A.

Data Collection

The data collection process was developed based on the following guidelines:

1. A segmentation process was carried out to include solely the respondents that fulfilled the research requirements. A contact BD was subsequently created.
2. Potential respondents were invited to voluntarily answer the survey by electronic and direct means. Simultaneously, control questions were established to confirm the respondents' profile.
3. Data collected from the respondents was included in the research BD until the required number of models was fulfilled in accordance with the sample size. For data processing purposes, each survey was allocated with a numeric code to keep track of its identity.
4. Relevant data was processed according to the statistical methodology premises.
5. Finally, the analysis of the results and their subsequent interpretation were carried out and conclusions relating to the research focus were drawn.

Data Analysis

In regard to the study's instrumentation, data mining was performed using Excel worksheets in accordance with Wahba (2013). Statistical assessment was carried out using the *partial least square – structural equation modeling PLS-SEM* method since the research model was focused on understanding the model's consistency and the strength of relationships and interactions between constructs. *PLS-SEM* was deemed appropriate due to the multivariate techniques it permits, which combine aspects of factor analysis and

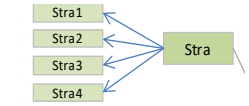
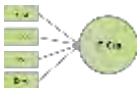
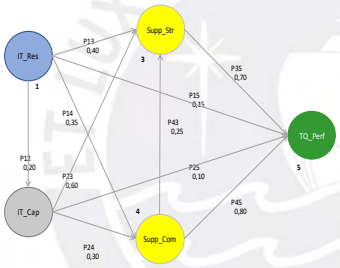
regression, enabling the simultaneous examination of relationships between measured variables and latent variables, as well as that observed between distinct latent variables. A *Statistical Package for Social Sciences SPSS* and *SmartPLS* software were used for data processing stage.

Validity and Reliability

Following *PLS-SEM* methodology, the study placed emphasis on the model's consistency, the strength of relationships, and the mediation and moderator effects between constructs. Therefore, it was deemed necessary to determine the psychometric quality of all constructs, the model's psychometric quality, the model's predictive capabilities, and the measurements of relationships by applying the statistical procedures illustrated below in Table 4 (Hair et al., 2014). These systematic procedures aimed at ensuring the validity and reliability of all components and of the research model itself to minimize issues that could potentially weaken the weight of the research, which will be presented in further detail in Chapter 4.

Table 4

Research Validity and Reliability Measurements

Measurement apply to	Reliability and validity criteria	
First-order reflective constructs.	Psychometric quality (Hair, et. al 2010 ; Anderson & Gerbing, 1998)	
	Reliability Cronbach's alpha composite reliability (CR)	Validity Confirmatory Factor Analysis (CFA)-Factor Loadings Average variance extracted (AVE) Variance inflation factor (VIF)
Second-order formative constructs.	Psychometric quality (Hair, et. al 2014)	
	Collinearity Variance inflation factor (VIF)	Significant and relevance outer weights
Between each set of predictor constructs		
	Model psychometric quality (Hair, et. al 2014) Collinearity Variance inflation factor (VIF) R^2	convergent validity: relevance weight weights vs maximum possible outer weight
Model's predictive capabilities and relationships between constructs (Hair, et. al 2014)		
	R^2 coefficients of determination or path coefficients Variance inflation factor (VIF) between constructs Q^2 Stone-Geisser's factor or model predictive relevance Omission distance D q^2 Effect size $Q^2included$ $Q^2excluded$ f^2 effect size $R^2included$ $R^2excluded$	Pij Significance of the path coefficients hypothesized relationships among constructs Bootstrapping procedure p value; empirical t value; standard error, confidence intervals Construct's direct and indirect effects *Pij* effects of underlying mechanism in the model
Importance-Performance Matrix IPMA analysis		
	Index value: rescale data; and total effects	Direct and indirect Path coefficients *Pij* p value; empirical t value; standard error
Mediation of underlying mechanism	Variance account for VAF	bootstrapping procedure
Heterogeneity – Moderator effects	Bootstrapping procedure Levene's test	Bootstrapping procedure p value of indirect effect

Given the method of gathering data, *common method variance CMV* and common method bias were of potential concern. To detect and remedy these effects, a *Harman´s single factor* was applied in all reflective constructs (Wang et al., 2012) and partial correlation testing using marker variables to partial out *CMV* influence was carried out. (Lindell & Whitney, 2001).

Summary

The development of physical infrastructure and related services in select countries (i.e. Latin American countries) is a determining factor with respect to their competitive edge. Therefore, it is essential to achieve a better understanding of the interactions between variables that promote PI project performance. This was accomplished by integrating systematic procedures to extract and process data in order to obtain consistent and revealing results. Increased knowledge in this field could contribute to the improvement of PI project performance and, in effect, contribute to the closing of a country's social gap. The research integrated a peer-reviewed survey, data collection procedures in accordance with academic standards, and *partial least square – structural equation modeling PLS-SEM* as a statistical methodology oriented to analyze the model's consistency, the strength of relationships, and the mediation and moderator effects between constructs. These features were convergent with the nature and design of the research. The following chapter will aim to present the empirical results obtained and hypotheses raised from the research questions.

Chapter 4: Results

The objective of this chapter is to report the statistical procedures carried out in conjunction with their results. This quantitative study aimed at understanding, under the BVIT concept, how IT resources and capabilities impact PI project performance. The research also aimed at analyzing how the underlying mechanism for IT support for core competencies and IT support for competitive strategies functions in terms of the enhancement of PI project performance as described by the same BVIT theory. The procedural organization and the results extracted from the data were developed based on the *partial least square – structural equation modeling PLS-SEM* statistical methodology with a foundation in the research questions and hypotheses formulated. Thus, the content of this chapter included data collection procedures, survey development, pilot procedures, and data analysis procedures and findings.

Data Collection Procedures

The survey, developed by Wang et al. (2012), had some slight modifications to align with the research focus and the Colombian context (Appendix A). An expert panel of three Senior Project Managers and two CIOs examined the face validity of the measured items associated with the study. The pilot was tested with 23 respondents prior to commencing the data collection stage. It was developed in collaboration with postgraduate management school *Escuela de Ingenieros Militares* in Bogota, Colombia. The questionnaire was processed directly by directors and coordinators dedicated to physical infrastructure projects. A total of 21 relevant responses were obtained and subsequently used for validation and further refinement. After calculating the values for *factor loading* and *Cronbach's alpha*, six items were dropped due to their factor loading value being less than .50. The *Cronbach α* value for all the first-order constructs was greater than .70.

The data was collected in Bogota, Colombia, between November 2015 and July 2016. A total of 393 questionnaires were distributed and a sample was drawn from the project managers, project coordinators, and project supervisors. Following three rounds of follow-up reminders, 145 questionnaires were returned. Out of these, 17 were dropped due to missing data, suspicious response patterns, or outlier effects. In the end, 128 questionnaires were kept for data analysis. The effective response rate was 32.57 %. Among the accepted cases there were no lack of information and, consequently, no need to remove or impute empty cases. As illustrated below in Appendix F and Figure 17, the respondents consisted of 11 general project managers, 27 project managers, 58 project coordinators, 28 project supervisors, and four middle-level managers. They were considered to be sufficiently knowledgeable about PI projects and capable of providing valid answers to the survey questions. The respondents answered the questions within a time frame of 15 to 20 minutes in a noise and pressure-free environment.

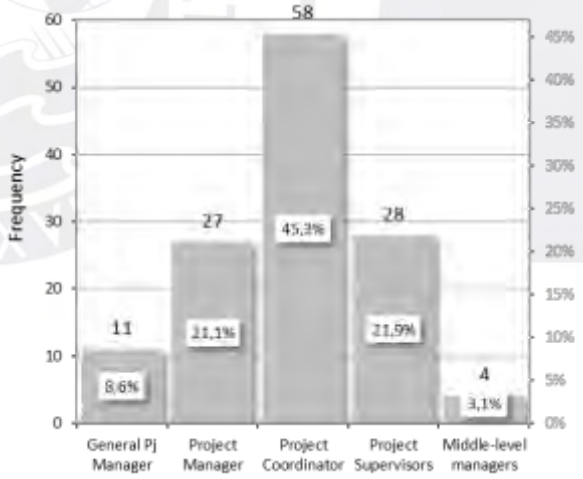


Figure 17. Respondents distribution.

The respondents, at the time of the survey, were working for government institutions or contracting firms whose core was physical infrastructure projects and related services developed in Colombia. The surveys included were carried out with 63 government institutions and 65 contracting firms. After the tabulation process of all 128 surveys, the data

was examined for any suspicious response patterns. Since there are two types of respondents, PI project officials and IT project officials, their respective capacities to respond to the survey questions may differ. Consequently, t-tests were performed to examine the potential statistical differences in the measured items. The results indicated that there existed no significant difference between PI project officials and IT project officials ($p > .05$).

Data Analysis Procedure

Based on the approach referred to in Chapter 3 concerning the *partial least square – structural equation modeling PLS-SEM* method, the focus of the statistical analysis aimed at examining the model's predictive capacities and the relationships between constructs to determine if the empirical data is representative of the underlying theory (Hair et al., 2014). Given that the structural model consists of four second-order formative constructs consisting of 13 first-order reflective subconstructs and one second-order formative construct (project performance) with three single items, it was deemed necessary to evaluate the reliability and validity of each one in order to provide support for the appropriateness of their inclusion in the model. Thus, the statistical analysis was divided into three main stages: measuring the psychometric quality of constructs, assessing the *PLS-SEM* structural model, and evaluating the structural model results in terms of the *Importance-Performance Matrix* (*IPMA*) with heterogeneity as the mediator analysis. (Hair et al., 2014).

Psychometric quality of constructs

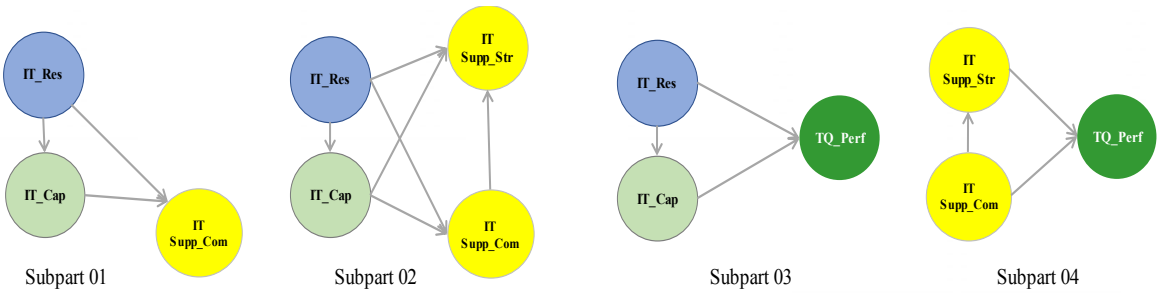
Initially, the assessment dealt with the internal consistency and convergent validity of the questionnaire items which conformed to the 13 first-order reflective constructs. This process required three rounds since collinearity was present in some of the first-order constructs and low significance was present in others. Hence, it was deemed necessary to exclude some items and merge certain predictors into a single construct. In the findings section, the adjustments made in the model's framework with the aim of confirming model

consistency will be presented. The results of the first-order reflective constructs following their respective adjustments are included in Table E1. *Cronbach's alpha*, *factor loading*, and *average variance extracted AVE* values indicated that these constructs had internal consistency reliability and acceptable convergent validity. Therefore, these items and the first-order constructs were considered appropriate to be included in the *PLS-SEM* analysis.

To integrate hierarchical components in the model, each first-order reflective construct was individually parceled by calculating the mean of its item scores. All the second-order constructs were transformed into first-order constructs with formative indicators. The psychometric quality of these parceled constructs was measure based on two aspects: (a) redundant information, to verify if a parceled construct exhibited high correlations with others of the same construct, and (b) significant contributions of the construct. Table E2 presents the *variance inflation factor VIF* and *outer weights*, whose results indicated that multicollinearity does not pose a significant problem to validity and that the indicators carried a significant and relevant weight.

Assessing *PLS-SEM* structural model results

Once the results confirmed that the construct measurements were reliable and valid, the next step consisted of assessing the structural model for determining psychometric quality. The structural model was measured separately in a set of constructs by subparts to check whether there were significant levels of collinearity between predictor constructs, as illustrated below in Figure 18. The results of the *variance inflation factor VIF* were calculated in a similar manner as the formative construct measurements, indicating that the model was not required to eliminate constructs, merge predictors into a single construct, or create higher-order constructs. Therefore, the model was confirmed to be free of collinearity.



IT_Res = IT resources, IT_Cap= IT capabilities; Supp_Cor = IT support for core competencies; Supp_Str = IT support for competitive strategies; TQ_Perf = PI project performance

Figure 18. Analysis of model psychometric quality by subparts.

According to the *partial least square – structural equation modeling (PLS-SEM)* methodology, the focus of the assessment of the structural model was to examine the model's predictive capacity and the relationships between constructs. *PLS-SEM* fits the model with the sample data, effectively obtaining the most optimal parameter estimates by maximizing the explained variance of endogenous latent constructs. This statistical concept is quite different from *covariance-based CB-SEM* methodology, an observation made by Hair et al. (2014) upon indicating that:

> "This aspect of PLS-SEM is different from CB-SEM, which estimates parameters so that the differences between the sample covariances and those predicted by the theoretical/ conceptual model are minimized. As a result, with CB-SEM, the covariance matrix implied by the theoretical/conceptual model is as close as possible to the sample covariance matrix. Goodness-of fit measures associated with CB-SEM (which are based on the difference between the two covariance matrices), such as the chi square (x2) statistic or the various fit indices, are not applicable in a PLS-SEM context.
>
> Instead of applying measures of goodness of fit, the structural model in PLS-SEM is assessed on the basis of heuristic criteria that are determined by the model's predictive capabilities. These criteria, by definition, do not allow for testing the overall goodness of the model fit in a CB-SEM sense. Rather, the model is assumed to be specified correctly and is assessed in terms of how well it predicts the endogenous variables/constructs (see Rigdon, 2012, for a discussion of model fit in CB-SEM vis-a-vis PLS-SEM's prediction orientation). The key criteria for assessing the structural model in PLS-SEM are the significance of the path coefficients (Step 2), the level of the R2 values (Step 3), the f2 effect size (Step 4), the predictive relevance (Q2), and the q2 effect size (Step 5). (Hair et al., 2014. pp 168-169)

As indicated above, assessment of the structural model with *PLS-SEM* enables one to determine how well empirical data supports the theory, thereby confirming the theory's reliability and utility. This assessment analyzed two key aspects: (a) the model's predictive capabilities and (b) the relationships between constructs. For this purpose, the model's measurements focused on the significance of the *path coefficients* Pij, which described the hypothesized relationships between constructs, and the *determination level* R^2, which measured the model's predictive accuracy. Additionally, the *Stone-Geisser's factors* Q^2 and q^2 (Geisser, 1974; Stone, 1974) and the *effect size* f^2, which evaluates changes of R^2 in endogenous constructs, were calculated to improve the study's predictive capacity.

Significance of the path coefficients

The measuring of *path coefficients significance* was carried out with bootstrapping routines, the examination of t and *p* values, the confidence intervals, and the relative sizes of path coefficients. The results led to the identification of the most key constructs which explain the endogenous constructs in the structural model. In turn, these coefficients represented the hypothesized relationships between the constructs. Path coefficient values vary between +1 to -1, +1 corresponding to very strong relationship and -1 corresponding to a lack of relation between the factors.

Since the study model incorporated an underlying mechanism (IT support for competitive strategies and IT support of core competencies), the research evaluated the direct and indirect effects of the construct. The interpretation of these effects was useful in examining the differential impact of diverse driver constructs via mediating constructs.

Level of the coefficients of determination

Given their predictive characteristics, the *coefficients of determination* R^2 measured the amount of variance in endogenous constructs explained by the exogenous constructs linked to them. The interpretation of the R^2 value depends on the research discipline. In this

management study, R^2 values of .25, .50, and .75 were considered as weak, medium, and substantial respectively (Hair et al., 2014).

It was not necessary to adjust R^2 values since the model was based on a widely recognized conceptual foundation and included only five constructs. Under the *partial least square – structural equation modeling PLS-SEM* methodology, the model was considered as parsimonious. Thus, the results of R^2 were the basis for understanding the model's predictive accuracy. The results indicated there was no inherent bias by including nonsignificant or minimally related constructs. (Hair et al., 2014). In addition to evaluating the R^2 values of all endogenous constructs, the change in R^2 value was calculated when a specified exogenous construct was omitted from the model to evaluate whether or not the omitted construct had a substantial impact on the endogenous constructs. This measure is known as *effect size* f^2 with small effects corresponding to a range value of .02, medium effects at .15, and large effects at .35 (Cohen, 1992).

The blindfolding procedure was used to assess the *Stone-Geisser's factor* or *model predictive relevance* Q^2 in endogenous latent constructs. They were each calculated in separate procedures. The measurement of *effect size* in this calculation q^2 had a similar procedure as that of f^2. However, instead of R^2 values, the *predictive relevance* Q^2 values were used as inputs. As a *relative predictive relevance* metric for exogenous constructs, the q^2 values .02, .15, and .35 are considered small, medium, and large respectively in terms of their predictive relevance for certain endogenous construct (Hair et al., 2014).

Evaluation of the structural model

Complementary with assessing the *PLS-SEM* structural model, the research included two additional evaluations: the extraction of construct scores denominated *importance-performance matrix analysis* (*IPMA*) and the *analysis of model heterogeneity* denominated

PLS-SEM multigroup analysis (*PLS-MGA)*. These evaluations aimed to contribute to the foundation of findings and implications (Hair et al., 2014).

The matrix analysis *IPMA* contrasts the structural model's total effects (importance) with the average values of construct scores (performance). A matrix view permits an additional dimension to detect areas wherein the improvement of activities to promote the key construct's performance is necessary (Volckner, Sattler, Hennig-Thurau, & Ringle, 2010). Importance, being the x-axis of the *IPMA*, is represented by total effects derived from a *PLS* path model estimation. The y-axis of the *IPMA* depicts the rescaled average of construct scores which required a rescaling and bootstrapping process to obtain their index values (Hair et al., 2014).

Another key aspect is the *multigroup analysis PLS-MGA* given that subpopulations could affect the results of the model and, consequently, lead to false conclusions. This relationship could be insignificant in regard to the aggregate data, but on a group level the effects could be seen as significant. As part of the study, the structural model heterogeneity test was included to verify the presence of these subgroups in the sample. The research included the type of organization and project manager traits as explicit subgroups. With respect to the type of organization, previous studies have confirmed that the potential benefits derived from deploying and using IT may vary depending on if the organization is a public or private firm. (Stoel & Muhanna, 2009). On the other hand, Muller and Turner (2007) evaluated how a successful project is moderated by project type, industry, and project manager traits. Given that the research focus was solely related to physical infrastructure projects associated with the construction industry, the moderator factor incorporated was that of project manager traits. This study included gender, nationality, age, level of education, project management certification, and job title as project manager traits. Further considerations were made to either include or exclude each factor as a moderator

factor, taking into account the research nature and focus: (a) there were no significant differences in project performance on the basis of gender alone; “Male and female project managers are equally good”. (Muller & Turner, 2007, p. 308); (b) since all respondents were born in Colombia, nationality was not considered; and (c) there are differences on the basis of age, but these are rather reflected by years of experience. Thus, the explicit moderator factors considered in the *multigroup analysis PLS-MGA* were organization type, be it a public or private firm, and project manager traits concerning years of experience, education level, and job title. It was necessary to formulate groups for each mediator factor and each subpopulation was required to fulfill the *PLS-SEM* sample size rules. The following are the subpopulations included in the study: (a) organization type, 63 public and 65 private firms; (b) years of experience, 60 with less than seven years and 68 with more than seven years; (c) education level, 70 professionals and 58 specialists; and d) job title, 67 high-level officials consisting of general project managers, assistant project managers, and chief project coordinators, and 61 mid-level project coordinators, project supervisors, and managers. It was necessary to test the reliability and validity constructs for each group prior to multigroup analysis. The comparison analysis between groups required a separate *PLS-SEM* modeling procedure using the bootstrapping procedure to calculate *path coefficients*, *outer weights*, and *standard error*. The existence of subpopulations in a sample was tested with the null hypothesis (Ho).

The results are presented in Findings section following the *PLS-SEM* methodology (Hair et al.,2014) which includes the specifications of the measurement model, data examination to verify suspicious response patterns, the psychometric quality of constructs, the model's predictive capacities, the importance-performance matrix analysis, and moderator effects.

Findings

The framework of the research model was primarily based on the Business Value of Information Technology (BVIT) concept (Sambamurthy et al., 2003) which postulated that, when an organization constantly incorporates, adjusts, and aligns its resources and capabilities as drivers to support strategy and core competencies, it is possible to improve corresponding performance. For the purposes of the research, this theoretical concept was developed to better understand how IT resources and capabilities improve project performance under the following thesis claim: When organizations promote their IT resources and IT capabilities and align them to physical infrastructure project management, they positively impact its performance.

In statistical terms and based on the *partial least square – structural equation modeling PLS-SEM* methodology, the main purposes were to determine the model's predictive capacity and the relationships between constructs to explain how well empirical data supports the theory and therefore conclude if the theory applied to PI projects has been empirically confirmed. The measurement model was adjusted for four second-order formative constructs consisting of 13 first-order reflective subconstructs and one second-order formative construct (project performance) with three single items. Organization type and project manager traits were included as moderator constructs of project performance.

The internal consistency and convergence validity test of the 13 first-order reflective constructs required three rounds for *Cronbach's alpha, factor loadings* (*l*ij), and *average variance extracted AVE* values respectively. These tests indicated that collinearity was present in some items, thus revealing a lack of internal consistency. Hence, the following necessary model adjustments were made: (a) the items *Tech1*, *Mana1*, and *Rela2* associated with the construct of IT Resources were excluded; (b) the items *Supp1*, *Supp4*, *Deve2*, *Deve3,* and *Deve4* associated with the construct of IT Capabilities were excluded; (c) the

first-order constructs of IT Infrastructure (*Infr*) and Technical IT Resources were merged (*Tech*); and (d) The first-order constructs of IT Use Capability (*Leve*) and IT Development Capability (*Deve*) were merged. Following these changes, the measurement model was adjusted to represent that illustrated below in Figure 19, with the statistical parameters included in Table E1. The results indicated internal consistency reliability and acceptable convergence validity. Therefore, the aforementioned items and first-order constructs were considered appropriate to be included in the *PLS-SEM* analysis.

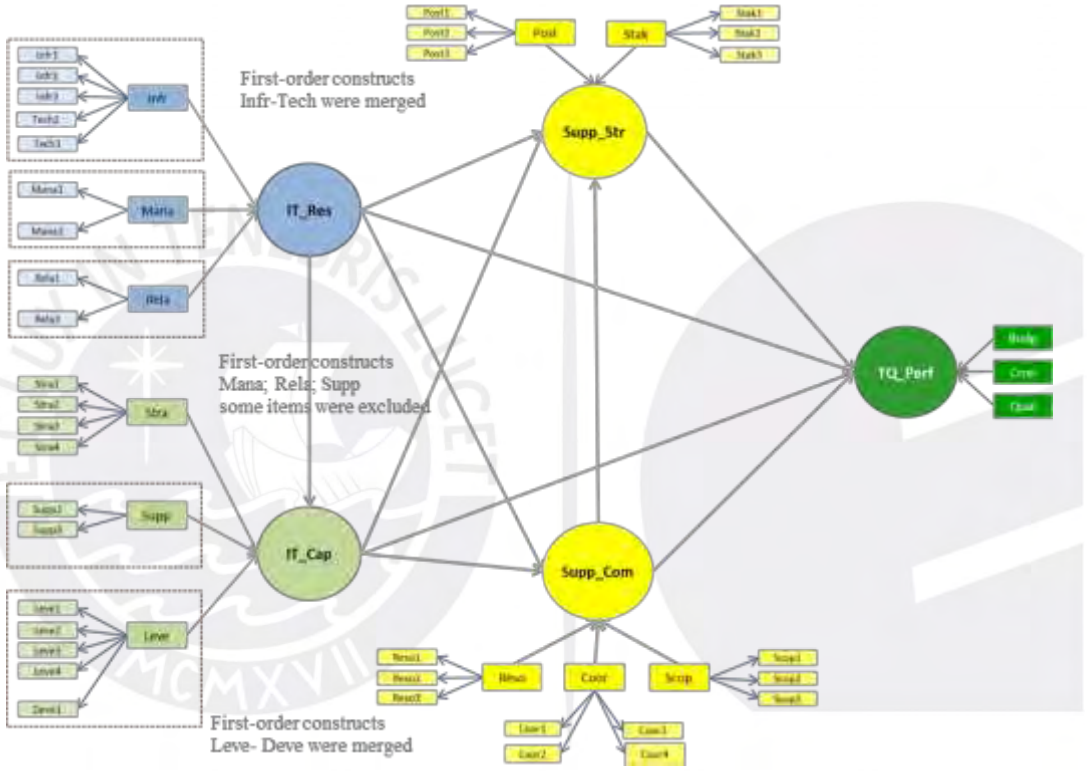


Figure 19. Research measurement model adjusted.

Data examination

First of all, it is important to point out that *PLS-SEM* is a nonparametric statistical method that does not carry assumptions concerning the underlying data and their distribution. "PLS-SEM's statistical properties provide robust model estimations with data that have normal as well as extremely non-normal (i.e., skewness and/or kurtosis) distributional properties" (Hair et al., 2014, p. 22). According to this methodology feature,

the collected data was checked for missing data and suspicious response patterns. Out of 145 questionnaires, 17 were dropped because they contained missing data or suspicious response patterns. In the end, 128 of the questionnaires were kept for data analysis. The following items would have suspicious response patterns in the form of atypical distributions: *Tech1, Mana2, Rela2, Supp1* and *Deve3*. In general, these findings coincided with the collinearity issues previously mentioned in regard to the exclusion of items or first-order constructs.

Psychometric quality of constructs

The goal of measuring each item and construct was to ensure their reliability and validity, effectively justifying their inclusion in the model. The key parameters, specifications, and limits for each type of construct and evaluation were established in Chapter 3 according to the *PLS-SEM* methodology (Hair et al., 2014). The psychometric quality of final first-order reflective constructs is illustrated in Table E1, indicating that the *Cronbach's alpha* and *composite reliability CR* of each subconstruct is above the threshold of .60 with acceptable reliability. The *factor loadings li* for each item in the first-order reflective constructs were calculated. The results provided that the items explain more than 68.8% of each construct's variance, substantially indicating that it is multicollinearity-free. In general, the *average variances extracted AVE* were more than .60, greater than the corresponding *maximum shared variance MSV* and *average shared variance ASV*, indicating satisfactory discriminant validity with block homogeneity and dimensionality. Only the first-order reflective construct *Rela* was slightly below this value, being calculated as .576.

The results of the psychometric quality of second-order formative constructs derived from the parceling process of first-order constructs are shown in Table E2. The *variance inflation factor VIF* range was between 1.129 and 2.386, indicating that multicollinearity

did not pose a problem to validity. The *weights* of each variable were contrasted with the *maximum possible outer weights*, indicating that the constructs were significant and relevant to describe each construct. The results ultimately indicated internal consistency reliability and acceptable convergence validity; thus, the constructs were deemed appropriate to be included in the *PLS-SEM* model (Hair et al., 2014).

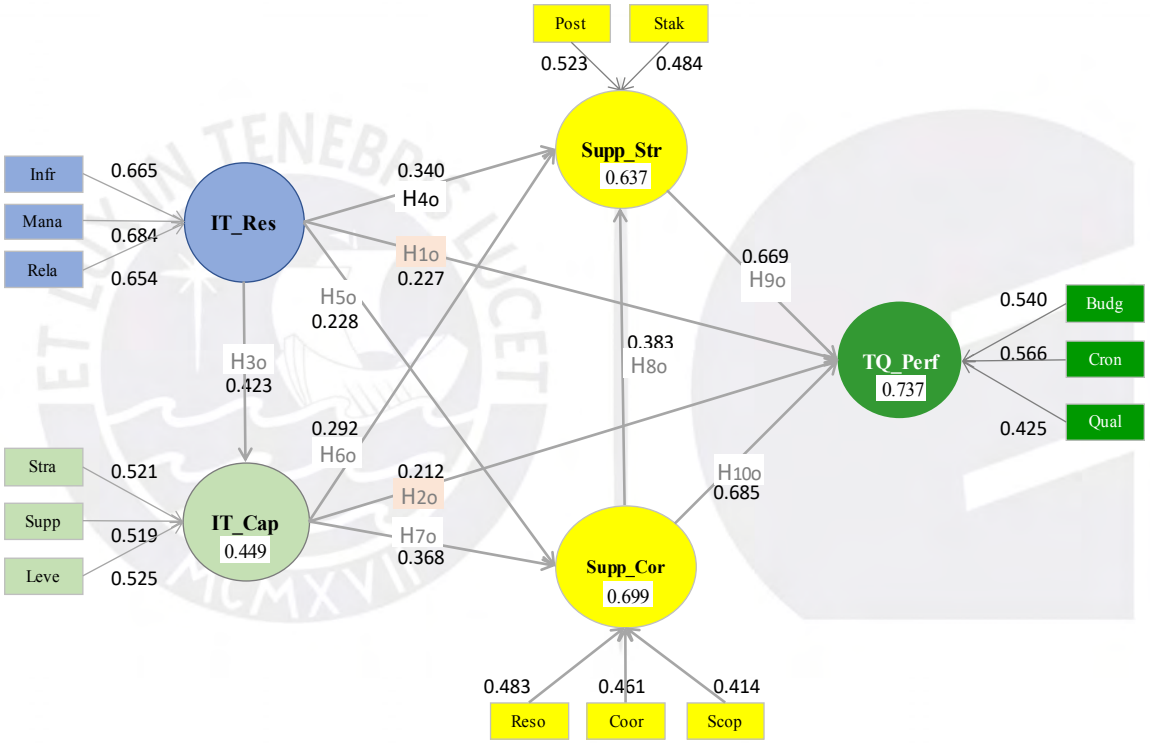
Psychometric quality of the model

The *variance inflation factor VIF* was used to assess the structural model´s collinearity issues. The calculation process took four rounds, one for each subpart of the model. In the first subpart, IT resources and IT capabilities were predictors of IT support for core competencies. In the second subpart, IT resources, IT capabilities, and IT support for core competencies were predictors of IT support for competitive strategies. In the third subpart, IT resources and IT capabilities were predictors of project performance. In the fourth subpart, IT support for core competencies and IT support for competitive strategies were predictors of project performance. Initially, the model score's R^2 for all constructs were calculated. Then, considering predictors as independent variables and the selected construct as the latent variable in each round, multiple regressions were computed to estimate new scores that excluded the construct evaluated in each case. This process resulted in the *variance inflation factor VIF* as shown in Table E3. In general, the *VIF* values were clearly below the threshold of five, indicating that the constructs included in the model were collinearity-free.

Predictive capacity of the model - Determination level (R^2)

The assessment of the structural model aimed to establish the model's predictive capacities. One of the key criteria in this assessment is the *determination level*, represented as R^2, a measure of the model's predictive accuracy. According to Hair et al. (2014), R^2 ranges were rated as follows: .75 is considered as substantial, .50 as moderate, and .25 as

weak. As illustrated in Figure 20, the overall result indicates that the amount of variance in project performance is corresponds to 73.7% by all constructs. This represents a substantial causality effect when considering the conceptual model of BVIT's application in PI project performance. The resulting value was statistically significant by a level of at least 5% with a *p-value* of 0.000. The *determination level* R^2 values for the endogenous constructs were considered substantial for IT support for core competencies (69.9%) and IT support for competitive strategies (63.7%). On the other hand, the R^2 value for IT capabilities was medium at 44.9%.



IT_Res = IT resources, IT_Cap= IT capabilities; Supp_Cor = IT support for core competencies; Supp_Str = IT support for competitive strategies; TQ_Perf = PI project performance

Figure 20. Results of model´s predictive capability

Predictive capacity of the model - Significance of the path coefficients (*Pij*)

The bootstrapping procedure was used to calculate and verify the *significance of the path coefficients Pij*. According to Hair et al. (2014), the typical significant level is 5% in the field of management. The *path coefficients* aimed to describe the relative relevance of

the exogenous constructs to explain each endogenous construct. Only the direct effects are covered in this section, the total effects will be presented in following section. To assess whether such relationships were significant, it was necessary to carry out the bootstrapping procedure with 5,000 subsamples. Table E4 displays the path coefficients, the *t-values* and their *significance levels*, the *p-values*, and the *confidence intervals*. Taking into account the field of the study, a value close to .70 was considered a strong relationship. Findings related to the direct effects are as follows:

1. For project performance: IT support of core competencies (.685) and IT support for competitive strategies (.669) had a significant and strong positive relationship, followed by IT capabilities (.368) with a significant and medium positive relationship. In regard to IT resources, however, project performance (.227) was not considered significant (p=0.0638).
2. For IT support for competitive strategies: IT support for core competencies was the most significant path (.383), followed by IT resources (.340) and IT capabilities (.292). These paths were significant and reflected a medium positive relationship.
3. For IT support for core competencies: IT capabilities (0.368) was the most important path with a medium positive relationship, followed by IT resources (.228) with a weak positive relationship. Both links were considered significant.
4. For IT capabilities: This construct only has one link with IT resources (.423), which was considered significant with a medium positive relationship.

As cited, the analysis of direct relationships was generally considered significant except in the case of IT resources – project performance (.227; p=0.0638) and some path

coefficients that had low scores. This result is consistent with the BVIT concept (Ravichandran & Lertwongsatien, 2005), which postulates the existence of an underlying mechanism composed of IT support for competitive strategies and IT support for core competencies which mediates the effects of IT resources and IT capabilities in the key construct, PI project performance. In the analysis of the total effects, the functions that predictive constructs carry out on the research model will be presented, specially their correlations with IT resources and capabilities. The results for direct effects were included in Table E4 and provided evidence concerning the research hypotheses as follows:

1. The IT resources – project performance path was considered non-significant (.227, p=0.0638). Therefore, it was not possible to reject the null hypothesis H_{1o}. Hence, IT resources were not relevant in directly explaining PI project performance and it was empirically established that there is no cause-and-effect relationship between these constructs.
2. IT capabilities had a significant and positive relationship with project performance (.212, p=.0301). This result provided evidence to reject null hypothesis H_{2o}, indicating IT capabilities has weak effect and low relevance to explain directly PI project performance.
3. IT resources had a significant and positive relationship with IT capabilities (.423, p=.0002). This result provided evidence to reject null hypothesis H_{3o}, indicating IT resources has a medium relevance to explain directly IT capabilities.
4. IT resources had a significant and positive relationship with IT support for competitive strategies (.340, p=.0000). This result provided evidence to reject null hypothesis H_{4o}, indicating IT resources has a medium relevance to explain directly IT support for competitive strategies.

5. IT resources had a significant and positive relationship with IT support for core competencies (.228, p=.0116). This result provided evidence to reject null hypothesis H_{5o}, indicating IT resources has a weak relevance to explain directly IT support for core competencies.
6. IT capabilities had a significant and positive relationship with IT support for competitive strategies (.292, p=.0000). This result provided evidence to reject null hypothesis H_{6o}, indicating that IT capabilities has medium effect and relevance in directly explaining IT support for competitive strategies.
7. IT capabilities had a significant and positive relationship with IT support for core competencies (.368, p=.0001). This result provided evidence to reject null hypothesis H_{7o}, indicating that IT capabilities had a medium effect and relevance in directly explaining IT support for core competencies.
8. IT support for core competencies had a significant and positive relationship with IT support for competitive strategies (.383, p=.0000). This result provided evidence to reject null hypothesis H_{8o}, indicating that IT support for core competencies had a medium effect and relevance in directly explaining IT support for competitive strategies.
9. IT support for competitive strategies had a significant and positive relationship with PI project performance (.669, p=.0000). This result provided evidence to reject null hypothesis H_{9o}, indicating IT support for competitive strategies has a strong effect and relevance in directly explaining PI project performance.
10. IT support for core competencies had a significant and positive relationship with PI project performance (.685, p=.0000). This result provided evidence to reject null hypothesis H_{10o}, indicating IT support for core competencies

had a strong effect and relevance in directly explaining PI project performance.

The results derived from the direct effects provide reliable evidence that IT resources and IT capabilities have low capacity to directly describe project performance. According to theoretical foundations, specifically the BVIT concept, the analysis of the total effects will establish how these constructs function in project performance through the underlying mechanism formed by IT support for core competencies and IT support for competitive strategies.

Total effect constructs

Tables E5 and E6 show the results of the bootstrapping process that establishes the statistical significance of the total effects from the four constructs: IT resources, IT capabilities, IT support for core competencies, and IT support for competitive strategies. This was calculated at least at a 5% level and described how strongly each construct influences PI project performance, the key endogenous construct. Likewise, these measurements led to the determination as to whether or not IT support for core competencies and IT support for competitive strategies have a mediating effect on IT resources and IT capabilities.

Among the four driver constructs, IT support of core competencies had the strongest and significant total effect on PI project performance (.942, p=.0001) with positive and strong relationship. This was followed by IT support for competitive strategies (.669, p=.00228) which also exhibited a positive and strong relationship. IT capabilities (.659, p=.0002), and IT resources (.611, p=.0000), in terms of total effects, also had a significant, positive, and strong correlation in describing PI project performance.

Table E5 includes the results of *variance accounted for VAF* to determine to what extent the variance in the relationships of each construct corresponds with the key construct

by indirect effects, and subsequently explained their indirect relationship. When *variance accounted for VAF* is less than 20%, no mediation takes place. In contrast, when *VAF* exceeds 80%, it assumes full mediation. If *VAF* is greater than 20% and less than 80%, it may be defined as partial mediation. (Hair et al., 2014). The following are the corresponding findings of the procedure:

1. IT resources-project performance path (.611): this path is significantly mediated by IT support for competitive strategies and IT support for core competencies. Its effect on project performance is explained by this mediation with a *VAF* of 62.83% and is therefore considered partial. The mediation effect contributed with a direct effect of 0.384.
2. IT capabilities – project performance path (0.659): this path is significantly mediated by IT support for competitive strategies and IT support for core competencies. Its effect on project performance is explained by this mediation with a *VAF* of 67.89% and is therefore considered partial. The mediation effect contributed with a direct effect of 0.448.
3. IT support for core competencies – project performance path (0.942): this path is significantly mediated by IT support for competitive strategies. Its effect on project performance is explained by this mediation with a *VAF* of 27.23% and is therefore considered partial. The mediation effect contributed with a direct effect of 0.256.

Endogenous construct´s predictive relevance (Q^2)

The blindfolding procedure was used to assess the *Stone-Geisser's factor* or the model's *predictive relevance* Q^2. The parameter adopted for *omission distance D* was 7 since the sample has 128 cases and its quotient with *D* (i.e. 128/7) must not an integer number. According to the *PLS-SEM* methodology, *predictive relevance* Q^2 values must be

computed separately and only in endogenous latent constructs. Following seven blindfolding rounds for each construct, the algorithm calculated Q^2 as the quotient of the *sum of the squared observations SSO* and the sum of the *squared prediction errors SSE*. Table E7 shows the results of the path model's *predictive relevance* Q^2, listing the following elements: IT capabilities (.421), IT support for core competencies (.413), IT support for competitive strategies (.341), and project performance (.417). All values are considerably greater than zero, thus providing support for the *model's predictive relevance* regarding the endogenous latent constructs.

Effect size (f^2) of exogenous-predictor constructs

The measure of *effect size* f^2 is a complementary metric of *determination level* R^2 applicable in endogenous constructs to establish the relative impact or relevance of a predictor construct on an endogenous construct. Specifically, *effect size* f^2 provides information regarding how much a predictor construct contributes to R^2-value of a target construct in the model. These metric computes with the change in *determination level* R^2 when a specific exogenous construct is omitted from the model in order to determine if this omitted construct has a substantial impact on the endogenous constructs. *Effect size* f^2 was calculated us the following expression in which R^2included and R^2excluded are the R^2 values of the endogenous construct when a selected exogenous construct is included in or excluded from the model (Hair et al., 2014):

$$f^2 = \frac{R^2_{\text{included}} - R^2_{\text{excluded}}}{1 - R^2_{\text{included}}}$$

The process required the *PLS path model* calculation to be carried out twice. In the first round the exogenous construct was included (R^2included) and in the second round it was excluded (R^2excluded). According to Cohen (1992), values of *effect size* f^2

corresponding to .02, .15, and .35 represent small, medium, and large effects respectively. The effect of the model was calculated with IT resources and IT capabilities as exogenous constructs. The results are presented in Table E8 with the following findings:

1. IT resources: large effect with IT capabilities (.383), large effect with IT support of core competencies (.291), medium effect with IT support for competitive strategies (.143) and medium effect with project performance (.104).
2. IT capabilities: large effect with IT support of core competencies (.321), medium effect with IT support for competitive strategies (.226) and medium effect with project performance (.171).
3. IT support of core competencies: medium effect with IT support for competitive strategies (.127) and medium effect with project performance (.248).
4. IT support for competitive strategies: medium effect with project performance (.212)

Relative predictive relevance of exogenous constructs (q^2)

The measurement of q^2 *effect size* consisted of a similar procedure as that of f^2. Instead of R^2 values, the *predictive relevance* measurements used Q^2 values as inputs. Following Hair et al. (2014), the *relative predictive relevance* q^2 of exogenous constructs was calculated using the following expression in which Q^2included and Q^2excluded are the Q^2values of the endogenous construct when a selected exogenous construct is included in or excluded from the model (Hair et al.,2014):

$$q^2 = \frac{Q^2_{\text{included}} - Q^2_{\text{excluded}}}{1 - Q^2_{\text{included}}}$$

Similarly, the process required the *PLS path model* calculation to be carried out twice. In the first round the exogenous construct was included (Q^2 included) and in the second round it was excluded (Q^2 excluded). As a *relative predictive relevance* metric for certain exogenous constructs, the q^2 values of .02, .15, and .35, were considered small, medium, and large respectively. The q^2 effect was calculated in the model with IT resources and IT capabilities as exogenous constructs. The results are also presented in the Table E8 with the following findings:

1. IT resources: large effect with IT capabilities (.332), large effect with IT support of core competencies (.278), medium effect with IT support for competitive strategies (.168) and medium effect with project performance (.107).
2. IT capabilities: large effect with IT support of core competencies (.317), medium effect with IT support for competitive strategies (.234) and medium effect with project performance (.187).
3. IT support of core competencies: medium effect with IT support for competitive strategies (.142) and medium effect with project performance (.239).
4. IT support for competitive strategies: medium effect with project performance (.193)

Importance-performance matrix *IPMA*

The *important-performance matrix analysis IPMA* permitted the contrasting of total effects (importance) against the average values of construct scores (performance) to detect potential areas of improvement, consequently proposing managerial activities that positively impact project performance (Volckner, Sattler, Hennig-Thurau, & Ringle, 2010). Prior to this analysis, data obtained through the survey answers were rescaled (0-100) using the following

equation in which *xi* represents the *ith* data point with respect to the variable score of the observation in the data set. *Minscale [x]* = 1, the minimum value of the Likert's scale, and *Maxscale [x]* = 7, the maximum value of the Likert's scale.

$$x_i^{rescaled} = \frac{(x_i - \text{Minscale}[x])}{(\text{Maxscale}[x] - \text{Minscale}[x])} \cdot 100$$

The rescaled data was the input in the model and, using the *PLS-SEM algorithm*, the scores of the latent constructs were calculated in terms of total effects and index values. This was the basic information required for the *important-performance matrix analysis IPMA* of project performance. Table E9 shows the results of the total effects and index values, denominated *importance* and *performance* respectively for the analysis. Instead of displaying the R^2 values of predictor constructs in the path model, the *IPMA* results display the performance values of each predictor rather than displaying the *standardized outer weights* (Figure 20). The *IPMA* results show the unstandardized and rescaled *outer weights* of the measurement models regardless of if they are formative or reflective. Using these results, the i*mportance-performance matrix* shown in Figure 21 was made, providing evidence concerning the predictor constructs and project performance as follows:

1. In the underlying mechanism, IT support for core competencies (.942, 57.3%) is of vital importance for project performance, exceeding IT support for competitive strategies (.669, 61.2%). Hence, managerial activities should be primarily oriented towards promoting core competencies given that their performance indexes are similar. The *IPMA* results are coherent with the theory which postulates that core competencies are part of competitive strategy drivers through their cause-and-effect relationship. (Barney, 1991).
2. In exogenous constructs, IT capabilities (.659, 77.2%) are of vital importance for project performance, exceeding IT resources (.611, 68.3%).

In the same fashion, managerial activities should be primarily oriented towards promoting capabilities, especially since its performance index is higher. The results are coherent with the theory which postulates that capabilities are the primary intangible asset that promote both core competencies and competitive strategies through their cause-and-effect relationship (Nevo & Wade, 2010; Pavlou & El Sawy, 2006).

3. The *IPMA matrix* indicated that performance was between 60% to 70% without a relevant difference between these indexes. This result indicated that the impact on the key construct, project performance, is determined by the combined effect of the four predictor constructs included in the model. (Teece et al., 1997)

4. The *importance indexes* for IT resources and IT capabilities were lower than the performance indexes of IT support for competitive strategies and IT support for core competencies. This complied with the mediator effects of the underlying mechanism described in the literature. In this sense, Barney (1991) postulated that, when resources and capabilities are accumulated and deployed, they have an impact on the internal competencies and facilitate the formulation and development of competitive strategies that impact firm performance.

5. The *importance index* of IT capabilities was lower than that of IT support for core competencies. This is consistent with the literature which points out the causal relationship between the process of incorporating and aligning resources and establishing capabilities to create core competencies (Spanos & Lioukas, 2001).

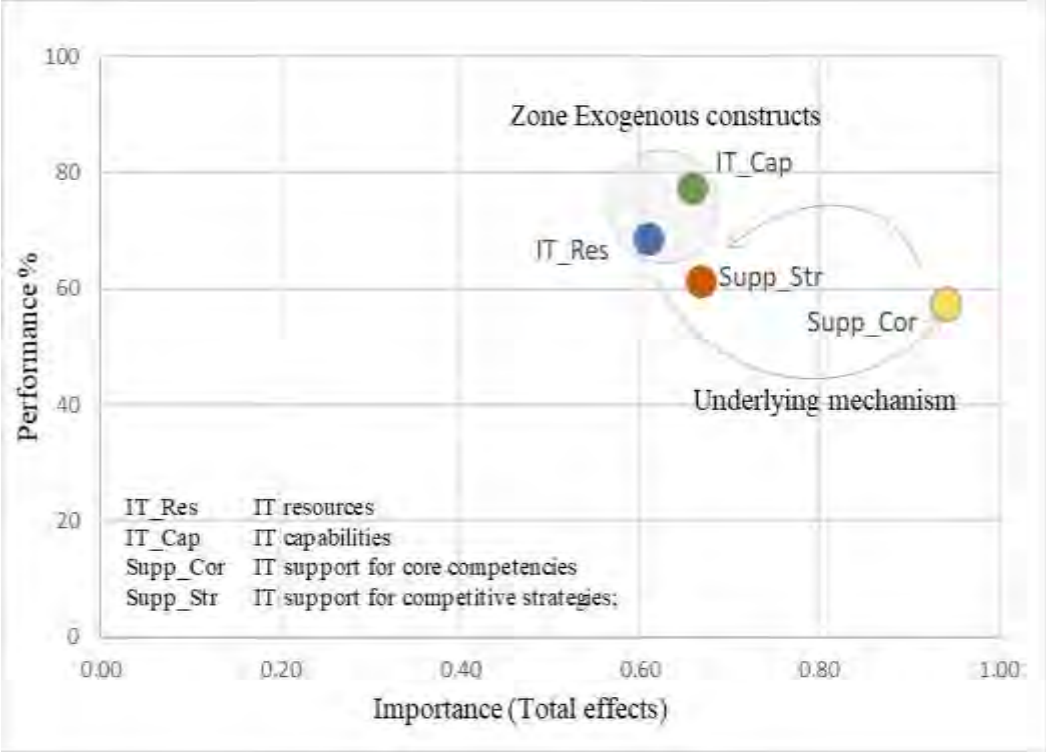


Figure 21. Results of Importance-performance matrix *IPMA* analysis.

Model moderator effects

In previous sections, the evaluation of the *PLS-SEM* model included all observations with the assumption of *respondents' homogeneity*. In this section, the research included the *heterogeneity analysis* as an empirical perspective to validate the existence of moderator effects derived from subgroups in the sample and their impact on model consistency. The results contributed to minimize misleading conclusions and erroneous recommendations, thereby enriching the research findings.

Based on previous studies (Muller & Turner, 2007) and the survey information, the research included four explicit moderator variables which correspond to a possible *subpopulation*. These were evaluated by conforming two subgroups in each one as follows: (a) organization type: (63, 65), (b) years of experience: (60, 68), (c) education level: (70, 58), and d) job title: (67, 61). Yet, *heterogeneity* normally being unobservable, future studies could incorporate additional moderator variables. According to Cohen (1992), and taking into

account the model´s statistical framework (minimum R^2 =0.25 in any endogenous construct, *model significance level* of 5%, *statistical power* of 80%, level of complexity based on the *maximum number of arrows pointing at a construct in the PLS path model*=4, and *maximum number of independent constructs*=2), the minimum sample size of the subgroups was 52. Therefore, all of them met this requirement.

The *PLS-SEM algorithm* was applied with parceled data by each previously tested *subgroup* to ensure convergence reliability and validity. The bootstrapping procedure (5,000 bootstrapping samples) was applied for each explicit moderator factor. The calculations involved path coefficient estimates and standard errors for each *subgroup*; these results are shown in Table E10. With the statistical parameters of each group and in each path, *Levene's test* was applied to evaluate the following hypothesis: The *standard errors* of group one are equal to the standard errors of group two. If the *p-value* of each path was higher than .05 and lower than .95, the hypothesis was not to be rejected. In this case, taking into account the respective *p-value*, it was possible to determine if the *path* was moderated by a specific *moderator factor*.

Analysis of the moderator factors allowed the relationships between constructs to be better described and was focused on testing the amount of moderator effects for each one and how much it absorbs a path relationship or can change its direction (i.e., suppressor effect). The *heterogeneity analysis* was done in each *path* and the results, grouped by explicit *moderator factors* in terms of the *p-value*, are shown as follow:

1. Organization type (public: 63, firms: 65): IT support for core competencies – project performance path (.368), IT support for core competencies – IT support for competitive strategies path (.701), and IT support for competitive strategies – project performance path (.264). In all cases, the *p-value* was greater than 5% and lower than 95%. Therefore, the empirical study

confirmed that organization type was not a moderator factor.

2. Years of experience (up to 7: 60, more than 7: 68): IT support for core competencies –project performance path (.400), IT support for core competencies – IT support for competitive strategies path (.390), and IT support for competitive strategies – project performance path (.004). The final path listed provided evidence that years of experience was a moderator factor in the model. The other paths, however, were not moderated.
3. Education level (professional: 70, specialist and other levels: 58): IT support for core competencies – project performance path (.873), IT support for core competencies – IT support for competitive strategies path (.696), and IT support for competitive strategies – project performance path (.679). In all cases, the *p-value* was greater than 5% and lower than 95%. Therefore, the empirical study confirmed that education level was not a moderator factor.
4. Job title (high-level: 67, mid-level: 61): IT support for core competencies – project performance path (.261), IT support for core competencies – IT support for competitive strategies path (.697), and IT support for competitive strategies – project performance path (.024). The IT support for competitive strategies – project performance path provided evidence that job title was a moderator factor in the model. The other paths, however, were not moderated.

Summary

Overall, the findings indicated that the model components (items, subconstructs, and constructs) and their corresponding relationships had sufficient psychometric quality (reliability and validity) to provide adequate support for their inclusion in the model. However, it was necessary to make adjustment in some of the items and first-order constructs due to

collinearity and low significance. Ultimately, some items needed to be excluded and some predictors merged into a single construct.

According to the *partial least square – structural equation modeling PLS-SEM* methodology, the structural model was to be measured following two key dimensions: the *model's predictive capacities* with *the coefficient of determination* R^2 and strength of the relationships with the *path coefficient Pij*. Altogether, the results indicated that the model fit substantially and produced evidence that the data supported the empirically confirmed theory.

In this field of study and according to Karl Popper's epistemology (Figueroa, 2012), the findings generated evidence to indicate that there is a cause-and-effect relationship between IT resources and IT capabilities with respect to physical infrastructure project performance upon referring to the *total effects*. Despite the low value of the *path coefficients* corresponding to the IT capabilities – project performance path (.212) and the non-significant path, IT resources – project performance, the *total path scores* increased to 67.89% and 62.83% respectively by means of the mediating effects of IT support for core competencies and IT support for competitive strategies. This ultimately corresponds to a level of *near-full mediation*. In terms of *total effects*, IT resources and IT capabilities were significant and relevant in describing the key construct known as PI project performance. These empirical results were consistent with the BVIT concept, which postulates the existence of an underlying mechanism (IT support for competitive strategies and IT support for core competencies) which realizes a mediation effect between the exogenous constructs (IT resources and IT capabilities) and the endogenous construct (PI project performance).

The IT resources – project performance *path* was not significant given that the empirical test indicated no causal relationship between these constructs. In the *total effects* analysis, all model paths had statistical significance and strong positive relationships in

effectively describing the key construct. Therefore, the null hypotheses could be rejected while the hypothesized relationships among the constructs could be confirmed.

The results of *predictive relevance* Q^2, *relative predictive relevance* q^2, and *effect size* f^2 confirmed that the structural model had reliable conformation. In other words, the *predictive capacity* of the individual constructs as a systemic part of the model were appropriate in describing PI project performance.

The *importance-performance matrix analysis IMPA* led to the detection of potential areas for improvement with respect to activities, taking into account the individual impact of each construct in project performance in terms of their *importance* and *performance* indexes. Another key aspect from the evaluation was the *multigroup analysis*, which permitted the measurement of moderator effects derived from the *respondents' characteristics*. There was no evidence that factors related to organization type and education level played a role in moderation. Nevertheless, as indicated in Table E10, there were two *moderator effects*: years of experience and job title. Both of these factors exhibited *moderator effects* in the same *path*, IT support for competitive strategies – project performance. However, given that *heterogeneity* is normally unobservable, future studies could expand on this analysis potentially through the incorporation of other *moderator factors*.

Chapter 5 will present the interpretation of the data results extracted in the study, focusing on the relevant findings and their implications in the fields of management and leadership. Finally, personal views, observations, and recommendations for future research will be postulated with the aim of advancing essential knowledge in this ever-growing field of study.

Chapter 5: Conclusions and Recommendations

In nearly one-third of countries there is a gap in physical infrastructure (PI) which negatively impacts people and economic agents (Perrotti & Sánchez, 2011). Given that the current physical infrastructure gap in certain countries (i.e. Latin American countries) is about 40%, any contribution to promote an adequate level of PI would promote the productivity platform and thereby increase the social indexes of equity and sustainability (Rozas & Sanchez, 2004). In this sense, the research integrated the Business Value of Information Technology (BVIT) as an academically recognized concept to study and understand how IT could create value in project management functions and how IT could positively impact PI project performance. In this way, this study can serve as a significant contribution towards the resolution of a situation that affects millions of people in the world. The design of this quantitative research aimed to measure to what extent IT resources and IT capabilities, the exogenous constructs, correlate with PI project performance, the endogenous construct.

From the problem raised and the conceptual bases derived from the literature review, the research included two key measurements: the research *model's predictive capacity* and the *strength of the relationships* between constructs. Both were used to develop the main objectives of study as follows: (a) to measure the *direct* and *indirect effects* of IT resources and IT capabilities with PI project performance in order to establish if there are causal relationships between these constructs and thus obtain the empirical arguments required to answer the research questions; (b) to measure and understand how the underlying mechanism (IT support for competitive strategies + IT support for core competencies) acts as described by the literature as a mediator mechanism between exogenous constructs (IT resources and IT capabilities) and the endogenous construct (PI project performance); (c) to establish if the *respondents' traits*, being considered as explicit factors, *moderate* the study and if they may constitute a research *heterogeneity* issue; (d) to establish if the predictor constructs involved

in the research model had adequate *predictive capacity* to plot PI project performance, hence relying on appropriate empirical evidence to confirm or reject the hypotheses raised. Following the research process, the overall goal was to determine how well the empirical data was supported by the theory and therefore conclude if theory was confirmed empirically; and (e) with the research results on hand, to provide conceptual and empirical bases that permit the formulation of recommendations concerning the primary actions in project management that may be adopted in public entities and firms to better contribute to increased performance in the development of PI, effectively promoting their efficiency and productivity and contributing greatly to the closing of development gaps present in countries.

In methodological terms, the research was cross-sectional and made use of deductive logic with an initial theoretical analysis based on the research questions and hypotheses by means of Popperian epistemology. Since the study required an evaluation of the *model's consistency*, the *strength of relationships*, and the *mediation* and *moderator effects* between constructs, *partial least square - structured equation modelling PLS-SEM* sufficed as an appropriate statistical methodology. The sample was oriented for convenience and, thus, not random, given that the respondents should exhibit certain conditions as defined by the research design. The respondents were limited to professionals and directors who, at the time of the survey, were working for organizations located in Colombia and voluntarily accepted to participate in the study. The data was all collected first-hand through these aforementioned surveys. Because the data was extracted by means of surveys, subjective evaluations could potentially occur, resulting in a certain degree of bias.

This chapter will initially discuss conclusions concerning the literature review, methodology, data interpretations, and inferences about the findings. Subsequently, it will integrate various implications in the field of the study with respect to leadership and global

actions. Finally, recommendations for managerial actions and potential future studies will be examined.

Conclusions

Penrose (1959), Nelson and Winter (1982), Wernerfelt (1984), and subsequently Prahalad and Hamel (1990), Mhoney and Polovian (1992), and Peterfaf (1993), among others, were the pioneers and drivers of the resource-based view. This strategic vision differed from the postulations of transaction cost or competitive advantage theory (Porter, 1980) and maintained that strategy should be based on the internal configuration of the organization with resources and capabilities as the drivers of firm performance. In this sense, Barney (1991) indicated that when resources and capabilities are accumulated and deployed, they significantly impact internal competencies and facilitate the formulation and development of competitive strategies that impact firm performance. This concept recognized that the accumulation of resources does not suffice, and that the role played by knowledge and technology is highlighted as a transversal element that interacts with the strengthening of mechanisms of core competencies and the establishment and deployment of competitive strategies.

When the organization is able to align its functional capabilities with IT, it can provide, understand, synthesize, improve, and accelerate knowledge management to the interior of the organization, as well as with its stakeholders, on a large scale (Peppard & Ward, 2004). Concerning this, Teece et al. (1997) indicated that these competencies are the result of the accumulation and systematic combination of resources, routines, and knowledge that are transformed into collective learning capabilities and cross-competencies in the dimension of intangible assets, which must be flexible so as to rapidly adapt to dynamic environments. These postulates focused on collaboration and soft skills were the foundation of this research, mainly the BVIT concept being applied to PI projects, to understand how IT

resources and IT capabilities could impact its development. As cited, the research was based on theories and concepts with academic recognition of the BVIT concept, which has been applied in diverse fields but not in the field of PI projects.

The methodological research involved the measurement of the *model's consistency*, the *strength of relationships*, and the *mediation* and *moderator effects* between constructs for which *PLS-SEM* was the statistics methodology selected. The increasing data volume, as well as powerful computer systems, permitted the development of next-generation analysis techniques, such as *structural equation modeling SEM*, which have received much acceptance and recognition in the social sciences in recent decades. *SEM* is a multivariate technique that combines *factor analysis* with *regression*, enabling the examination of relationships of measured variables and latent variables, as well as between distinct latent variables. (Hair et al.,2014).

It is essential to highlight the specific methodological differences between *covariance-based CB-SEM* and *PLS-SEM*, the latter being used in the research. On one hand, the corresponding statistics for *CB-SEM* are derived from the discrepancy between the empirical and theoretical covariance matrix. On the other hand, *PLS-SEM* focuses on the discrepancy between manifest variables or approximation in the case of latent variables. Hence, evaluation by means of *PLS-SEM* builds on a set of nonparametric evaluation criteria and uses procedures such as bootstrapping and blindfolding to measure the *model's predictive capacities*. Given that *PLS-SEM* is nonparametric, it does not assume the data to be normal. *PLS-SEM* relies on a nonparametric bootstrapping procedure (Davison & Hinkley, 1997) to test coefficients for their significance. Others *PLS-SEM* features include achieving a high level of statistical power with a small sample size, functionality with all scale of measurements, and minimization of the amount of unexplained variance (i.e. maximizes the

R^2values). Some researchers have indicated that it has some limitations with categorical data regarding the measurement of endogenous constructs.

Considering that the level of development of physical infrastructure is considered a key factor in the competitiveness of countries (Rozas & Sanchez, 2004), the main goal of the research was to achieve a better understanding of the extent to which IT resources and IT capabilities are related with PI performance. Increased knowledge in this field could contribute to the improvement of PI project performance and, by collateral effect, these findings could contribute in some way to the closing of countries' social gap. Observing the relevant findings within a holistic view, this main research goal was achieved and resulted in the description and a better understanding of the causal effects of IT on PI project performance and effectively determined how well the empirical results support the theory. Given the research design and methodology, the achievement of its central objectives was the result of the systemic incorporation of each component in order to obtain an adequate predictive capacity of the measurement model. To do this, the data and each model component had a relative importance in regard to obtaining coherent results. Following this systemic research condition, the subsequent sections will present the components' psychometric quality, the model's consistency, the strength of relationships, and the mediation and moderator effects.

Psychometric quality of constructs and model

In first-order reflective constructs, the *internal consistency* and *convergence validity test* required three rounds given that the *Cronbach's alpha, factor loadings lij*, and *average variance extracted AVE* values indicated collinearity. It was necessary to make slight model adjustments such as excluding some items and merge some first-order constructs (Figure 19). This finding was associated with the items integrated into the constructs of IT resources and IT capabilities and confirmed the academic difficulty of establishing the boundary between

these two constructs. After adjusting the model, each component was empirically tested. The psychometric quality of first-order reflective constructs indicated that *Cronbach's alpha and composite reliability CR* were generally above the threshold .60 and *factor loadings lij* explained more than 68.8% of each construct's variance, indicating a lack of *multicollinearity*. In general, the *average variance extracted AVE* values were greater than .60, which was greater than the corresponding *maximum shared variance MSV* and *average shared variance ASV* values (Table E1). The results indicated *internal consistency reliability* and acceptable *convergence validity*, concluding that the items and first-order constructs were deemed appropriate to be included in the model.

Table E2 shows the psychometric test of second-order formative constructs. The *variance inflation factor VIF* exhibited a range of values between 1.129 to 2.386, indicating that *multicollinearity* did not pose a significant problem to validity. The *outer weights* were contrasted with the *theoretical maximum outer weights*, indicating that constructs were significant and had relevant weight. Reliability and convergence validity were deemed appropriate to include constructs in the model (Hair et al., 2014). The model was tested in two aspects: redundant information, or high correlations, and significant contributions of the construct. Table E3 shows the *variance inflation factor VIF* and *outer weights*, which indicated that *multicollinearity* did not pose a significant problem to validity and indicators had significant and relevant weight.

Predictive capacity - level of the coefficients of determination (R^2)

The amount of variance in project performance is explained by all constructs at 73.7% (p= 0.0000), which represents a substantial causality effect in the field of study. The *coefficient of determination* R^2 values of the endogenous constructs were substantial, IT support for core competencies (.699) and IT support for competitive strategies (.637), whereas the R^2value of IT capabilities (.449) was moderate. (Figure 20). These metrics

were complemented with the relative predictive capacities to establish if there existed an inherent bias by including nonsignificant minimally-related constructs. All *predictive relevance* Q^2 results of the model were considerably above zero (Table E7) and the *relative predictive relevance* q^2 of exogenous constructs was more than medium with large relevance between IT resources and IT capabilities (.332), as well as IT capabilities and IT support of core competencies (.317). The relative impact or relevance of a predictor construct on an endogenous construct measured with the exogenous-predictor construct´s *effect size* f^2 revealed a substantial effect in all cases, having a large effect between IT resources and IT capabilities (.383), IT resources and IT support for core competencies, and IT capabilities and IT support for core competencies (.321). All these metrics provided support and evidence to the *model's predictive relevance* regarding the endogenous constructs.

Predictive capacity – path coefficients for hypotheses

Despite the low value of the *path coefficients* (direct effects) for the IT capabilities – project performance path (.212) and the non-significant IT resources – project performance path (p=0.0638), the scores dramatically increased by 67.89% and 62.83% respectively when the *total effects* were calculated (*variance account for* - *VAF*). These variations were presented by means of the *mediation effects* produced by IT support for core competencies and IT support for competitive strategies (Table E5). In other words, IT resources and IT capabilities were *significant* and *relevant* in describing the key construct, project performance, by means of a *mediation effect* for the underlying mechanism described by the literature (core competencies + competitive strategies). For this reason, *direct effects* in this kind of study only represent an approximation of *model´s predictive capacity*. These results are consistent with the BVIT concept (Ravichandran & Lertwongsatien, 2005), which postulates the existence of an underlying mechanism composed of IT support for competitive strategies and

IT support for core competencies in the performance framework. The *total effects analysis*, presented in Figure 22, provided evidence to confirm that postulates of the BVIT concept could justifiably be integrated into this field of study (i.e. physical infrastructure projects).

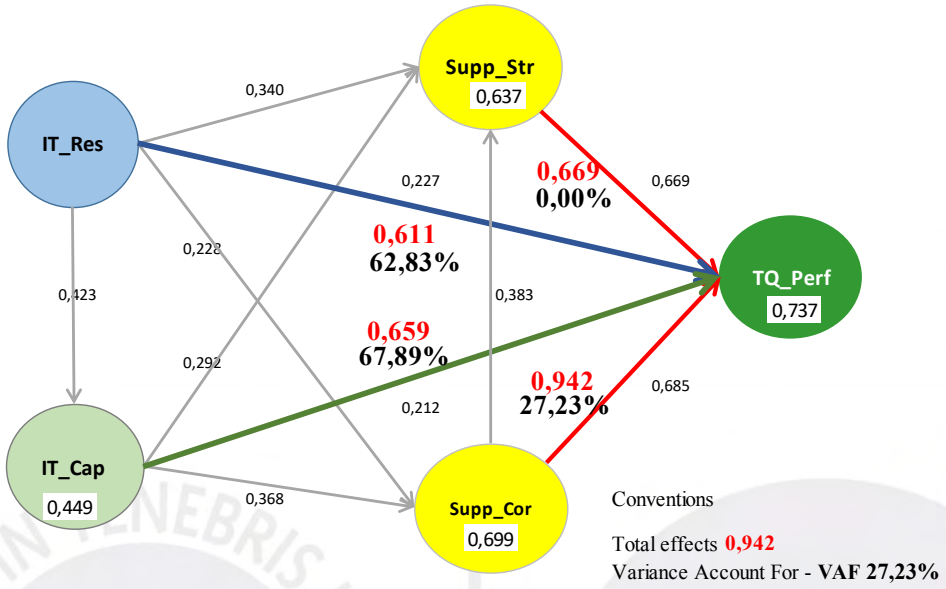


Figure 22. Results of total effects - measurement model.

The results of *total effects analysis* (Table E5, Table E6, and Figure 22) provided evidence concerning the research hypotheses, by at least a 5% level, which effectively described how strongly each construct ultimately influences the key endogenous construct, project performance, resulting in the following conclusions:

1. IT resources has a significant and strong relationship with project performance (.611) which is 62,83% mediated by IT support for competitive strategies and IT support for core competencies. This result provides evidence to reject null hypothesis H_{1o}.
2. IT capabilities has a significant and strong relationship with project performance (.659), which is 67,89% mediated by IT support for competitive strategies and IT support for core competencies. This result provide evidence to reject null hypothesis H_{2o}.

3. IT resources has a significant and strong relationship with IT support for competitive strategies (.611) which is 44.45% mediated by IT capabilities and IT support for core competencies. This result provide evidence to reject null hypothesis H_{4o}.
4. IT resources has a significant and medium relationship with IT support for core competencies (.384) which is 40.63% mediated by IT capabilities. This result provide evidence to reject null hypothesis H_{5o}.
5. IT capabilities has a significant and medium relationship with IT support for competitive strategies (.433), which is 32.56% mediated by IT support for core competencies. This result provide evidence to reject null hypothesis H_{6o}.
6. IT support for core competencies has a significant and strong relationship with project performance (.942) which is 27.23% mediated by IT support for competitive strategies. This result provide evidence to reject null the hypotheses H_{8o} and H_{10o}.

The results for the *direct effects* (Table E4 and Figure 22) provided evidence concerning the research hypotheses, by at least a 5% level, resulting in the following determinations:

1. IT resources has a significant and medium relationship with IT capabilities (.423) and provide evidence to reject null hypothesis H_{3o}.
2. IT capabilities has a significant and medium relationship with IT support for core competencies (.368) and provides evidence to reject null hypothesis H_{7o}.
3. IT support for competitive strategies has a significant and strong relationship with project performance (.669) and provides evidence to reject null

hypothesis H_{9o}.

The *predictive capacity* of the model establishes the empirical evidence necessary to reject all the null hypotheses. Consequently, the presence of the underlying mechanism composed of IT support for competitive strategies and IT support for core competencies is confirmed and verified to act with *near-full mediation* between the effects that IT resources and IT capabilities have on project performance in accordance with the BVIT concept (Ravichandran & Lertwongsatien, 2005).

Overall, the results indicated that the model fit well with respect to the research focus. These results effectively brought about empirical evidence concerning the data which supported and empirically confirmed the theory. Hence, this study exhibits statistical conformity between the beta propositions *(β1: "Structuring IT resources positively impacts PI project performance"* and *β2: "Establishing IT capabilities positively impacts PI project performance"*) and the empirical relations between the endogenous and exogenous constructs. In turn, proposition α is consistent with reality.

Likewise, the *predictive capacity* of the model brings about empirical evidence to answer the major and minor research questions raised. In terms of the *total effects*, IT resources and IT capabilities have a cause-and-effect relationship with PI project performance. This answer carries with it a systemic and holistic view which was covered by Barney (1991). He indicated that, when resources and capabilities are accumulated and deployed efficiently, they positively impact the internal competencies and facilitate the formation and development of competitive strategies that, in turn, impact firm performance.

Moderator effects

A *multigroup analysis* was included in the research to measure *moderator effects* derived from the respondents' features with the following explicit factors being noted as significant: organization type, years of experience, education level, and job title. In general,

there was no evidence pointing to organization type and educational factors as being *moderator effects*. As indicated in Table E10, there were two significant *moderator effects* in the study: years of experience and job title. However, these two factors moderated only a single relationship, that of the IT support for competitive strategies – project performance path. In the context of the *model's predictive capacities*, this *moderator issue* may be considered minor and, therefore, does not affect the study or the results. Yet, given that the *heterogeneity* normally went unobserved, future studies could expand on this analysis and incorporate additional moderator factors that comply with the research focus.

Data and findings analysis

The study confirmed that the underlying mechanism performed in a relevant and integral manner in the research model. The results of the *importance-performance matrix IPMA* showed that IT support for core competencies (.942, 57.30%) was the primary factor impacting project performance. Considering this, managerial activities should be primarily oriented towards improving upon this particular construct. Given this consideration, it was necessary to systemically establish, from the results of the model, prioritized actions to be carried out in this sense. Methodologically, the prioritization process was realized by focusing on the higher path scores from the predictor constructs, from the first-order constructs up to the items. With respect to IT support for core competencies, the first-order construct, *Reso,* related to *IT support for resource efficiency*, had the major outer weight (.483). Its corresponding item, *Reso1,* related to *IT support in achieving project requirements with adequate response times*, had the higher *factor loading* value (.864). This path suggests that, in order to improve PI project performance, one of the most effective ways is to improve IT support for schedule fulfillment by means of the fulfillment of an efficient supply of project resources. This finding aligned with one of the main premises of project management under the effectiveness criteria and corresponded to a level of schedule compliance (McCoy, 1986;

Morris & Hough, 1987; Pinto & Slevin, 1988; Turner, 1993) which is known in the literature as the *project management process* (Baccarini, 1999). This is the first conclusion in the data and findings analysis and specifically points out that, in order to improve PI project performance, one should aim at enabling and aligning IT as effectively as possible to support the procurement of project resources and meet its needs in a timely fashion, thereby accomplishing the right task at the right time in the right manner (Tuman, 1986). It also implies that project information systems should provide relevant information on the quality of resources to minimize deviations in specifications and reduce irrelevant costs related to quality. Since project conditions are established during the contractual process, it is crucial that information systems (IS) allow the project's progress to be tracked by all stakeholders during its execution. This would effectively make project evolution visible, provide time-based information, ensure compliance with milestones for delivering products, and permit one to observe and trace the supply and conformity of resources.

IT support for competitive strategies (.669, 61.20%) is the second predictor construct in terms of *importance* in promoting performance and is an integral part of the underlying mechanism directly linked to PI project performance. Using the same methodology, the findings provided empirical evidence to suggest that managerial activities should be prioritized according to the greatest scores from the *paths*. In this construct, the relevant *path* was associated with the first-order construct, *Post*, related to *IT support to complete project closure and its termination* (.523), and its corresponding item, *Post1,* related to *IT support for reducing project deviations,* had the higher factor loading value (.870). This finding suggests that *performance* is positively impacted when IT contributes to the minimization of deviations and reduction of costs. These correspond to an optimal practice described in the literature as *product success* (Baccarini, 1999). Managerial activities, in accordance with this conclusion, should be associated with identifying technical problems during the project and solving them

in a timely and efficient way (Freeman & Beale, 1992). This finding suggests that project information systems must be provided with an alarm system so that, when deviations do occur, officials can be warned in real-time and suggest actions to restore the project to normal.

Regarding exogenous constructs, IT capabilities (.659, 77.20%) were the primary factor impacting project performance. Its first-order construct, *Leve*, related to the *IT use capability*, had the highest score (.525), and its corresponding item was *the functionaries' ability to use IT applications in project management*, which had the largest factor loading value.

Although the analysis of *direct effects* showed that the IT resources – project performance relationship was not significant, its *total effects* described the leading role of IT resources in all predictive constructs and in the model to promote project performance. This finding was important for two reasons: (a) because functionaries, before perceiving IT as equipment or software, found it more crucial to understand how IT interacts with the business' functions; and (b) because companies with a higher level of resource alignment and IT capabilities have integrated their corporate strategy into technology strategy. This finding leads to the conclusion that the creation of value by means of IT and performance impact is due, not only to the incorporation of IT resources, but to the way in which corporate strategy is aligned with technology strategy. This process is an essential part of an organization's maturation stage and has succeeded in rendering IT the backbone of a business' functions, resulting in enhanced possibilities that increase the organization's competitive edge in a dynamic and international business environment.

With an integral view of the first-order constructs involved in the research model, presented in the *importance-performance matrix* (*IPMA*) below in Figure 23, it can be concluded that the theory is supported by empirical findings related to how IT could develop its capacity to create value in PI project performance. As Grantt (1991) indicated in his

practical framework (Figure 3), there is a strategic and systemic procedure to identify managements gaps which must be improved upon. Corresponding studies have indicated the resource-capabilities theories (since Penrose, 1959) and the BVIT concept so that, when brought together, these theoretical postulates are reflected in the matrix of the first-order constructs whose conclusions are expressed below.

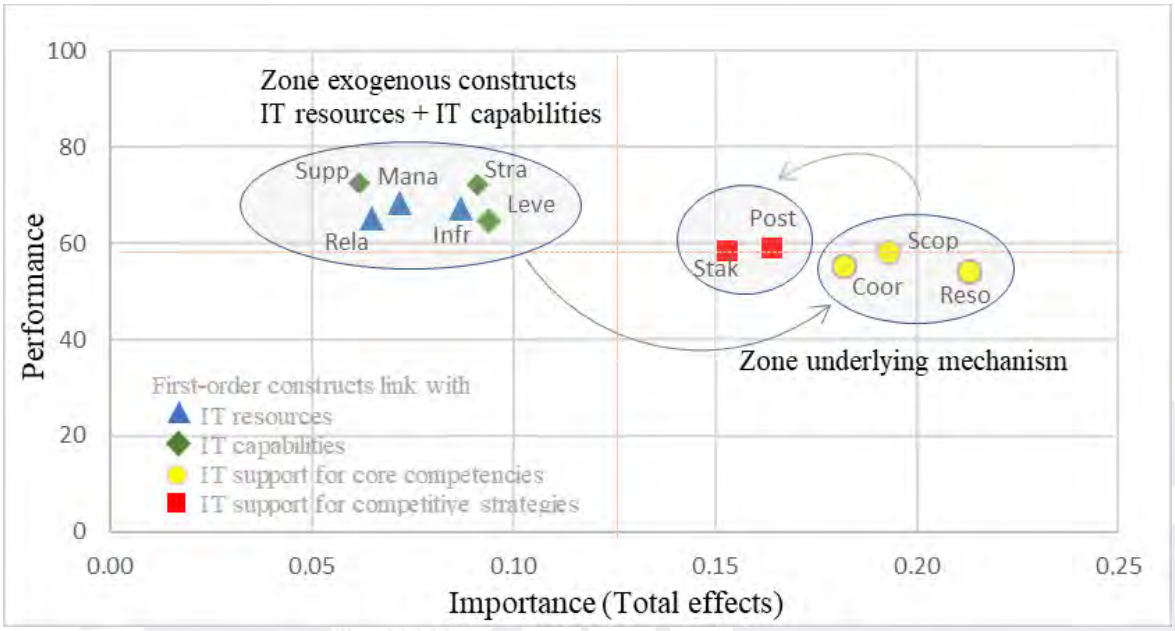


Figure 23. Results of *IPMA* matrix analysis – first-order constructs.

These concepts converge in expressing that the organizational strengthening process must occur in a certain algorithmic order, prioritizing paths that lead to the achievement of goals in an expeditious way that generates high-impact changes. These postulates also recognize that the accumulation of resources does not suffice on its own and that the role played by knowledge and technology is recognized as a transversal element that interacts in the strengthening of mechanisms related to core competencies and the establishment and deployment of competitive strategies. When an organization is able to properly align its functional resources and capabilities with IT, it can provide, understand, synthesize, improve upon, and accelerate knowledge management to the interior of the organization and its stakeholders to a great extent (Wade & Hulland, 2004; Peppard & Ward, 2004). Following

this, Teece et al. (1997) indicated that these competencies are the result of the accumulation and systematic combination of resources, routines, and knowledge that are transformed into collective learning capabilities and cross-competencies in the dimension of intangible assets. Furthermore, they must be flexible so as to rapidly accommodate to dynamic environments.

The corresponding impact on performance depends on the identification of resources and capabilities that may potentially become competitive advantages and collectively promote competitive core competencies. Although this gives competitive strategies a temporary dimension, that of whether to strengthen existing core competencies or generate new ones, both situations positively impact performance. Value creation occurs when IT is capable of positively impacting core competencies and competitive strategies. IT further develops its effect on core competencies when it promotes those which are rare, difficult to reproduce, and irreplaceable (Hafeez et al., 2002; Hamel, 1994; Prahalad & Hamel, 1990). They are considered rare when they are unique, specialized, and/or non-transactional. They are considered difficult to reproduce when they are associated with complex relationships between resources, functions, and multidimensional technologies, or when they depend on specific experts in the organization. They are considered irreplaceable when they are perfectly immobile and are associated with the organization's culture, idiosyncrasy, and/or crossed-competencies (Dietrich & Cool, 1989). The integration of IT resources and IT capabilities with the aim of developing IT support for core competencies can be leveraged through the deployment of competitive expansion strategies that positively impact performance. If organizations leverage their IT permeability capacity and integrate it into business functions, there is a high chance of creating value in the organization. In this sense, IT contributes to learning, replicability, cooperative work, information handling, decision-making, and the fostering of performance via soft elements (Teece et al., 1997).

The results for the empirical test concerning predictive constructs (Figure 22) and first-order constructs (Figure 23) coincided in describing the algorithmic order postulated by the literature and summarized by Grantt (1991). The zone in the *IPMA matrix* where IT resources and IT capabilities have a lower *importance index*, but a greater *performance index* draws the starting point for creating value with IT. This correlates to structuring IT resources and developing IT capabilities to the extent of being able to support the business' functions, the decision-making process, collective learning among those who use it, etc. The IS literature postulates that, when an organization systemically incorporates and aligns its IT resources and IT capabilities, its develops advantageous features that promote its core competencies (Ravichandran & Lertwongsatien, 2005). For this reason, the zone where constructs related to IT support for core competencies are located is characterized for having the highest *importance* given that it directly impacts PI project performance and summarizes the effects of IT resources and IT capabilities. When replicability in organizational functions is achieved with adequate resources and aligned organizational capacities, the likelihood of developing competitive strategies increases dramatically. Therefore, constructs related to IT support for competitive strategies exhibit less *importance* than IT support for core competencies since it absorbs the effects of other predictor constructs. However, it has higher *importance* than IT resources and IT capabilities for its *direct* impact on PI project performance. From this assessment, the organization can develop and deploy IT strategies that generate value and subsequently impact *performance* in a positive manner.

Findings in relation to predictor constructs and first-order constructs confirmed there is a relatively intermediate range of *performance* indexes. This reflects how the impact on *performance* is due to a synchronized and algorithmic process of resources and capacities which foster core competencies and competitive strategies. Hence, the IT value creation

process is systemic and requires multidimensional efforts rather than concentrated efforts in some organizational dimension. (Wang et al., 2012).

As part of the final conclusions of this study, the following section presents the research's interpretation in terms of its contributions and significance for other researchers and managers. Three specific points are highlighted for the research field:

The study has empirically confirmed that the conceptual model based on BVIT could be applied in various fields such as industries and consulting firms, which have been the subject of previous research (Wang et al., 2012), or physical infrastructure and the construction sector, as was the case in this research. The findings were consistent with the theory since IT value creation under the BVIT concept is based on the systemic integration of IT resources and the efficient deployment of IT capabilities. Both demonstrate their *effects* on performance through the underlying mechanism composed of IT support for core competencies and IT support for competitive strategies. The low *path score* for the IT capabilities – project performance relationship and non-significant relationship of IT resources – project performance confirmed the *mediating effect* described in the literature. Therefore, future research studies should integrate a systemic view of value creation by proposing managerial adjustments from the causal relationships derived from structuring IT resources and deploying IT capabilities which primarily impact core competencies.

Derived from the previous point, the study established the *total effects* of predictive constructs, thereby confirming the *importance* of IT resources and IT capabilities in creating value when the organization is conceived as a whole. *Direct effects* may at first glance seem to not have a causal effect on performance. However, by integrating relationships with the underlying mechanism, IT resources and IT capabilities dramatically increase their *effect* on *performance*. For this study, the effects of IT resources and IT capabilities increased by 62.83% and 67.89%, respectively. This is consistent with the literature, since Penrose (1959)

and the resource-capabilities concepts have been preserved throughout the resource-based theories up to this point. Basing managerial decisions on *direct* relationships alone can lead to managers making decisions that are not appropriate for achieving objectives. In terms of central goals, project management must be oriented to comply with the schedule in a timely fashion and fulfill the budget while preserving quality. This fulfillment can be severely put at risk if the vision is unidimensional. Therefore, it is of vital importance that researchers generate the conceptual and methodological bases necessary to support PI project managers and, in turn, minimize these kinds of risks.

Another relevant aspect expanded upon in the literature is the ambiguity of devising a concrete border between the definitions of resources and capabilities. In this study, it was empirically verified that this difference is diffuse, especially in the field of IT. This gray area may be the object of future research to better understand it so that managers may incorporate more assertive actions, thereby leading to more effective yields in performance.

From the literature and research findings, the following relevant conclusions are oriented to managers: For almost 60 years (Penrose, 1959) researchers of the resource-based view have indicated that performance is the result of a systemic process born within the organization. If it is done in an organized and systemic fashion, there is a great chance of obtaining notable results in market shares and profit. The research empirically confirms that results are the consequence of a multidimensional vision and involves the definition of competitive strategies that describe the operational way of aligning resources and deploying capabilities that strengthen core competencies. Therefore, managers' efforts should be focused on identifying the underlying weaknesses in resources and capabilities that distort their core competencies and prevent the achievement of strategic goals. However, intervening in a single dimension or only partially will result in a weak impact on performance.

Organizational complexity and the generation of huge volumes of information have exposed organizations to dynamic environments and carried them towards new trends in management. A prevalent trend described in the IS literature is the alignment of corporate strategy with IT strategy (Ravichandran & Lertwongsatien, 2005). This concept has been widely accepted both in government entities and firms, but in practice there is an applicational gap. This phenomenon, taking example from Colombia, arises because organizations consider IT investments an expense rather than an investment with payback. As made evident in the empirical test, perceptions about CEOs are obscure and respondents claimed they are not part of the relevant actions and decisions made by the organization. This lacking area of information about organizational roles creates weaknesses in the processes, prevents the sharing of knowledge, prevents the observance of project activities, etc., and impacts an organization's performance. In this sense, IT and the managers should play a preeminent role, especially when IT has revolutionized human actions, and the case of PI projects should not be an exception. Organizations that have succeeded in synchronizing business strategies and operations with IT strategies and operations have achieved quantitative leaps in performance. This type of benefit is what is being sought with this research in the field of physical infrastructure.

According to recent measurements, a gap in physical infrastructure is present in nearly a third of all countries (World Economic Forum [WEF], 2017), including all of Latin America (Rozas & Sanchez, 2004). This is a multifactorial phenomenon, but a key determining factor is the low visibility of project evolution by means of IT. Reviewing the measurements of technological readiness (WEF, 2017), these countries typically exhibit relatively low levels of technological absorption. This reduces the possibility of having reliable and timely information systems for government activities and their respective interactions. If countries do not develop their IT ecosystem with timely functions and more advanced technology, it shall

remain difficult to articulate government actions, thus resulting in a fertile field for bad practices with respect to technology and budgeting. In this context, a strategic advantage would be to strengthen the PI project's digital ecosystem in order to characterize the nation, regions, and firms, and achieve efficiency in the deployment of social programs by making them visible, optimizing public budget, and reducing bad or risky practices. This managerial distortion was the motivation for developing this research, which seeks to make a conceptual and applied contribution to promote the closing of the physical infrastructure gap that affects millions of people worldwide.

Implications

With the evolution and specialization of nations, certain responsibilities have been delegated to firms, such as the construction of physical infrastructure, which is typically carried out through different types of contracts and partnerships. These relationships aim to develop upon this public aspect, forcing both government entities and companies to share the responsibilities facing citizens. The current state of PI indicates that almost one-third of the world does not have an adequate state of roads, hospitals, schools, housing developments, water, and sanitation systems, among others features (WEF, 2017). For example, the PI gap in Latin American countries is nearly 40% (Rozas & Sanchez, 2004). This situation calls upon the following reflection: In what ways is it possible to stimulate a transformational leadership (D 'Alessio, 2013) to change the current PI situation that impacts millions of people around the world?

Some research suggests that the possibility to exercise the leadership to transform reality, (i.e. PI), is defined by the nation's context (Ronen & Kraut, 1977), and it causes that in some clusters of countries the status quo has low possibilities of change. If this premise were true, there would be little chance of covering the social debt in terms of the sustainability, equity, and life quality associated with the PI gap. Fortunately, the IT

revolution could be the determining factor leaders may take advantage of to achieve high-impact changes. Hence, providing timely and reliable information concerning the development of PI projects is a strategic challenge for nations. On one hand, IT promotes the productive development of companies based on their sophistication and diversification, as was incorporated in the Colombian Productive Development Policy's (PDP) vertical agenda. (*Departamento Nacional de Planeación,* [DNP], 2016 a). On the other hand, IT insertion into organizational functions strengthens coordination and promotes the execution of optimal goods and services for citizens, an integral part of the PDP's horizontal agenda (DNP, 2016 a). The combination of these effects would allow better articulation between PI actors, deployment efficiency of social programs, public budget optimization, and measures of risk reduction to prevent unwanted practices. Altogether, these elements would contribute to the countries' sustained growth and development. (Crespi, Fernández-Arias & Stein, 2014). If IT were to be thought of as the backbone of management, the project managers' decisions would be based on reliable data analysis, promoting their critical thinking capacities, limiting their emotional postures, and enhancing their emotional intelligence. Additionally, the visual observance of a project's evolution in real-time will render them less prone to unfavorable practices and contribute to public ethics. This set possibilities derived from IT are the fertile field to apply the transformational leadership describe by D 'Alessio (2013).

The challenge of leadership in PI is broader and would have to involve the government, firms, and academies of the country. In this way, it would be possible to change the current PI situation by means of transformational leadership supported by IT, mainly inferring director conducts and thereby contributing to the closing of social gaps.

The following section will present an overview about the main problem associated with the research, its context, and an approximation of its solution. A specific reference has been made to Colombian PI (geographical research limitation) based on its competitiveness

indexes (WEF, 2017). Additionally, some official documents from the Colombian government reflect its current state. These records point to possibilities to improve PI performance through a joint effort of social actors. Its presentation has the form of an elevator pitch in accordance with academic regulations.

In the front of Washington's World Bank Headquarters there is a stone plate inscribed, "Our dream is a world without poverty," signifying its primary goal in 145 countries around the world. Despite efforts, nearly one billion people (WEF, 2017) experience critical life conditions associated with the low level of PI development such as poor roads, hospitals, schools, housing developments, water, and sanitation systems. In some countries, such as those of Latin American, the PI gap is around 40% with the transversal and dramatic effects in social indexes being primary related to equality and sustainability (Rozas & Sanchez, 2004).

Taking these PI effects into the social context, it is a challenging feat to improve PI project performance and effectively contribute to restoring the current social debt. Hence, the purpose of this research study was to understand how IT can contribute to PI project performance by considering the ways in which IT has changed human behavior and integrated itself as a foundation for human activities, the effects of which have been disruptive in various aspects such as public transport, the hospitality industry, banking transactions, etc. This disruptive capacity can be repaired and improved upon to positively impact PI and its environment by eliminating unfavorable and ineffective practices present at both the public and private levels. As any natural starting point, this prospective idea has a utopian basis. Regardless, if the ideas and concepts are systematically structured and perform well in the main sectors, it will become possible to achieve high impact changes sooner than later.

During the fourth industrial revolution in which we currently find ourselves, the organization, exhibition, and dialogue of information by means of IT between governments and firms has proven to be a strategic challenge for national and international

competitiveness. This IT ecosystem could be applied in PI field, being the driver of the organization's sophistication through its knowledge transfer capacities. In this respect, recent studies about emerging countries indicated that, when existing knowledge is incorporated, methods, technologies (the 'catch-up process'), productivity, and competitive gains could be realized in the short-term, showing potential improvements by more than 70% (McKinsey Global Institute, 2015). However, indexes concerning abortion capacity and BVIT in several countries are still in their early stages and show high chances of improvement.

The first step in this process of change is to recognize the reality of the situation. The Global Competitiveness Index (GCI) is a consolidated measurement consisting of twelve factors (or pillars) associated with the country's ability to provide resources and capabilities and ensure prosperity for its citizens. The second GCI pillar concerns Infrastructure (PI) in terms of coverage and efficiency for social welfare and the functioning of a country's economy. (WEF, 2017)

As mentioned previously, Latin American countries show, on average, a PI gap of about 40%. The Colombian PI gap follows this regional average and ranks 84th out of 138 countries in this respect. This indicator broadly describes regional problems and indicates countries with a medium to low level of development. Recent assessments on PI project management indicated that nearly 70% of Colombian towns experienced difficulties in formulating and developing projects. The main reasons officially recognized for this incapacity were as follows: institutional disarticulation, the project development cycle did not respond to standardized guidelines and methodologies, there were no clear national and regional roles or responsibilities, resulting in a duplication of effort, and project officials had low levels of instruction and knowledge in project management. (DNP, 2016 b). These negatively-impacting conditions are reflected in the competitiveness indexes. Colombia ranked sixth out of 18 Latin American countries with respect to government effectiveness

indexes and ranked 124th out of 138 countries with respect to regulation cost indexes (WEF, 2016). Colombian productivity growth, even in the construction sector, was virtually null between the period of 1991 to 2015 (DNP, 2016 a).

At the same time, IT has been a component towards which the Colombian government has given special emphasis with the aim of promoting competitiveness and has effectively contributed to procedural simplification and centralization of strategic information systems among other factors. (DNP, 2016 a). However, indexes like Open Government (IGA, for its acronym in Spanish) and Government Online (GEL, for its acronym in Spanish) indicate that IT is still in its nascent stage and, in some respects, has regressed. For example, with respect to the innovation index, Colombia fell from 71st place in 2007 to 79th in 2016. 89% of companies do not use IT in the production processes and, when it is used, 95% of companies use outdated technologies. As the Colombia government recently expressed, Colombia is in dire need of an advanced level of technology and processes that go beyond managerial practices. (DNP, 2016 b). This statement outlines the institutional situation and gives scope to the situation of the firm regarding the productive development policy (PDP) of Colombia. One of the relevant components in the scaling-up of business productivity is knowledge transfer stemming from the quality of management and the adoption of technology. In Colombia, during the period between 2006 and 2016, the index related to confidence in professional management fell to 4.3, constituting one of the lowest-ranking indexes in comparison to some benchmark countries. Furthermore, the rate of technological adoption was unchanged, remaining at 4.4 (Consejo Privado de Competitividad [CPC], 2017).

For countries like Colombia, which has dedicated itself to providing better conditions for citizens by promoting PI development, the challenge is multidimensional and must be addressed systematically. Given all the background and results from this study, three key

aspects are proposed to speed up and improve PI development with absolute efficiency. These three aspects are as follows:

1. Initially, it must be recognized that technology itself is *not* the solution to the problem. Everything should start from a conceptual basis based on optimal project management practices. In this sense, the first step is to adopt a Unified Methodology of Project Management (UMPM) based on optimal practices; this is the golden rule for management in government entities and firms. This is because the organization's sophistication starts with a common language through the transfer of knowledge and technology. As previously cited, many studies recommend incorporating existing knowledge, methods, and technologies to achieve improvements in productivity, a phenomenon known as the *catch-up process*. The UMPM methodology should be parametrizable throughout the entire project cycle and be adaptable to regional heterogeneity so that it is easily adopted by officials and managers.
2. Concepts supported by a transactional computer tool that allows the transfer of technology and knowledge to the directors of organizations, as well as visibility among related audiences, constitutes a real response to a situation as burdensome as the PI gap. Therefore, the second step is to implement a functional information system (IS) that supports the UMPM and permits movement between PI actors. This system must have its evolution recorded in real-time and allow reports about the project's Key Success Factors (KSF) to be made. This IS must have an alarm module that is activated when project deviations are detected. As a whole, a holistic IS will promote open government (IGA) and online government (GEL) indexes.
3. From UMPM and IS, it is possible to carry out the transfer of knowledge

and technology that leads to the scaling-up process of productivity by government entities and firms. In this way, officials can properly structure and develop PI projects and project managers will be able to sophisticate their project management capabilities and disperse knowledge within the company.

The IS-UMPM would minimize redundant efforts and permit the achievement of PI project objectives. By having a simple and parameterizable management model it is possible to carry out activities in a timely manner, thereby minimizing unfinished PI projects (Colombian term for this occurrence: white elephants). Efficiency in PI project development will exhibit a positive and transversal impact on regions, contributing to the closing of social gaps. IS-UMPM will provide a technological window of accountability, effectively reducing regulatory costs, permitting centralized fiscal control, optimizing budgets, and reducing the likelihood of unfavorable practices. Development of this initiative could become a reference of innovative public procurement based on the systemic integration of optimal practices with high possibilities for national and international dispersion. To describe a consistent route of PI productive transformation, the initiative is synthesized with a multidimensional view whose deployment is realized in an ascending way from the perspective known as collective competencies. (Figure 24)

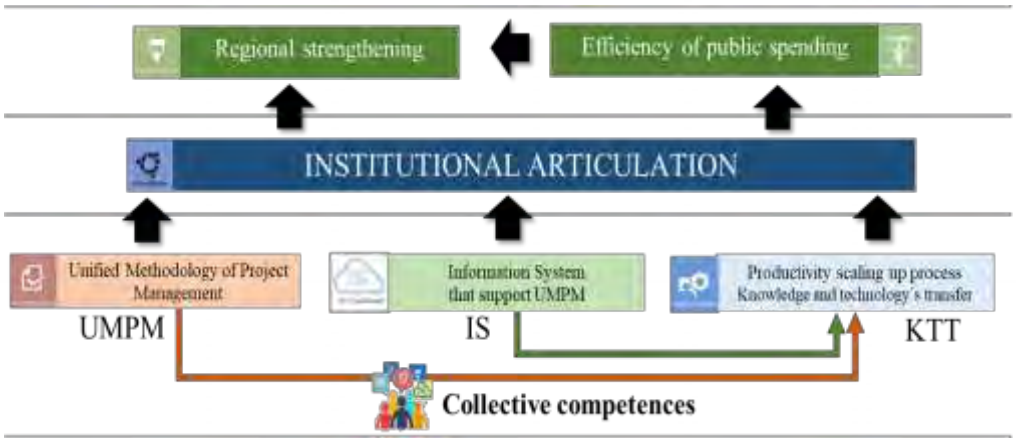


Figure 24. Algorithmic proposal to impact PI project performance.

This route begins with the adoption of the Unified Methodology of Project Management (UMPM) criteria, which will serve as a basis for the information systems (IS) development. These two components will lead to the scaling-up of productivity by means of knowledge and technology transfer (KTT) in entities and the construction sector. Collective competencies (UMPM + IS + KTT) would promote institutional articulation and positively impact the efficiency of public spending and regional reinforcement. These causal relationships altogether could transform the current status quo and cause national levels of competitiveness to rise through IT impact on PI project management.

This confluence of actions will permit a positive disruptive solution, promoting government efficiency and sophisticating PI management of the company while making project evolution visible to the stakeholders. In fact, emerging countries have advantages regarding technological adoption since they may feasibly do so with shorter learning times and no limitations on inherited technologies, resulting in a quick catch-up process with the potential for continuous improvement and innovation. However, these actions are only possible if there exists a political will oriented towards public service.

Recommendations

Researchers and academics such as Sir Ken Robinson and Vivek Wadhwa have indicated that technological advances which have revolutionized recent history involved at least two aspects. The first of these consists of attitude, persistence, and collaborative work. The second is derived from combinations of disciplines. These two conditions have resulted in disruptive changes that were unimaginable, yet managed to change status quo. To a certain extent, these orientations provided a philosophical lever in this research. This is present in the first instance given that it is oriented toward promoting change in the reality of PI and producing management options to improve its backward status, thus dramatically impacting millions around the world. It seems there is no clear and concerted view to solve this problem. IT as a

key research component was considered to be the trigger of the effects of productivity and competitiveness, elements which shall be reflected in the construction sector and the economic and social state of the countries themselves.

The research is an invitation to society as a whole, integrating governments, companies, and academia, to promote IS as a backbone to the institutional reinforcement and productivity of firms. In this sense, the first relevant recommendation for future investigations is to study fields of knowledge which utilize IT to mitigate the most pressing needs of the citizens, such as health, education, housing, sanitation, transportation, etc. By means of these coordinated combinations, there are or will be solutions to these pressing issues in the short-term, such low-cost alternative energy systems, urban transport without drivers, and buildings constructed with 3D-printers, among many other revolutionary societal advancements. This is not some part of fiction, it is happening in this very moment. The second recommendation is to make use of this research framework for future studies and investigations which deal with the correlation between performance in different fields of knowledge with IT, such as health or education performance. This would facilitate research in new disciplines based on the prominent theories recognized by the literature, which are heavily used by critical groups of technology-based researchers.

With respect to the research subject, the following are recommendations for future studies: Quantitative longitudinal studies that measure the evolution of IT effects on the improvement of project performance, primarily in budget optimization for government entities and profit generation for firms. GSS Groups support system studies to identify how IT influences group capabilities for the development of PI projects. Construction sector analyses to identify the installed technological capacity and its potential to create value in government entities and firms. And finally, a potentially insightful study opportunity would

be to assess to what extent IT contributes to management based on previous activities and knowledge management.

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Appendix A: Informed Consent

Bogotá, XX

Sr.

Organización

Respetado Director

Soy estudiante del programa doctoral en Business Administration (DBA) en Centrum - PUCP y en Maastricht School of Management, y estoy desarrollando como tema de investigación: "Recursos y capacidades de la tecnología informática como dinamizadores del desempeño de los proyectos de infraestructura física" (*IT Resources and IT Capabilities as a Driver of Physical Infrastructure Projects Performance*). Este estudio busca encontrar las relaciones entre la tecnología dispuesta y la utilizada y como soporta la gestión y el desempeño de las organizaciones que tienen como responsabilidad el desarrollo de la infraestructura física del país.

Con este estudio se busca comprender en mejor forma esta relación para proponer nuevos modelos de gestión entre las entidades de gobierno y las firmas contratistas, y aportar académicamente al cierre de la brecha en infraestructura y ser contributivos al desarrollo del país.

Por lo anterior, le solicito comedidamente, responder la encuesta que acompaña esta comunicación, lo cual le tomará cerca de 10 minutos. Si Usted considera que otro colega director podría dar respuesta a esta encuesta, le agradecería me lo pueda referenciar

La información de sus respuestas se utilizará únicamente con fines académicos y serán tratados con la máxima confidencialidad.

Si está interesado en recibir una copia del resumen ejecutivo de los resultados, por favor hágamelo saber.

Muchas gracias por su colaboración,

Luis Guillermo Molina Cuellar
Investigador
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Centrum - Pontificia Universidad Católica del Perú
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e-mail: gmolinak@hotmail.com
Bogota-Colombia

Part 1 Survey Introduction

Respetado Director,

De antemano me permito agradecerle por participar en esta encuesta voluntaria realizada por el Guillermo Molina Cuellar de la Escuela de Negocios de Centrum PUCP del Perú y la Escuela de Negocios de Maastricht de Holanda.

El estudio que estoy adelantando tiene como objetivo es establecer las relaciones entre la utilización de las tecnologías de la información y el desempeño de los proyectos en las organizaciones que tienen como responsabilidad el desarrollo de la infraestructura física en Colombia..

Por la naturaleza y enfoque, su organización cumple con el perfil que se ha establecido en el estudio para ser evaluada, por lo tanto, agradezco de antemano su colaboración.

Este estudio tiene una finalidad académica y científica y sus resultados se publicarán con las más estrictas medidas de confidencialidad.

Cordialmente

Luis Guillermo Molina Cuellar
Investigador
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Part 2 Respondent Profile

Nombre (Es opcional)	

Edad (Es opcional)	25 o menos	26 a 30	31 a 35	36 a 40	41 a 45	46 a 50	51 a 55	más de 56

Tipo de Organización Marque con X	ORGANIZACIÓN GUBERNAMENTAL	COMPAÑÍA PRIVADA

Nombre del Cargo Actual	

Nivel de su cargo actual El Nivel 01 es el del cargo más alto en su organización Marque con X	Nivel 01	Nivel 02	Nivel 03	Nivel 04	Nivel 05

Participación en la ejecución de proyectos. El estudio está orientado a: Categoría 1: Funcionarios que tienen responsabilidades en la ejecución de los proyectos y Categoría 2: Funcionarios de Tecnología de la Información que soportan la gestión de proyectos. Seleccione una de ellas (Marque con X)	Categoría 1: Funcionario de proyectos	Categoría 2: Funcionario Tecnología de la Información

Años de Experiencia Profesional Marque con X	menos de1 año	1 a 3	3 a 5	5 a 7	7 a 10	más de 10

Años de permanencia en la actual organización Marque con X	menos de1 año	1 a 3	3 a 5	5 a 7	7 a 10	más de 10

Máximo nivel de estudios logrado Marque con X	Técnico	Profesional	Especialista	Master	Ph. D

Procedencia de su organización (País)	

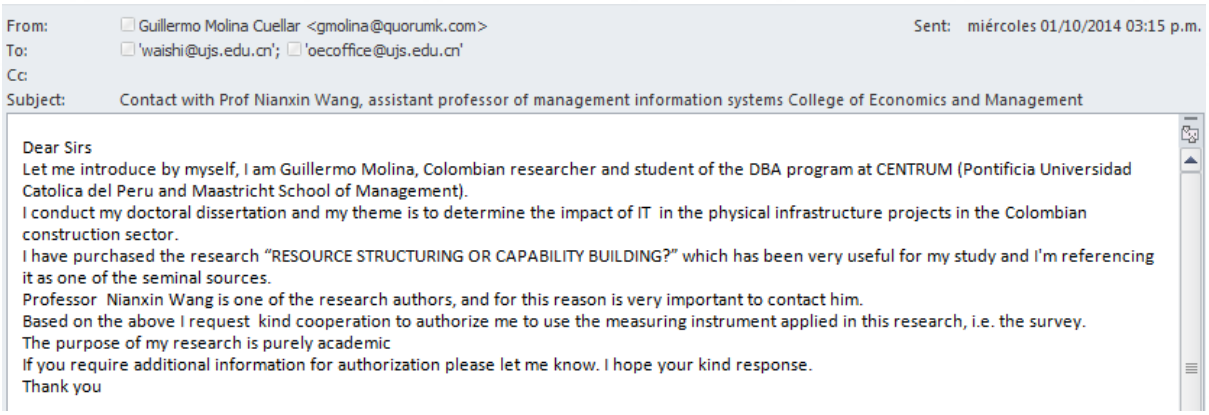
Part 3 - Assessment form

Please put a check mark (X) on the space provided after each statement or item.

SURVEY – English Version			Strongly Disagree			Neutral			Strongly Agree
		Questions	1	2	3	4	5	6	7
Oper	1	The project budget is always fulfilled							
Oper	2	The project schedules always fulfilled							
Oper	3	The projects contribute positively in the organization finances							
Inno	1	The projects satisfy the citizen/clients needs							
Inno	2	The customer /citizen always done major complaints about the quality of projects							
Cost	1	The use of information systems has decreased our projects cost.							
Ente	1	The use of information systems has enhanced our responsiveness to client / citizen							
Ente	2	The use of information systems has helped to determine client / citizen needs							
Inte	1	The previous projects data are a referent for next projects							
Inte	2	The use of information systems has helped to integrated internal business / areas units							
Inte	3	The use of information systems has helped us to correct opportunely the project deviations							
Func	1	The use of information systems has helped us to develop adequately the project planning process							
Func	2	The use of information systems has helped us to develop adequately the project control process							
Func	3	The use of information systems has helped us to establish the project quality traceability							
Stra	1	IT effects have been considered in our organization strategy.							
Stra	2	We are able to consciously analyze the potential of IT in enhancing our organization's							
Stra	3	The effects of IT on realizing our organization strategy are well understood.							
Stra	4	The alignment between organization strategy and IT strategy has not been achieved.							
Supp	1	Our IT function cannot effectively manage IT assets							
Supp	2	Our IT function can maintain an efficient budget for IT operations.							
Supp	3	Our IT function cannot satisfy organization requirements timely							
Supp	4	Our IT function has the competencies to train project staff.							
Leve	1	Our project staff knows little about the functionality of our IT applications.							
Leve	2	Our project staff does not know when to use IT applications.							
Leve	3	Our project staff is skillful in using IT applications effectively.							
Leve	4	Our project staff knows little about how to use IT applications.							
Deve	1	Our organization is able to purchase suitable information systems to meet projects needs							
Deve	2	Our organization is able to implement the information systems that meet project needs							
Deve	3	Our organization is able to develop the information systems that meet project needs							
Deve	4	Our organization has poor IT project management skills.							
Infr	1	The capacity of computer networks in our organization cannot satisfy projects needs.							
Infr	2	Our software applications adequately meet our projects needs.							
Infr	3	Our organization's projects data is not sharable across organizational units							
Tech	1	Our IT personnel have strong skills of systems analysis and design.							
Tech	2	Our IT personnel are able to solve technical problems quickly.							
Tech	3	The skills of our IT personnel are out of date.							
Mana	1	Our IT function is poorly managed.							
Mana	2	The executive of our IT function has strong leadership skills.							
Rela	1	The top management of our organization is willing to allocate necessary resources to the IT							
Rela	2	Our projects functions have cooperated well with our IT function.							
Rela	3	Our project staff resists the use of IT in their job.							

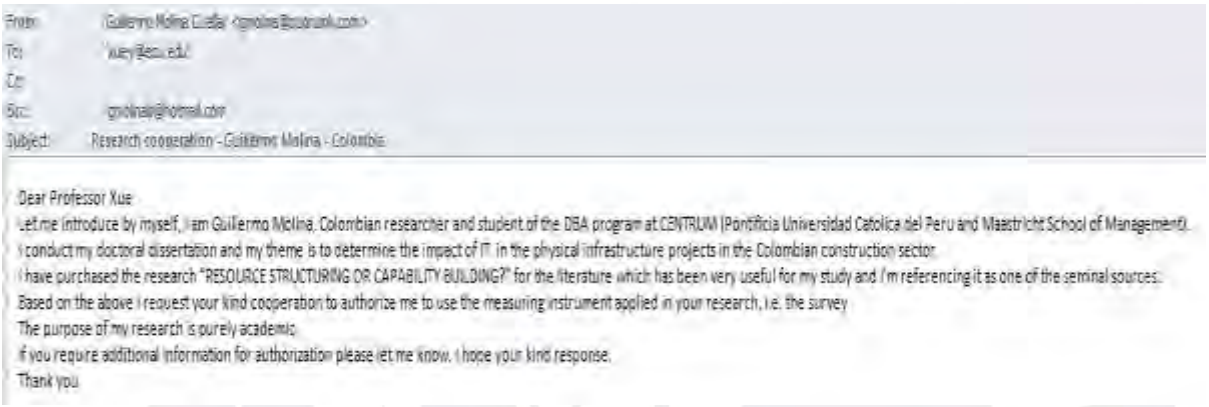
Thank you.

Appendix B: Authorization for the Use of Instrument



From: Guillermo Molina Cuellar <gmolina@quorumk.com> Sent: miércoles 01/10/2014 03:15 p.m.
To: 'waishi@ujs.edu.cn'; 'oecoffice@ujs.edu.cn'
Cc:
Subject: Contact with Prof Nianxin Wang, assistant professor of management information systems College of Economics and Management

Dear Sirs
Let me introduce by myself, I am Guillermo Molina, Colombian researcher and student of the DBA program at CENTRUM (Pontificia Universidad Catolica del Peru and Maastricht School of Management).
I conduct my doctoral dissertation and my theme is to determine the impact of IT in the physical infrastructure projects in the Colombian construction sector.
I have purchased the research "RESOURCE STRUCTURING OR CAPABILITY BUILDING?" which has been very useful for my study and I'm referencing it as one of the seminal sources.
Professor Nianxin Wang is one of the research authors, and for this reason is very important to contact him.
Based on the above I request kind cooperation to authorize me to use the measuring instrument applied in this research, i.e. the survey.
The purpose of my research is purely academic
If you require additional information for authorization please let me know. I hope your kind response.
Thank you



From: [illegible]
To: [illegible]
Cc:
Sent: [illegible]
Subject: Research cooperation - Guillermo Molina - Colombia

Dear Professor Xue
Let me introduce by myself, I am Guillermo Molina, Colombian researcher and student of the DBA program at CENTRUM (Pontificia Universidad Catolica del Peru and Maastricht School of Management).
I conduct my doctoral dissertation and my theme is to determine the impact of IT in the physical infrastructure projects in the Colombian construction sector.
I have purchased the research "RESOURCE STRUCTURING OR CAPABILITY BUILDING?" for the literature which has been very useful for my study and I'm referencing it as one of the seminal sources.
Based on the above I request your kind cooperation to authorize me to use the measuring instrument applied in your research, i.e. the survey
The purpose of my research is purely academic
If you require additional information for authorization please let me know. I hope your kind response.
Thank you

Appendix C: Official Translation

Luis Orlando Hernandez Camargo
Official Translator
Ministry of Justice – Republic of Colombia

Bogotá, September 7, 2015

Reference:
Questionnaire translation certification: English into Spanish, Spanish into English
Dissertation: IT resources and IT capabilities as a driver of physical infrastructure projects performance
Recursos de tecnología informática TI y Capacidades de tecnología informática TI, como dinamizadores del desempeño de los proyectos de infraestructura física.
Eng. Luis Guillermo Molina Cuellar

To whom it may concern

I, the undersigned, by means of the present document, and under the Colombian Law, certify that the document related to questionnaire included in the doctoral dissertation "**IT Resources and IT Capabilities as a Driver of Physical Infrastructure Projects Performance** ", is a correct translation from English into Spanish, and from Spanish into English. Likewise, the present statement confirms the faithful translation of the document submitted originally in english by Eng. Luis Guillermo Molina Cuellar

I state that I am an English-Spanish-English Official Translator as certified by Resolution No.6770 of December 19, 1978 of the Ministry of Justice of the Republic of Colombia, which is the entity that authorizes this type of formalities.

Certification issued on September the 7th in the city of Bogotá – Colombia

Luis Orlando Hernandez Camargo
Official Translator
Ministry of Justice – Republic of Colombia

Luis Orlando Hernandez C.
Traductor e Intérprete Oficial
Inglés - Español - Francés
Resol. 6770 y 3906 MinJusticia

Luis Orlando Hernandez Camargo
Phone: 310 - 772-2912
Mail: lohernandezc@unal.edu.co
Bogotá - Colombia

Appendix D: Questionnaire Validation Test

Survey was developed by Wang et al. (2012), and is peer review. It was originally written in English and was translated into Spanish maintaining the academic back translation standards (Usunier, 2011). Findings indicated overall model components, items, subconstructs and constructs, had psychometric quality (reliability and validity), which provided support for the suitability of their inclusion in the research model. However, it was necessary made some adjustments in items related IT resources and IT capabilities constructs, due collinearity and low significance, which were explained in Chapter 4, section Data examination. These findings were consistency with the literature and confirmed the academic difficulty to define the boundary between IT resources and IT capabilities, which was supported conceptually in Chapter 2. Some authors highlighted this gray boundary as a source for new researches (Wang et al., 2012). According to Ravichandran and Lertwongsatien (2005), and the focus research, PI project performance was defined in operational dimension, associated to project management success, in terms of cost, time and quality, as showed in Figure 16 (Baccarini, 1999).

Psychometric quality of all first-order constructs, after adjustments, is showed in Table E1. Cronbach's alpha and composite reliability CR of each subconstruct is above the threshold .60, with acceptable reliability. For each item, and in each first-order construct, was calculated the factor loadings *li*. Results showed items explain more than 68,8% of each construct's variance, considered substantial, indicating multicollinearity free. In general, average variances extracted AVE were more than .60, greater than corresponding maximum shared variance MSV and average shared variance ASV, that indicates satisfactory discriminant validity, with block homogeneity and dimensionality.

Appendix E: Econometric Estimations

Table E1

Psychometric quality of first-order reflective constructs

Constructs	Items	Standardized Loadings	Variance Extracted	Estimated Loadings	Standard Error	*p* -value	Relibility and Validity	
Infr	Infr1	0.688	0.473	1.000			Cronbach´s α =	0.703
	Infr2	0.786	0.618	0.914	0.047	11.034	CR =	0.897
	Infr3	0.869	0.755	0.962	0.039	12.354	AVE =	0.636
	Tech2	0.835	0.697	1.324	0.027	10.942	MSV =	0.167
	Tech3	0.799	0.639	0.983	0.043	13.958	ASV =	0.135
Mana	Mana1	0.781	0.610	1.000			Cronbach´s α =	0.914
	Mana3	0.844	0.712	1.132	0.083	12.305	CR =	0.796
							AVE =	0.661
							MSV =	0.075
							ASV =	0.075
Rela	Rela1	0.755	0.570	1.000			Cronbach´s α =	0.852
	Rela3	0.763	0.582	0.994	0.105	13.512	CR =	0.731
							AVE =	0.576
							MSV =	0.042
							ASV =	0.042
Stra	Stra1	0.834	0.696	1.000			Cronbach´s α =	0.914
	Stra2	0.832	0.692	1.014	0.108	13.952	CR =	0.910
	Stra3	0.870	0.757	1.003	0.060	13.547	AVE =	0.716
	Stra4	0.848	0.719	0.972	0.086	12.876	MSV =	0.174
							ASV =	0.054
Supp	Supp1	0.784	0.615	1.000			Cronbach´s α =	0.794
	Supp2	0.846	0.716	0.973	0.093	11.469	CR =	0.847
	Supp3	0.786	0.618	0.984	0.018	12.351	AVE =	0.649
							MSV =	0.162
							ASV =	0.088
Leve	Leve1	0.804	0.646	1.000			Cronbach´s α =	0.812
	Leve2	0.814	0.663	0.974	0.044	13.415	CR =	0.897
	Leve3	0.803	0.645	0.982	0.049	13.725	AVE =	0.636
	Leve4	0.832	0.692	0.962	0.037	12.415	MSV =	0.171
	Deve1	0.731	0.534	0.942	0.048	12.945	ASV =	0.103
Reso	Reso1	0.864	0.746	1.000			Cronbach´s α =	0.720
	Reso2	0.831	0.691	0.953	0.026	13.985	CR =	0.871
	Reso3	0.802	0.643	0.967	0.030	14.032	AVE =	0.693
							MSV =	0.167
							ASV =	0.133
Coor	Coor1	0.794	0.630	1.000			Cronbach´s α =	0.824
	Coor2	0.784	0.615	0.895	0.026	12.478	CR =	0.839
	Coor3	0.812	0.659	0.943	0.025	13.095	AVE =	0.635
							MSV =	0.172
							ASV =	0.171
Scop	Scop1	0.740	0.548	1.000			Cronbach´s α =	0.754
	Scop2	0.793	0.629	0.942	0.031	12.052	CR =	0.822
	Scop3	0.802	0.643	0.937	0.032	13.504	AVE =	0.607
			0.000				MSV =	0.169
							ASV =	0.116
Post	Post1	0.870	0.757	1.000			Cronbach´s α =	0.765
	Post2	0.821	0.674	0.981	0.017	13.701	CR =	0.880
	Post3	0.834	0.696	1.030	0.024	12.098	AVE =	0.709
			0.000				MSV =	0.165
							ASV =	0.146
Stak	Stak1	0.831	0.691	1.000			Cronbach´s α =	0.608
	Stak3	0.823	0.677	1.020	0.023	13.904	CR =	0.812
							AVE =	0.684
							MSV =	0.038
							ASV =	0.038

Notes: Cronbach´s α = Cronbach's alpha
CR= composite reliability AVE= average variance extrated
MSV= maximum sahred variance ASV=average shared variance

Table E2

Psychometric quality of second-order formative constructs

Constructs	Items	Outer Weight (OT)	Δ OT Max	Outer Weight Bootstrap	Contribution R^2	Tol	VIF
IT_Res	Infr	0.665	0.087	0.584	23.7894	76.2106	1.312
	Mana	0.684	0.107	0.521	23.8615	76.1385	1.313
	Rela	0.654	0.076	0.412	52.3491	47.6509	2.099
IT_Cap	Stra	0.521	-0.057	0.531	58.082	41.918	2.386
	Supp	0.519	-0.058	0.498	30.454	69.546	1.438
	Leve	0.525	-0.052	0.401	11.464	88.536	1.129
Supp_Cor	Reso	0.483	-0.094	0.435	34.711	65.289	1.532
	Coor	0.461	-0.116	0.489	32.848	67.152	1.489
	Scop	0.414	-0.163	0.561	32.441	67.559	1.480
Supp_Str	Post	0.523	-0.184	0.587	50.587	49.413	2.024
	Stak	0.484	-0.223	0.654	49.413	50.587	1.977
TQ_Perf	Oper1	0.540	-0.037	0.516	38.423	61.577	1.624
	Oper2	0.566	-0.011	0.527	32.825	67.175	1.489
	Oper3	0.425	-0.152	0.416	28.752	71.248	1.404

Notes: R^2 = proportion of variance associated with other constructs — Max VIF 2.386

Tol= tolerance VIF= variance inflation factor — Min VIF 1.129

VIF>5 potencial collinearity issue (Götz, Liehr-Gobbers, & Krafft, 2010)

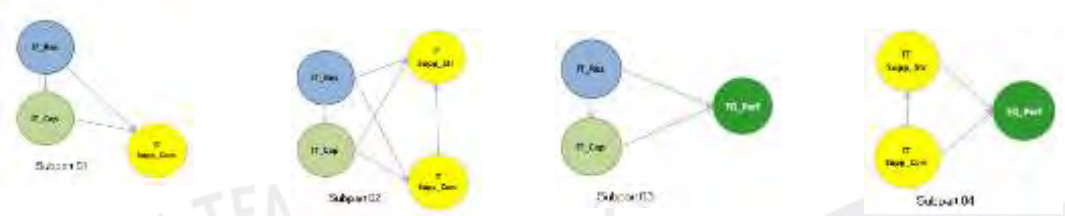
It_Res = IT resources, IT_Ca p= IT capabilities; Supp_Cor = IT support for core competencies

Supp_Str = IT support for competitive strategies; TQ_Perf = projects performance

Table E3

Model psychometric quality

Subpart 01 Core Competence		Subpart 02 Competitive Strategy		Subpart 03 Project Performance		Subpart 04 Project Performance	
Contructs	VIF	Constructs	VIF	Constructs	VIF	Constructs	VIF
IT _ Res	2.431	IT _ Res	2.418	IT _ Res	2.739	Supp _ Cor	2.357
IT _ Cap	2.213	IT _ Cap	3.241	IT _ Cap	2.914	Supp _ Str	2.951
		Supp _ Cor	2.759				



Notes. VIF= variance inflation factor

VIF>5 potencial collinearity issue (Götz, Liehr-Gobbers, & Krafft, 2010)

It_Res = IT resources, IT_Cap= IT capabilities; Supp_Cor = IT support for core compentenc

Supp_Str = IT support for competitive strategies; TQ_Perf = projects performance

Table E4

Model predictive capability - path coefficients - direct effects

Path	Path Coefficients	Standard Error	*t* value (empirical)	Significance Levels	*p* value	90% Confidence Intervals
IT_Res → IT_Cap	0.423	0.113	3.743	***	0.0002	[0.644 , 0.202]
IT_Res → Supp_Str	0.340	0.041	8.293	***	0.0000	[0.420 , 0.260]
IT_Res → Supp_Cor	0.228	0.090	2.534	**	0.0116	[0.405 , 0.052]
IT_Res → TQ_Perf	0.227	0.122	1.858	NS	0.0638	[0.467 , -0.012]
IT_Cap → Supp_Str	0.292	0.044	6.636	***	0.0000	[0.378 , 0.206]
IT_Cap → Supp_Cor	0.368	0.091	4.046	***	0.0001	[0.547 , 0.190]
IT_Cap → TQ_Perf	0.212	0.097	2.176	**	0.0301	[0.402 , 0.021]
Supp_Cor → Supp_Str	0.383	0.038	10.082	***	0.0000	[0.458 , 0.309]
Supp_Cor → TQ_Perf	0.685	0.111	6.189	***	0.0000	[0.902 , 0.468]
Supp_Str → TQ_Perf	0.669	0.099	6.795	***	0.0000	[0.862 , 0.476]

Notes: *p <0,10 ** p<0,5 *** p <.0,01 NS= not significant

Two-tailet test t value = 1.96 degree of fredom 449

It_Res = IT resources, IT_Ca p= IT capabilities; Supp_Cor = IT support for core competences

Supp_Str = IT support for competitive strategies; TQ_Perf = projects performance

Table E5

Model predictive capability - constructs total effects

Path			Effects		Indirect Effects	σ Indirect Effects	*t* value (indi effec)	*p* value	Significance Levels	Total Effect	Variance Account For - VAF (%)	Mediation
IT_Res	→ TQ_Perf		0.227		0.384					0.611	62.83	Partial
IT_Res	→ Supp_Str	→ TQ_Perf	0.340	0.669	0.228	0.098	2.322	0.021	**			
IT_Res	→ Supp_Cor	→ TQ_Perf	0.228	0.685	0.156	0.031	5.041	0.000	***			
IT_Cap	→ TQ_Perf		0.212		0.448					0.659	67.89	Partial
IT_Cap	→ Supp_Str	→ TQ_Perf	0.292	0.669	0.195	0.083	2.355	0.019	**			
IT_Cap	→ Supp_Cor	→ TQ_Perf	0.368	0.685	0.252	0.093	2.712	0.007	***			
Supp_Cor	→ TQ_Perf		0.685		0.256					0.942	27.23	Partial
Supp_Cor	→ Supp_Str	→ TQ_Perf	0.383	0.669	0.256	0.084	3.052	0.002	***			
Supp_Str	→ TQ_Perf		0.669				6.795	0.000	***	0.669		Partial

Notes: *p <0,10 ** p<0,5 *** p <.0,01 Two-tailed test t va 1.96 degree of fredom 449

VAF range estimations: 20% to 80% partial mediation, more tran 80% full mediation (Hair, et al.,2014)

It_Res = IT resources, IT_Cap= IT capabilities; Supp_Cor = IT support for core competencies ;

Supp_Str = IT support for competitive strategies; TQ_Perf = projects performance

Table E6

Significance testing results of the total effects

Path			Total Effect	Standard error	*t* value (total effects)	Significance Levels	*p* value	90% Confidence Intervals		
IT_Res	→	TQ_Perf	0.611	0.148	4.128	***	0.0000	[0.611	,	0.611]
IT_Cap	→	TQ_Perf	0.659	0.178	3.704	***	0.0002	[0.660	,	0.659]
Supp_Cor	→	TQ_Perf	0.942	0.238	3.956	***	0.0001	[0.942	,	0.941]
Supp_Str	→	TQ_Perf	0.669	0.293	2.284	**	0.0228	[0.714	,	0.625]

Notes: *p <0,10 ** p<0,5 *** p <.0,01

Two-tailet test t value= 1.96 degree of fredom 449

It_Res = IT resources, IT_Ca p= IT capabilities; Supp_Cor = IT support for core competencies

Supp_Str = IT support for competitive strategies; TQ_Perf = projects performance

Table E7

Model predictive capability - R^2 coefficients of determination and Q^2 predictive relevance

Endogenous Latent Variable	R^2 Value	Q^2 Value
IT_Cap	0.449	0.421
Supp_Cor	0.699	0.413
Supp_Str	0.637	0.341
TQ_Perf	0.737	0.417

Notes: R^2 *range values: .25 weak, .50 medium, .75 substanc*
Q^2 >0 exogenous constructs have predictive relevance for endogen constructs under research conditions. (Hair, et al.,2014)
It_Res = IT resources, IT_Ca p= IT capabilities;
Supp_Cor = IT support for core competencies
Supp_Str = IT support for competitive strategies;
TQ_Perf = projects performance

Table E8

Relative predictive relevance of constructs - effect size f^2 and q^2

Construct Excluded	IT_Cap Path Coeff	IT_Cap f^2 Effect Size	IT_Cap q^2 Effect Size	Supp_Cor Path Coeff	Supp_Cor f^2 Effect Size	Supp_Cor q^2 Effect Size	Supp_Str Path Coeff	Supp_Str f^2 Effect Size	Supp_Str q^2 Effect Size	TQ_Perf Path Coeff	TQ_Perf f^2 Effect Size	TQ_Perf q^2 Effect Size
IT_Res	0.423	0.383	0.332	0.228	0.291	0.278	0.340	0.143	0.168	0.227	0.104	0.107
IT_Cap				0.368	0.321	0.317	0.292	0.226	0.234	0.212	0.171	0.187
Supp_Cor							0.383	0.127	0.142	0.685	0.248	0.239
Supp_Str										0.669	0.212	0.193

Notes: f^2 range values: .02 weak, .15 medium, .35 large effects (Cohen, 1988)

q^2 range values: .02 weak, .15 medium, .35 large effects (Hair, et al.,2014)

It_Res = IT resources, IT_Ca p= IT capabilities; Supp_Cor = IT support for core competencies

Supp_Str = IT support for competitive strategies; TQ_Perf = projects performance

Table E9

Importance - performance matrix IPMA analysis

Predictor construct	Importance (Total Effects)	Performance (Index Values)
IT_Res	0.611	68.30
IT_Cap	0.659	77.20
Supp_Cor	0.942	57.30
Supp_Str	0.669	61.20

Notes: It_Res = IT resources, IT_Ca p= IT capabilities;
Supp_Cor = IT support for core competencies
Supp_Str = IT support for competitive strategies;
TQ_Perf = projects performance

Factor / Path	$p^{(1)}$	se ($p^{(1)}$)	$p^{(2)}$	se ($p^{(2)}$)	$\lvert p^{(1)} - p^{(2)} \rvert$	*t* value	*p* value	T-Test Equal Variances
Organitation Type	Group 1: Public (n=63)		Group 2: Firms (n=65)			Group 1 vs Group 2		
Supp_Cor → TQ_Perf	0.834	0.110	0.698	0.103	0.136	0.903	0.368	Do not reject Ho
Supp_Cor → Supp_Str	0.413	0.023	0.393	0.460	0.020	0.385	0.701	Do not reject Ho
Supp_Str → TQ_Perf	0.789	0.134	0.567	0.145	0.222	1.123	0.264	Do not reject Ho
Years of Experience	Group 1: Until 7 years (n=60)		Group 2: More Than 7 years (n=68)			Group 1 vs Group 2		
Supp_Cor → TQ_Perf	0.864	0.254	0.636	0.119	0.228	0.844	0.400	Do not reject Ho
Supp_Cor → Supp_Str	0.745	0.117	0.624	0.082	0.121	0.862	0.390	Do not reject Ho
Supp_Str → TQ_Perf	0.936	0.165	0.421	0.076	0.515	2.947	0.004	Reject Ho
Education Level	Group 1: Professional (n=70)		Group 2: Specialists and more (n=58)			Group 1 vs Group 2		
Supp_Cor → TQ_Perf	0.856	0.345	0.783	0.277	0.073	0.160	0.873	Do not reject Ho
Supp_Cor → Supp_Str	0.534	0.421	0.318	0.328	0.216	0.392	0.696	Do not reject Ho
Supp_Str → TQ_Perf	0.799	0.171	0.658	0.187	0.141	0.556	0.579	Do not reject Ho
Job Title	Group 1: High Level (n=67)		Group 2: Middle Level (n=61)			Group 1 vs Group 2		
Supp_Cor → TQ_Perf	0.693	0.090	0.437	0.216	0.256	1.130	0.261	Do not reject Ho
Supp_Cor → Supp_Str	0.289	0.232	0.185	0.114	0.104	0.390	0.697	Do not reject Ho
Supp_Str → TQ_Perf	0.995	0.267	0.354	0.030	0.641	2.278	0.024	Reject Ho

Notes: Ho: the standar error of Group 1 is equal of standar error of Group 2 Significance Level 5%
$(p^{(1)})$ and $(p^{(2)})$ are path coefficients $se(p^{(1)})$ and $se(p^{(2)})$ are the standard error
IT_Res = IT resources, IT_Ca p= IT capabilities; Supp_Cor = IT support for core competencies; Supp_Str = IT support for competitive strategies;
TQ_Perf = PI project performance

Appendix F: Results of Structural Model

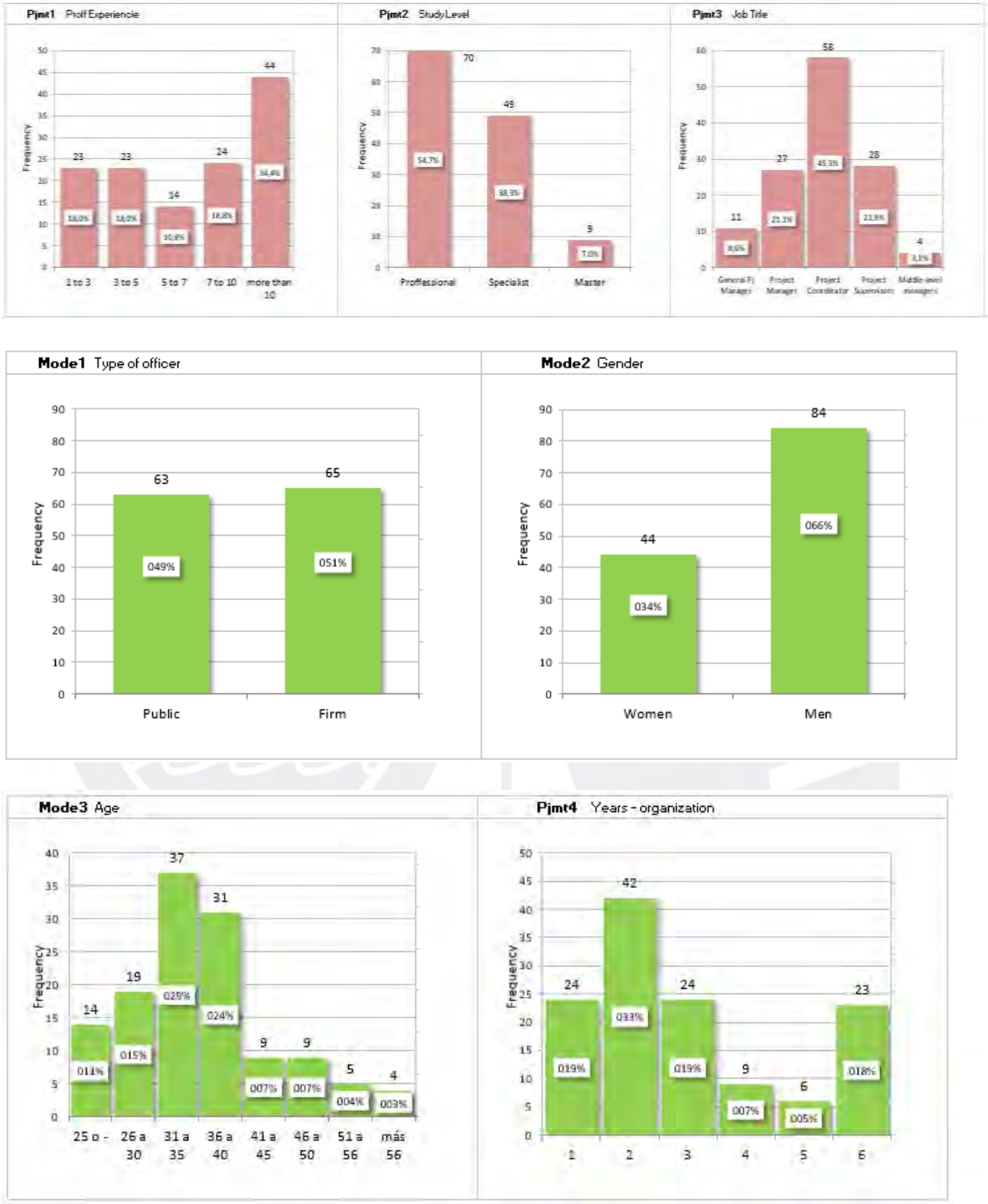


Figure F1. Histograms of respondent traits.

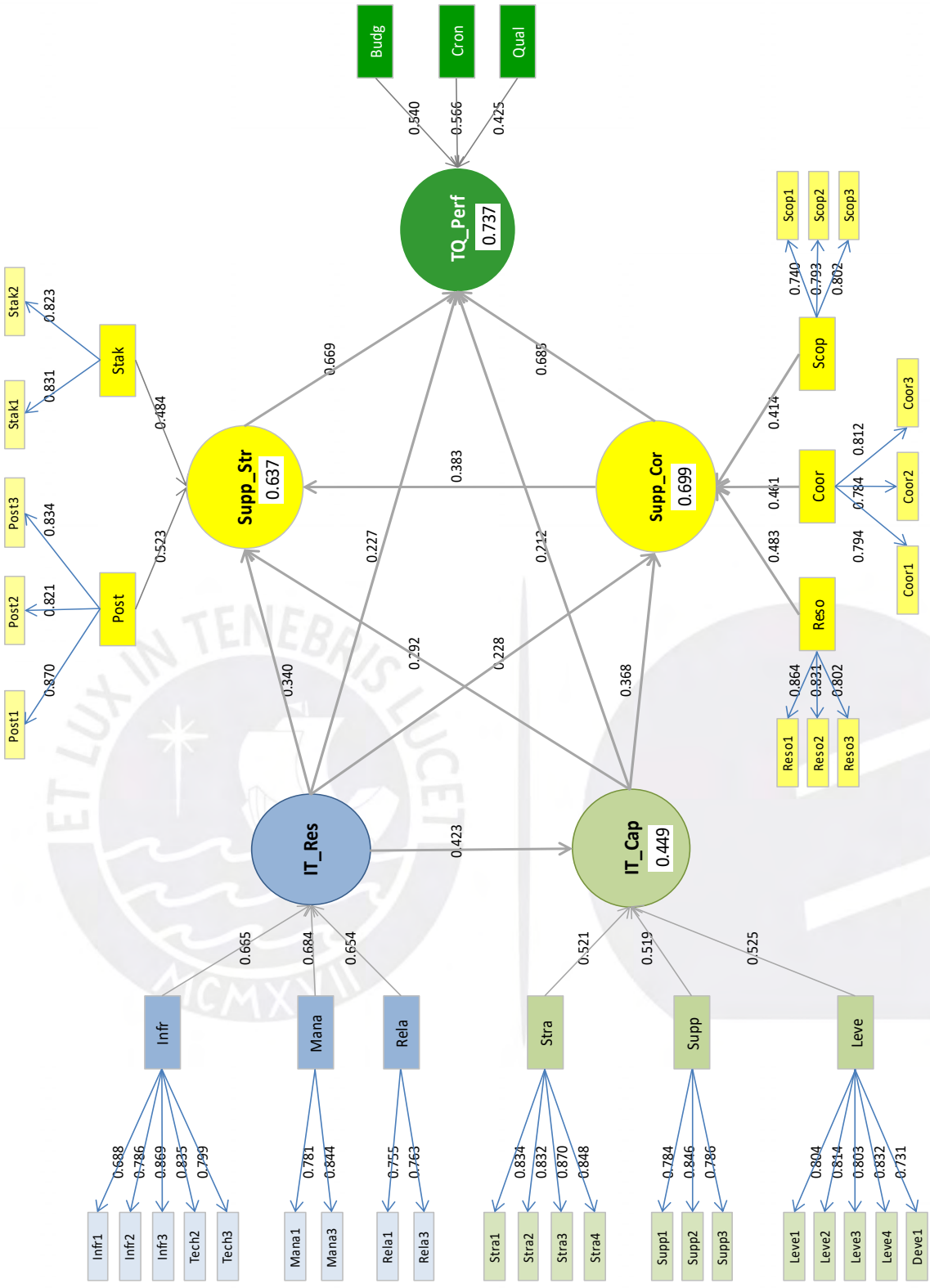


Figure F2. Research Model predictive capabilities.