



## IT capabilities' business value: analysis of multi-level performance in Brazilian organizations

### *Valor das capacidades de TI para o negócio: análise de desempenho multinível nas organizações brasileiras*

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**Abstract:** Considering the demands of the Resource-Based Theory (RBT) and Information Systems (IS) literature regarding the identification of IT value in multi-level business performance, this article aims to detect the extent to which IT Capabilities directly impact performance at the process level and indirectly impact performance at the company level. A survey method was adopted and applied in three research phases: i. Pre-test survey – with researchers representing IT and business areas; ii. Pilot study – with IT and business professionals, and iii. Complete study – with IT and business managers in large Brazilian organizations, according to the 2012 ranking of the largest Brazilian organizations. The measurement model was defined using the Structural Equation Modeling in the pilot study and confirmed in the complete study, with the research hypotheses tested in the structural model. The results show that IT Capabilities positively impact Process Performance, which, in turn, impacts Company-level performance. Additionally, IT Capabilities are found to have an indirect impact on Company Performance, confirming partial mediation by Performance at the Process level. The moderating effects of four variables (company size, lifespan, sector dynamism, and industry) were tested in the relationship between IT Capabilities and Process Performance, presenting null results for all four. The theoretical contributions of this research, along with its limitations and research opportunities, are provided in the discussion and conclusion of the article.

**Keywords:** IT value; IT capabilities; Multi-level performance.

**Resumo:** Considerando as demandas da Teoria Baseada em Recursos (TBR) e da literatura de Sistemas de Informação (SI) quanto à captação do valor da TI em multiníveis de desempenho do negócio, este artigo objetiva identificar em que medida as Capacidades de TI impactam diretamente o Desempenho em nível de Processos e indiretamente o Desempenho em nível de Firma. Adota-se como método a survey, aplicada em três fases de pesquisa: i. Survey pré-teste – com pesquisadores representantes das áreas de TI e de negócios; ii. Survey piloto – com profissionais de TI e de negócios; e iii. Survey completa – aplicada a gestores de TI e de negócios em organizações brasileiras de grande porte, conforme ranking de 2012 das maiores empresas do Brasil. Por meio da Modelagem de Equações Estruturais, o modelo de medida é definido no estudo piloto e confirmado no estudo completo – sendo testadas as hipóteses de pesquisa no modelo estrutural. Os resultados evidenciam que as Capacidades de TI impactam positivamente o Desempenho de Processos e este impacta o Desempenho em nível da Firma. Adicionalmente, constata-se o impacto indireto das Capacidades de TI no Desempenho da Firma, configurando-se a mediação parcial pelo Desempenho de Processos. Testa-se a moderação de quatro variáveis (tamanho da firma, tempo de atuação, dinamismo do setor e indústria) na relação entre Capacidades de TI e Desempenho de Processos, obtendo-se resultados nulos para ambas as moderadoras. As contribuições teóricas da pesquisa, as limitações e oportunidades de investigação constam na discussão e nas conclusões do artigo.

**Palavras-chave:** Valor da TI; Capacidades de TI; Desempenho multinível.

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## 1 Introduction

The business value of Information Technology (IT) has been investigated for more than 30 years, predominating in research that seeks to identify an association between IT resources (or investments) and firm performance (Stoel & Muhanna, 2009; Masli et al., 2011). Because of the mixed results of this approach (Liang et al., 2010; Wiengarten et al., 2013), a recent line of investigations have fomented the use of the concept “IT Capabilities,” in place of IT individual resources (Hartono et al., 2010; Chen & Tsou, 2012). Likewise, the adoption of intermediate measures of performance at the firm level has been defended in the literature on IT value (Tallon, 2010; Kim et al., 2011).

As for the use of “IT Capabilities,” the Resource-Based Theory (RBT) serves as a lens to identify and comprehend IT value in organizations (Qu et al., 2010), based on internal capabilities. RBT understands the firm as a set of resources that, by possessing attributes (value, rarity, imitation difficulty, impossibility for substitution), explains superior performance (Barney, 1991).

With respect to performance level, studies point to process as the first instance of IT’s impact (Ray et al., 2004; Chen & Tsou, 2012), despite this level also having a relation with performance at the firm level (Qu et al., 2010; Kim et al., 2011). The literature has also presented the need for research on IT’s impact on various organizational processes and capabilities (Tallon, 2010) and on the use of IT Capabilities – in contrast to individual technological resources (Schwarz et al., 2010).

This approach to IT from the perspective of capabilities – instead of isolated technology resources (Park et al., 2011) – has support from the concept of “resources” from RBT (Barney, 1991; Barney et al., 2011) and on the premise that IT resources and investments [in themselves] do not lead to competitive performance and advantage but that the form and intensity of IT use do (González-Gallego et al., 2010). This use is encompassed by “IT Capabilities,” which represent the firm’s abilities to gather, integrate, and develop IT-based resources (Liu et al., 2008).

Research that incorporates these research aspects (capabilities and performance level) give initial support in comprehending the value of IT capabilities at a level below the firm, including organizational processes and capabilities (Tallon & Kraemer, 2007; Chen & Tsou, 2012), despite other studies utilizing firm-level performance indicators to evaluate IT’s indirect impact (Stoel & Muhanna, 2009). Most recently, the literature has presented distinct results as to IT’s role in business, mainly, when RBT is used to

understand the “IT value” phenomenon (Liang et al., 2010; Masli et al., 2011).

Specifically, in the field of IT capabilities, some works point to distinct forms of association between these capabilities and performance (Liang et al., 2010; Kim et al., 2011), when, in fact, the mechanisms of association and the total measuring variables involved are unknown, given the complexity of this relationship (Fink, 2011).

Thus, in response to the literature’s affirmations and research demands relating to IT’s impact at a level below the firm (Qu et al., 2010; Kim et al., 2011) and the mixed results on IT’s indirect impact on firm-level performance (Tallon & Kraemer, 2007; Tallon, 2010; Wiengarten et al., 2013), the objective of this article is to identify the extent of IT Capabilities’ direct impact on Performance at the Process level and their indirect impact on Performance at the Firm level.

This article is structured in five sections. Section 2 presents the theoretical framework – including the concepts of IT capabilities and their facets, the main results of the relation between IT and performance from the RBT perspective, the levels of IT’s impacts, the research model, and hypotheses. The methodological procedures for data collection and analysis are explained in section 3. Section 4 describes the results, and section 5 presents conclusions, limitations, and research opportunities.

## 2 IT capabilities and performance: RBT perspective

In this section, IT capabilities are described (2.1) and the model with the hypotheses is presented simultaneously with the discussion on the relationship between IT capabilities and performance levels (2.2), from the perspective of Resource-Based Theory.

### 2.1 IT capabilities (ITCAP)

These capabilities can also be conceptualized as the “[...] ability to mobilize and organize IT – which represents the resources based in combination or coexistence with other resources and capabilities” (Wu et al., 2008, p. 526). Therefore, they are part of the firm’s capabilities and are viewed as difficult to replicate by competitors (Liu et al., 2008). The imitation difficulty of capabilities is explained by its connection to the firm’s history, culture, and experience (Bharadwaj et al., 1999).

Normally, IT capabilities are discussed in the literature in three constructs: IT infrastructure, IT human capabilities, and IT management capabilities. Infrastructure is composed of IT tangible assets. Kim et al. (2011) refer to **IT infrastructure capabilities** as “IT infrastructure flexibility.” For the authors, these

capabilities involve IT assets (hardware, software, and data), systems and their components, communication and network ease, and applications.

**IT human capabilities** comprehend the technical and managerial abilities in the field of technological knowledge. Park et al. (2011) include four dimensions of IT human capabilities: managerial abilities of technology, the business's functional abilities, interpersonal and managerial abilities, and technical abilities. IT human capabilities are related to abilities in managing resources related to IT (Park et al., 2011). As for managerial and technical abilities, Bharadwaj (2000) defends that they are developed over time through experience and tend to be local and specific to the organization, accumulated by interpersonal relations – which make them difficult to acquire and complex to imitate.

**IT management capabilities** encompass knowledge assets, client orientation, synergy (Bharadwaj, 2000), and abilities in aligning IT and business (Kim et al., 2011). Studies that consider IT management capabilities as a research construct emphasize IT strategy and business alignment, mainly, in relation to personnel's IT knowledge of the business's functions and strategies (for example: Kim et al., 2011; Park et al., 2011).

A fourth group of IT capabilities also presented in the literature is **IT reconfiguration capabilities** (including adaptation and improvisation capabilities) (Pavlou & El Sawy, 2006, 2010). These capabilities refer to the firm's ability to appropriate IT resources and capabilities to its business and market needs, and they are justified in turbulent environments that demand serving clients' new needs, maintaining competitive advantage, and new technological applications – without the possibility of prior formal planning (Pavlou & El Sawy, 2010; Wu, 2010).

## 2.2 The Impacts of IT capabilities on performance: hypotheses and research model

Under the prism of Resource-Based Theory (RBT), IT capabilities are investigated from their relationship with performance, in various forms. Multiple performance measures are adopted so as to detect IT business value, business process performance (Kim et al., 2011), innovation (Huang, 2011), inter-firm relation performance (Hartono et al., 2010), and firm performance (Nevo & Wade, 2011).

These measures can be divided into two groups: (i) performance at the firm level (ii) and performance at a level below the firm. The first group is the firm's aggregate measures (for example: firm performance and inter-firm relation performance – supply chain performance, company-client relation), generally operationalized by profitability variables such as return on investments, return on stockholders' equity, profit margin, earnings per share (Masli et al., 2011), and efficiency measures such as productivity, cost saving, revenue growth (Liang et al.). For performance at a level below the firm, measures related to process performance (Qu et al., 2010), innovation (Huang, 2011), sector/department performance (Nevo & Wade, 2011), etc. are included.

In sections 2.2.1 and 2.2.2, the performance levels are discussed, and the research model with the hypotheses is presented in Figure 1. In section 2.2.3, the moderating variables of the relation between IT Capabilities and Performance are described from the perspective of the literature. In the last section (2.2.4), the operational definition of the research constructs is presented.

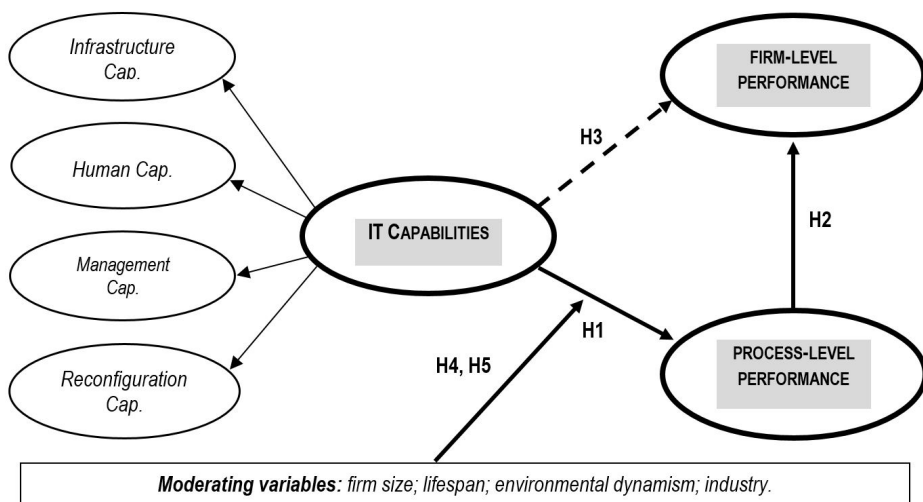


Figure 1. Research Model. Source: Elaborated from the literature.

### 2.2.1 Performance at a level below the firm

In the context of analyzing IT value at a level below the firm, Tallon & Kraemer (2007) defend that IT's impact occurs firstly on organizational processes so as to, later on, impact aggregate performance. Accordingly, some works have identified the impact of isolated facets of IT capabilities on performance at the process level and, indirectly, on firm performance (Wu et al., 2008; Kim et al., 2011).

In another correlate study, in analyzing the impact of internally produced IT resources and those provided by third parties, Qu et al. (2010) conclude that the development and use of internal IT resources have greater impact on business processes connected to IT. These processes, as a consequence, lead to greater firm performance when IT resources are employed in the organization itself.

Processes linked to client relations and services are examples that are impacted by IT capabilities (Tallon, 2010; Chen & Tsou, 2012). These processes mediate the relation between IT capabilities and firm performance and/or are directly impacted by IT (González-Gallego et al., 2010).

Therefore, the present work contemplates the following for the hypotheses (**H1** and **H2**): (i) studies that defend that performance at the process level precedes performance at the firm level, with respect to IT's impact (Tallon & Kraemer, 2007; Kim et al., 2011); (ii) the different results, up to the present moment, regarding IT's direct impact on performance measures at the firm level (Muhanna & Stoel, 2010; Liang et al., 2010); and (iii) the RBT works' argument over the need to identify IT value in levels below the firm (Ray et al., 2004).

**H1:** IT Capabilities (ITCAP) positively impact Performance at the Process Level (PP).

**H2:** Performance at the Process Level positively impacts Performance at the Firm Level (PF).

### 2.2.2 Firm-level performance

There are currents of literature that defend the direct relation between IT capabilities and performance at the firm level (Tian et al., 2010; Masli et al., 2011). The works from these currents also find support in RBT that affirms the role of IT resources on performance and competitive advantage (Stoel & Muhanna, 2009).

Nevertheless, the impact of IT capabilities on performance at this level still needs more consensus in the literature (Oliveira & Maçada, 2012), given the presence of distinct and even divergent results (Liang et al., 2010; Oliveira & Oliveira, 2012). Masli et al. (2011), Byrd & Byrd (2010), and Quan (2008) are examples of research without complete

support for the direct impact of IT capabilities on firm-level performance.

The first work identifies a greater positive relation between IT capabilities and firm performance from 1988 to 2007 – yet highlights the reducing tendency of IT capabilities' impact on performance beginning in 1999, legitimized by the dotcom crash and short lifespan of competitive advantage driven by IT (Masli et al., 2011). The second work identifies IT's positive impact on profitability indicators (net margin, return on investments) and on the decrease of some cost indicators (operating expenses per sale; sales, general, and administrative expenses) and one null impact for the indicator “cost of goods sold per revenue” (Byrd & Byrd, 2010). Similarly, the third study analyzes IT's impact on profitability variables and cost indicators, identifying a partially positive impact on measures related to profitability and no impact on cost measures (Quan, 2008).

These differences in results over the direct association between IT Capabilities and firm performance have justified discussions in the field of RBT on IT value at lower levels, such as the process level (Ray et al., 2004; Qu et al., 2010).

The third hypothesis is elaborated considering the results for the indirect association between IT capabilities and firm-level performance (Tallon & Kraemer, 2007; Hartono et al., 2010; Kim et al., 2011) as well as research that presents null results on the direct relation between IT and aggregate firm performance (Quan, 2008; Oliveira & Oliveira, 2012).

**H3:** The impact of IT Capabilities on Performance at the Firm Level is mediated by Performance at the Process Level.

### 2.2.3 Moderating variables in the relation between IT and performance

Given the complexity of the phenomenon of “IT value” for business (Stoel & Muhanna, 2009; Fink, 2011) for research that tests its impact on performance, some variables related to the industry's characteristics are considered moderators: the firm's size and age (lifespan), environmental dynamism (level of changes in the sector), and the industry (trade/manufacturing, services).

The firm's size is an indicator of past performance (Tian et al., 2010); therefore, it can affect current performance (Ortega, 2010) since larger firms tend to present a variety of resources (Lun & Quaddus, 2011). Nonetheless, the relevant aspect is not always resource quantity but in how they are gathered in the form of unique organizational capabilities, such as IT Capabilities (Soto-Acosta & Meroño-Cerdan, 2008; Schwarz et al., 2010). The firm's lifespan (age) can confer competitive advantage to firms and better

performance (Ortega, 2010), although Wu et al. (2008) did not find the lifespan's impact when they investigated the relation among IT capabilities, decision making, and organizational performance.

The level of industry dynamism is underscored in the literature as influential in the relation between IT capabilities and process and product innovation. For industries with high levels of dynamism, IT capabilities contribute to improvements in products and processes (Ortega, 2010). This dynamism reflects the level of changes that occur and the consequent need for the firm to respond to them quickly (Nevo & Wade, 2011). Mixed results as to the role of dynamism on the relation between IT and performance are also found in the literature (Stoel & Muhanna, 2009; examples: Protogerou et al., 2012).

There are also indications in the literature that the firm's sector (industry) influences the relation between IT capabilities/resources and performance since there is an adjustment between the firm's capabilities and its relevant industry (Stoel & Muhanna, 2009). Furthermore, Byrd & Byrd (2010) identify greater impact of IT capabilities on performance in manufacturing firms rather than on those in services. However, Kim et al. (2011) relate in their results that this impact is greater for companies in the "non-manufacturing" sector (services) than for those in manufacturing. Also, there are results in the Brazilian context that indicate this variable's null impact on the proposed relation (Oliveira & Oliveira, 2012). All these studies consider moderation of the impact at the firm level. This work proposes to test the industry's moderating effect (trade/manufacturing versus services) in the relation between IT Capabilities and Process-level Performance.

Considering the variables' effects on the relation between IT and performance in correlate investigations, the following hypotheses are proposed.

**H4:** The impact of IT Capabilities on Process Performance is greater when there is an increase in:

**H4a:** The firm's size;

**H4b:** The firm's lifespan;

**H4c:** Environmental dynamism.

**H5:** The impact of IT Capabilities on Process Performance is moderated by the type of industry in which the firm operates.

## 2.2.4 Operational definition of the constructs

IT Capabilities are a second-order construct measured by fourteen items, distributed among four first-order constructs (IT infrastructure, IT human,

IT management, and IT reconfiguration capabilities). Process-level Performance is measured by six items in one first-order construct, related to the increase in profit and market participation.

To measure the model's three constructs, a 7-point Likert scale was used, with 1 representing "totally disagree" and 7 "totally agree," or similar expressions.

The moderating variables (hypotheses H4 and H5) are measured as follows: *i.* Firm size – measured in number of employees (Tian et al., 2010); *ii.* Lifespan – years of activity in the market (Liu et al., 2008); *iii.* Environmental dynamism – reflects the level of changes in the companies' market environment (Nevo & Wade, 2011), measured by the Likert scale (1 to 7 – from stable to dynamic environment); and *iv.* Industry – sector in which company predominately operates (trade, services, or manufacturing) (Byrd & Byrd, 2010).

## 3 Method

### 3.1 Data collection procedures

Research on IT business value has demonstrated that the managers'/users' perceptions of IT's impact at the process and firm levels present the same results as the objective evaluation metrics of IT performance, thus validating perception as a form of evaluating results (Tallon & Kraemer, 2007; Tallon, 2010).

From this perspective, the survey was adopted as the methodological approach in the investigation. In studies on IT value, the survey has been constantly utilized (Kim et al., 2011; Maçada et al., 2012), mainly, because they involve latent variables – or non-observable variables.

The complete survey for testing the hypotheses was preceded by the instrument's pre-test and pilot study.

#### 3.1.1 Pre-test

From an extensive review of the literature, the research instrument was composed and submitted to a pre-test so as to verify the clarity of the content of the items, the time it takes to fill out, and related observations, as indicated in the literature (Gable et al., 2008; Kim et al., 2011). The pre-test was executed with two IT researchers, representing IT managers, and a business researcher, representing business professionals in the organizations. Their participation brought contributions as to the presentation of the items, response time, clarity, and design of the research questionnaire. Participation from this public has been encouraged by the literature on Information Systems (IS) (Kim et al., 2011; Nevo & Wade, 2011).

Observations and fill-out time of the survey in this stage were analyzed for adjustments to the instrument for the next stage – the pilot study. Among the adjustments made were alterations in the composition

and order of the questions and information/questions that characterize the sample, among others.

### 3.1.2 Pilot study

A pilot study was executed after the instrument's pre-test, as recommended in the literature (Gable et al., 2008) – so as to refine the proposed measurement model and to confirm the constructs defined in the research model.

To confirm the measurement model, no alteration in the form or composition of the manifest variables was made during or after the pilot study, following the premise of some works (Nevo & Wade, 2011; Ali & Green, 2012).

The pilot study was applied to IT and business professionals. IT managers possess a profound knowledge of IS and a broad understanding of business processes. Business managers were included for their involvement with processes that aggregate value to the organization and to identify IT value for individuals from outside IS (Maçada et al., 2012).

The pilot study was applied to graduate students (specialization and Master's degree programs) in IT and business administration at learning/research institutions in Brazil. In these courses, students/candidates who work in IT or business were asked to participate, in their respective organizations. Only those who work in profitable organizations were considered for research, due to the constructs adopted in the model. The coordination team of the course mediated access to the public for research, with the instrument applied in person and online (by link to fill out the survey).

One hundred forty-four IT and business managers participated in this pilot phase.

### 3.1.3 Complete study

The complete study was executed with IT and business managers from profitable organizations – selected from a sample – to test the proposed research model. A relation of the 500 largest companies in Brazil, in a ranking in a magazine specialized in economics and business, Exame, “Melhores e Maiores” [“The Best and the Biggest”] of 2012 (Editora Abril, 2012), composes the research sample to test the model. The choice for this relation of companies is due to the supposed maturity of the organizations with respect to IT use and their perception of technology value for process and firm performance.

The questionnaire for data collection, refined from the pilot study, was sent to the addresses of the 500 companies' headquarters at the beginning of September 2012 – by way of a letter sent via official delivery service, with a return stamp. Along with copies of the questionnaire for the IT and business managers was a letter presenting the research. In total,

2,000 research instruments were sent to the companies, two for IT personnel and two for business personnel at each company.

In a second approach, the 500 companies were contacted by email (Rapp et al., 2010; Fink, 2011; Kmiecik et al., 2012), one by one – asking them to participate in the study.

During the second approach (contact and questionnaire by email), many organizations alleged not to have any available employees (IT and business) to participate in the study or impossibility to respond because of information included in their Strategic Plan – which, generally, are identified as reasons for a reduced number of responses (Bradley et al., 2012). Another reason relates to the research demands of senior managers and their reduced free time to meet them (Wang et al., 2008).

At the end of data collection, only large companies compose the complete study, making up a total sample of 150 observations. Considering the criteria of large, as established by the Ministry of Development, Industry, and International Business (MDIC), 57 observations of this sample originate from the 500 largest companies. Another 93 observations obtained from the pilot study were inserted in this stage for the complete study – as done in correlate studies (Angeles, 2009; Lunardi et al., 2010a). Through multi-group analysis, invariance of the measurement model in the subsamples was confirmed, thus being treated as one sample.

## 3.2 Analysis procedures: pilot study and complete survey

Because of the presence of multiple latent variables (independent and dependent) in the research hypotheses – added to the presence of mediating and moderating variables – Structural Equation Modeling (SEM) is the recommended procedure for analyzing results (Hair et al., 2005; Vieira, 2009).

Structural Equation Modeling (SEM) adopts Maximum Verisimilitude (analysis based on covariance structure) as the method for estimation, unlike other approaches such as Partial Least Squares (PLS) and Multiple Regression, which utilize variance analysis (Ringle et al., 2012). SEM is used for first- and second-order modeling (Koufteros et al., 2009).

Estimation by “Maximum Verisimilitude” adopts intrinsic assumptions to interpret the results of the structural model adequately: (i) independence of the observations, (ii) normality of data, (iii) analysis of outliers, and (iv) multiple indicators (Hair et al., 2005).

For the complete survey data, all the aforementioned assumptions of SEM were met, making analysis of the measurement and structural model possible. A proportion of five observations for each observable variable were maintained in the survey (Hair et al., 2005).

To confirm and refine the measurement model, Confirmatory Factor Analysis (CFA) was utilized in the pilot study. Criteria such as factor loadings ( $>0.50$ ), reliability ( $>0.70$ ), convergent/discriminant validity, and fit indices were analyzed (Fornell & Larcker, 1981; Hair et al., 2005; Farrell, 2010), confirming that the research model fits the data well. A total of 22 items composed the instrument for applying the survey, distributed throughout three constructs of the model – with 14 items for IT Capabilities and eight items for the two Performance constructs (process and firm). The constructs and items are demonstrated in Appendix A.

Likewise, CFA was reapplied to the complete study – confirming that the model fits the data (section 4.2). Consequently, the structural model was analyzed to test the research hypotheses (section 4.3).

## 4 Results and discussion: complete study

In this section, a characterization of the complete study sample, analysis of the measurement model, the structural model test, and discussion of the results are covered.

### 4.1 Characterization of the sample

As described in section 3.1.3, one hundred fifty observations (managers), with 113 from IT and 37 from business, comprise the complete survey sample. Of the managers, 57 are connected to the largest companies of Brazil, based on the 2012 ranking (Editora Abril, 2012). Another 93 are managers, participants of the Pilot Study, since there were

no alterations in the questionnaire with respect to composition and no addition of variables/items, in accordance with procedures already adopted in the literature (Lunardi et al., 2010a).

All the respondents are connected to large companies. They are characterized in Table 1, based on the size, age, and business sector of the respective companies.

It is important to note the company size demographic. Sixty-five percent have more than 1,000 employees, while 15 percent have more than 10,000. This last characteristic is predominant in manufacturing companies, which demand a greater number of employees. On the other hand, large companies in services (technology, finance) are among Brazil's largest in the magazine's ranking (Editora Abril, 2012), due to elevated revenue, despite the reduced number of employees.

### 4.2 Measurement model

The recommendation for the minimum loading ( $>0.50$ ;  $p < 0.001$ ) for the measurement model was observed and conciliated with the fit indices and reliability and validity indicators to assure the solidness of the structural model for testing the hypotheses.

The fit indices recommended in the literature for validating the measurement model show how much the model fits the data (Hartono et al., 2010). These second-order indices of the model (IT Capabilities) are within the recommended limits ( $\chi^2/Gl = 1.654$ ; CFI = 0.946; TLI = 0.937; IFI = 0.946; PCFI = 0.819; RMSEA = 0.066). For PCFI, a value greater than 0.60 is recommended; for RMSEA, recommendations of  $<0.08$ ; and the other indices must be greater than 0.90 (Sharma et al., 2005; Kim et al., 2011).

**Table 1.** Companies' demographic data by area and industry characteristics.

Characteristics	IT Managers	Business Managers	N
<b><i>Firm size (n° of employees)</i></b>			
From 80 to 199	12	06	18
From 200 to 999	25	09	34
From 1,000 to 4,999	41	13	54
From 5,000 to 9,999	19	03	22
From 10,000 to 99,999	16	04	20
More than 100,000 employees	-	02	02
<b><i>Firm's age (in years)</i></b>			
Up to 05	02	01	03
From 06 to 15	19	07	26
From 16 to 30	31	08	39
From 31 to 100	56	20	76
More than 100 years	05	01	06
<b><i>Industry (Business sector)</i></b>			
Trade	11	05	16
Services	66	19	85
Industry/Manufacturing	36	13	49
<b>TOTAL</b>	<b>113</b>	<b>37</b>	<b>150</b>

Source: Research data.

Along with the model's fit indices, reliability and convergent and discriminant validity indicators are specified in the literature.

In confirmatory studies, composite reliability must be above 0.70 (Hair et al., 2005). The reliability coefficients for the model's constructs are between 0.87 and 0.96, meeting the recommended level.

In studies with latent variables, generally the measurement model is analyzed in terms of convergent and discriminant validity (Bradley et al., 2012) before the structural model is tested.

Convergent validity indicates the extent to which the scale correlates with other methods to measure the same construct (Churchill, 1979). The constructs' convergent validity was calculated considering the Average Variance Extracted (AVE>0.50), as defended in the literature (Fornell & Larcker, 1981).

Discriminant validity is the extent to which a latent variable is different from other latent variables (Farrell, 2010). To measure this difference among constructs, the square root of AVE of each factor is recommended to exceed the correlation between each pair of factors (Tallon, 2010).

Table 2 illustrates the convergent and discriminant validity indicators, based on the first-order model – with fit indices considered acceptable by the literature.

Based on Table 2, convergent and discriminant validity are confirmed.

Discriminant validity in second-order models are executed when there is more than one second-order construct (Koufteros et al., 2009). In the research model in question, there is only one second-order construct (IT Capabilities), which conventionally makes demonstrating discriminant validity unviable.

For Koufteros et al. (2009), issues over discriminant validity for second-order models are of less significance, in light of the assumption of high correlations among the first-order constructs – which, technically, tend to make discriminant validity unviable (because of the existence of the abstract second-order factor).

### 4.3 Structural model: testing the hypotheses

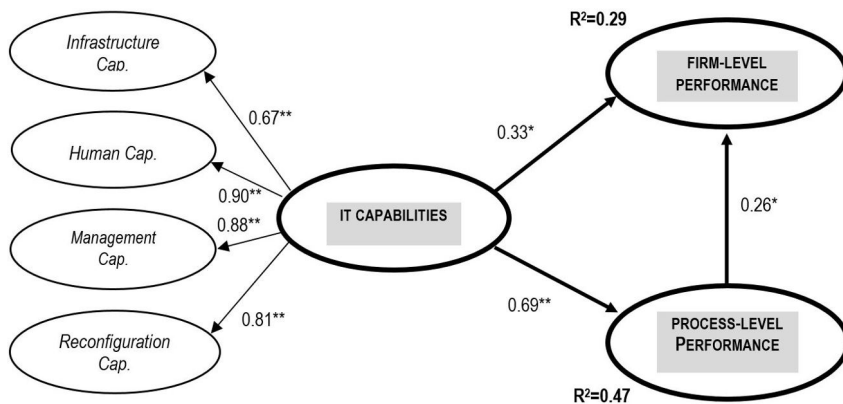
The structural model refers to the set of one or more dependent relations that connect the latent variables hypothesized in the model (Hair et al., 2005). In this case, the structural model tests the hypotheses presented in the theoretical framework, as shown in Figure 2.

Through the structural model (Figure 2), IT Capabilities are observed to exert a significant impact on Process Performance ( $\beta=0.69$ ;  $p<0.001$ ); therefore,

**Table 2.** Convergent and Discriminant Validity (based on first-order model).

Constructs	1	2	3	4	5	6
1. IT Infrastructure Capabilities (ITIC)	0.94					
2. IT Human Capabilities (ITHC)	0.65	0.86				
3. IT Management Capabilities (ITMC)	0.55	0.78	0.89			
4. IT Reconfiguration Capabilities (ITRC)	0.50	0.72	0.71	0.88		
5. Process Performance (PP)	0.43	0.59	0.63	0.57	0.89	
6. Firm Performance (FP)	0.28	0.42	0.49	0.48	0.48	0.89

Notes: The values in the diagonal are the square roots of Average Variance Extracted (AVE). Values below the diagonal are inter-construct correlations. Source: Research data.



\*  $p<0.05$ . \*\*  $p<0.001$ .  $\chi^2/GI = 1.654$ ; CFI = 0.946; TLI = 0.937; IFI = 0.946; PCFI = 0.819; RMSEA = 0.066).

**Figure 2.** Results of the Structural Model<sup>a</sup>. Source: Research data.



H1 is confirmed. The second hypothesis (H2) is also confirmed because the results indicate a positive impact of Process Performance on Firm Performance ( $\beta = 0.26$ ;  $p < 0.05$ ). The model explains 29 percent variance on Firm Performance and 47 percent variance on Process Performance.

To conclude over hypothesis H3, it is necessary to analyze the mediating effects on the structural model. In a model where there are three or more latent variables (independent and dependent), mediation occurs when the following conditions are satisfied (Baron & Kenny, 1986): **(1)** The predicting variable (ITCAP) must impact the mediator (PP); **(2)** the mediating variable (PP) must impact the dependent variable (FP); and **(3)** the predicting variable (ITCAP) must impact the dependent variable (FP).

To analyze total or partial mediation, a fourth condition is defended in the literature (Vieira, 2009; Hartono et al., 2010): **(4)** The impact of the predicting variable (ITCAP) on the dependent variable (FP) must not be significant (complete mediation), or the impact must be reduced (partial mediation) when the mediator (PP) is inserted in the model. It is worthy to note that in model (4), if the relation between predictor and mediator or between mediator and the dependent variable is not significant, mediation can be concluded as nonexistent. Table 3 presents the results of the cited four models for mediation analysis.

Analyzing Table 3, it can be observed that the four models are satisfied. In model 4, (mediation model), the coefficient of the relationship  $ITCAP \Rightarrow FP$  is reduced in relation to model 3 (from  $\beta = 0.50$  to  $\beta = 0.33$ ) but continues to be significant at  $p < 0.05$ . Therefore, partial mediation of the construct Process Performance can be concluded, thereby partially confirming H3 as well.

For hypotheses H4 and H5, multi-group analyses were made in accordance with the moderating variables involved (Table 4), as recommended in the literature (Marôco, 2010). For the variable "size," the sample was separated into firms of large and small size, and for "firm lifespan," the sample was divided into long and short lifespan, according to the number of employees and time in the market (years). For dynamism, the sample was divided into groups of "high/low" dynamism. For industry, the firms were categorized as trade/manufacturing ( $N=65$ ) and services ( $N=85$ ).

For the four moderating variables, the models were compared with the fixed structural coefficients and with free coefficients, concluding that the fixed models do not have a worse fit to the groups. Therefore, the entire structural model for the two groups (in each of the hypothetical moderators) is invariant, which indicates that the coefficients of the trajectories are similar for firms in both groups. It can thus be concluded that in

**Table 3.** Mediation Tests of the Construct "Process-level Performance".

Relation	Model (1)	Model (2)	Model (3)	Model (4)
Before (ITCAP) impact on Process Performance (PP)				
$ITCAP \Rightarrow PP$	0.69**	0	0	0.69**
IT Capabilities' (ITCAP) Impact on Firm Performance (FP), mediated by Process Performance (PP)				
$ITCAP \Rightarrow PP$	0.69**	0	0	0.69**
$PP \Rightarrow FP$	0	0.48**	0	0.26*
$ITCAP \Rightarrow FP$	0	0	0.50**	0.33*
Chi squared/degree of freedom	1.755	1.910	1.781	1.654
CFI	0.946	0.979	0.953	0.946
TLI	0.937	0.968	0.942	0.937
IFI	0.946	0.980	0.953	0.946
PCFI	0.811	0.630	0.778	0.819
RMSEA	0.071	0.078	0.072	0.066

\*  $p < 0.05$ . \*\*  $p < 0.001$ . Source: Research data.

**Table 4.** Results of the Multi-group Analysis: Moderating Variables.

Trajectories	Firm Size		Lifespan		Dynamism		Industry	
	Large	Small	Long	Short	High	Low	Trad/Manu.	Services
$ITCAP \Rightarrow PP$	0.72***	0.68***	0.70***	0.71***	0.66***	0.67***	0.72***	0.69***
$ITCAP \Rightarrow FP$	0.38*	0.23 n.s.	0.41 n.s.	0.32 n.s.	0.44*	0.17 n.s.	0.14 n.s.	0.29 n.s.
$PP \Rightarrow FP$	0.28 n.s.	0.31 n.s.	0.14 n.s.	0.32 n.s.	0.26 n.s.	0.29 n.s.	0.55**	0.19 n.s.

\*  $p < 0.05$ . \*\*  $p < 0.01$ . \*\*\*  $p < 0.001$ . n.s. Insignificant ( $p > 0.05$ ). Source: Research data.

the sample utilized, there is no difference in impact of IT Capabilities on Process Performance in firms of different sizes, lifespans, sector dynamism, and industries – rejecting H4 and H5.

#### 4.4 Discussion

IT Capabilities' impact on Process Performance is in accordance with the results of Kim et al. (2011) and Qu et al. (2010). Specifically, these technological capabilities are associated with the performance of three business processes: production and operations, product/service improvement, and client relations – corroborating Tallon's results (2011).

In production and operations, the results that IT contributes significantly to improvements in production and service volume in addition to improved productivity of the operational work are confirmed (Tallon & Kraemer, 2006). For the process in improving products/services, IT capabilities are effective in reducing time for launching new products and services and contributing to the products'/services' quality (Tallon, 2010; Bradley et al., 2012). In client relations, the association of IT Capabilities to aspects such as the ability to attract and retain clients and client support throughout the sales process are confirmed – which also substantiates Tallon & Kraemer (2007) and Chen & Tsou (2012).

For one current of IS literature, Performance at the Process level is related to the aggregate measures of Firm Performance (Tallon & Kraemer, 2007; Chen & Tsou, 2012). In this investigation, this premise is corroborated, since business processes are associated with improvement of aggregate performance (H2), measured by the increase in profit and market participation.

The existence of multiple organizational variables that explain the variance in Firm-level Performance fortifies the assumption of IT's indirect impact on this level of performance (Goldoni & Oliveira, 2010). The mediation test reveals that IT Capabilities' impact on Firm Performance is mediated partially by Process Performance. This result verifies studies that defend IT's impact on levels below the firm (aggregate measures of profitability, efficiency) (Ray et al., 2004; Qu et al., 2010; Chen & Tsou, 2012). Correspondingly, the results of this study contribute to the explanation behind the distinct results over IT value (Liang et al., 2010; Masli et al., 2011) when firm performance is considered to be the first level of IT performance, corroborating the understanding that this value is directly identified in levels below the firm (Oliveira & Oliveira, 2012).

Mediation of IT Capabilities' impact on Firm Performance (H3) by Process Performance sustains the assumptions regarding IT's benefits firstly at the level of business processes (Tallon & Kraemer, 2007;

Tallon, 2010; Bradley et al., 2012). This result is also in line with studies that treat process performance in its various facets, such as operational performance, agility of processes and entrepreneurship, client performance, human resources performance, among others (Soto-Acosta & Meroño-Cerdan, 2008; Tallon, 2008; Doherty & Terry, 2009; Iyer, 2011; Mithas et al., 2011; Bradley et al., 2012).

Considering the intervening potentials in the relation between IT Capabilities and Process Performance, testing of the moderating variables (size, lifespan, dynamism, and industry) revealed that there is no difference in the degree of association between variables (ITCAP and PP). For the size of the firm, the RBT premise is that larger firms have more resources; therefore, they enjoy better performance indicators (Lun & Quaddus, 2011). Nevertheless, the way resources are gathered to form IT capabilities makes them relevant to impacts on performance – not the quantity of isolated and/or invested resources (Soto-Acosta & Meroño-Cerdan, 2008; Schwarz et al., 2010) – which substantiates the use of the concept IT Capabilities in investigations on IT business value. This perspective is corroborated by indifferent results for firm size.

For time in the market, the results are convergent with those of Wu et al. (2008), despite the assumption of competitive advantage conferred by the firm's age (Ortega, 2010). This apparent paradox is resolved when considering that new companies tend to construct and organize sufficient IT Capabilities to bring benefits to business processes, which is justified by the absence of any organization before IT and by the organization's capacity for innovation (Oliveira & Oliveira, 2012).

As for the level of dynamism, there are no observed differences between firms that operate in High and Low dynamic sectors, which confirms the value of IT Capabilities for environments with constant changes as well as stable ones (Protogerou et al., 2012).

For industry intervention on the relation between IT and performance, mixed (Byrd & Byrd, 2010; Kim et al., 2011) and null results (Oliveira & Oliveira, 2012) are identified in the literature. In this work, industry's null impact on the relationship in question is verified, since the structural coefficients are invariant for industries in trade/manufacturing versus services.

## 5 Conclusions

The research objective is to identify the extent to which IT Capabilities directly impact Process-level Performance and indirectly impact Firm Performance.

From the structural model's results, it can be concluded that IT Capabilities positively and significantly impact Process Performance, specifically in production and operations processes, improvements in product/service, and client relations (H1). Similarly, the performance of these processes is related in a positive and significant

way to the aggregate Performance of the Firm (increase in profit and market participation) – H2.

The mediation tests demonstrate that the impact of IT Capabilities on Firm Performance is mediated partially by Process Performance (H3), which confirms direct IT value on intermediate levels of the firm. The result is also convergent with the premise that aggregate performance is explained by an extensive number of organizational variables, one of which is IT.

The Process Performance mediation model corroborates Resource-Based Theory's premise that defends IT's impact on intermediate levels of performance and studies over IT value from other theoretical perspectives that consider intermediate measures.

Analyses of the role of the industry's characteristics (size, lifespan, dynamism, and industry) on the relation between IT Capabilities and Process Performance indicate no interference from the moderators, since the structural coefficients remained positive and significant throughout the groups. It is worthy to note that these moderators were considered in the context of Process Performance, not in the context of Firm Performance, as in many studies on IT business value.

Adopting a sample of large companies and in different sectors are research limitations. Nonetheless, regarding size, this choice is justified by the possibility of extracting reliable information from consolidated companies that are market leaders with a well-developed IT area with defined functions. As for the different sectors – despite the results not presenting answers exclusive to specific business sectors – the research model revealed to be valid overall and also invariant when divided into two industry groups (trade/manufacturing versus services).

To respond to the limitations, we recommend the following approaches to future studies: (i) applying the research model to a sample of small and medium-sized companies and (ii) identifying IT value for specific business sectors, such as telecommunications, bank services, etc., from the validated model.

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**Appendix A.** Constructs and variables/items of the research model.

<b>Construct</b>	<b>Items</b>	<b>Adapted from</b>
<b>IT Infrastructure Capabilities</b>	Regarding the use of Information Technology (IT) resources and capabilities, in our organization... <ul style="list-style-type: none"> <li>- Sufficient hardware resources are utilized to support the business;</li> <li>- Sufficient network and communication technology is utilized to support the business;</li> <li>- Sufficient database technology is utilized to support the business.</li> </ul>	Hartono et al. (2010)
<b>IT Human Capabilities</b>	Regarding the use of Information Technology (IT) resources and capabilities, in our organization... <ul style="list-style-type: none"> <li>- The IT team's cooperation ability is appropriate to the business;</li> <li>- The IT team is trained in terms of management of project life cycles;</li> <li>- The IT team is very skilled in the areas of data and network management and maintenance;</li> <li>- The IT team has sufficient professional/technical knowledge for the business;</li> <li>- The IT team has initiative to adopt new technologies for the business.</li> </ul>	Huang et al. (2006); Ordanini & Rubera (2010); Park et al. (2011); Kim et al. (2011)
<b>IT Management Capabilities</b>	Regarding the use of Information Technology (IT) resources and capabilities, in our organization... <ul style="list-style-type: none"> <li>- We constantly align IT planning to business strategy;</li> <li>- IT and business areas share information, in such a way that the decision makers have access to all available knowledge;</li> <li>- We coordinate IT innovations with changes related to the business;</li> <li>- Risks and responsibilities of IT innovation are shared by IT and business areas.</li> </ul>	Huang et al. (2006); Ordanini & Rubera (2010); Park et al. (2011); Kim et al. (2011)
<b>IT Reconfiguration Capabilities</b>	Regarding the use of Information Technology (IT) resources and capabilities, in our organization... <ul style="list-style-type: none"> <li>- We can reconfigure our IT resources to conceive new products/services;</li> <li>- The IT team is successful in calculating its actions as new demands for IT solutions in the organization arise.</li> </ul>	Pavlou & El Sawy (2006); Xiao & Dasgupta (2006); Pavlou & El Sawy (2010); Park et al. (2011)
<b>Process Performance</b>	In comparison with competitors, to what extent does IT contribute to... <ul style="list-style-type: none"> <li>- Improving the result of production and service volume?</li> <li>- Improving work productivity?</li> <li>- Reducing launch time of new products and/or services?</li> <li>- Refining the quality of the products and/or services?</li> <li>- Refining our ability to attract and retain clients?</li> <li>- The company's support to clients during the sales process?</li> </ul>	Tallon (2010)
<b>Firm Performance</b>	Compared to our competitors, in the last three years our organization... <ul style="list-style-type: none"> <li>- Increased its profit margin;</li> <li>- Increased its market participation.</li> </ul>	Tallon & Kraemer (2007)