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Business value of IT capabilities: effects on processes and firm performance in a developing country

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Abstract

Purpose –This article proposes an integrated three-stage model, which tests the impact of IT capabilities at the firm level.

Design/methodology/approach – The measurement model was constructed from the following research phases: i) assessment of the variables by experts in the fields of IS and business; ii) survey pretest; and iii) pilot survey. The full survey was applied to managers from IT and business fields in Brazil's largest organizations, and was analyzed through Structural Equation Modelling.

Findings – The results of the full survey allow us to conclude about the relationships that exist between IT capabilities, information quality and performance processes. Performance processes partially mediate the impact of IT capabilities on firm performance.

Originality/value – The results presented contribute to the academic and management aspects, for they allow: i) to replicate the model in other research contexts (national, international) and evaluating incremental improvements of IT capabilities on firm performance; ii) the identification of intermediate performance indicators, associated with the use of IT, and the concentration of energy of organizations in the measurement of IT effects on business processes; iii) the adoption of the model for horizontal analysis of IT performance in large companies, from the perspective of business and IT managers.

Keywords – IT benefits; IT return; Performance variables; Process and firm level; Value measurement.

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1 Introduction

The application of technological and organizational resources in building IT capabilities by firms assumes that such capabilities significantly contribute to business performance (Cano & Baena, 2015; Chen et al., 2014). However, there is in literature and in the business field a growing interest in consolidating tools and methodologies that appropriately measure the benefits generated by IT as well as the conditions under which the effects manifest themselves (Chen & Tsou, 2012; Chen, Wang, Nevo, Benitez-Amado, & Kou, 2015), so as to justify IT investments.

The pressure of competition, the need to stay in the market and the growing volume of data and information have given IT a strategic role for business in shaping technological capabilities (Soto-Acosta & Meroño-Cerdan, 2008).

Recent studies on the business value of IT have emphasized the aspect of technological capabilities, in contrast with the amounts of investments applied; however, the mechanisms under which IT contributes to firm performance are still inconclusive and require further studies (Crook, Ketchen, Combs, & Todd, 2008; Fink, 2011).

In one of the research streams on IT, recent studies based on archive data – directly linking IT capabilities (binary measurements) and aggregate performance measures of the company (book and market) – presented null and mixed results for IT value (Chae, Koh, & Prybutok, 2014; Oliveira, Maçada & Oliveira, 2015). These results support other research stream that considers IT capabilities as multidimensional constructs [infrastructure, management, people, knowledge] (Kim, Shin, Kim, & Lee, 2011) and which analyzes IT value on intermediate performance (Garrison, Wakefield, & Kim, 2015), namely: business processes (Chen et al., 2014) and information quality (Hartono, Li, Na, & Simpson, 2010).

Based on this last stream, this research seeks to answer the following question: to what extent are IT capabilities associated with the quality of information, with a firm's processes and performance? As a response, our research offers three contributions to IT business value.

First, this research uses continuous variables to measure the dimensions of IT capabilities, according to demands presented in studies that gave these capabilities binary nature. Binary measurements do not allow assessment of incremental improvements in IT capabilities on firm performance, as other approaches do, e.g. the use of scales (Chae et al., 2014; Santhanam & Hartono, 2003). The use of validated scales, such as the one presented here, enables horizontal analysis of the impact of IT capabilities on the managerial context.

As a second contribution, we consider mediating constructs that potentially capture IT value directly, namely, information quality and processes performance. The mediation test within the research model (Figure 1) is aligned with the indirect impacts of IT on firm performance (Chen & Tsou, 2012) and the null results of the direct relationship between IT capabilities and aggregate performance of the firm (Chae et al., 2014). From a managerial perspective, the phenomenon of business process mediation could lead organizations to adequately measure IT performance at intermediate levels (e.g. processes), avoiding frustration with analysis at the firm level, directly.

Additionally, we use the data collected from managers in IT and business departments in large Brazilian companies to test the proposed research model (e.g. see the section 3). IT business value has been predominantly studied in developed countries, e.g. firms from the US (Tallon, 2010) and from Korea (Hartono et al., 2010); studies about IT capabilities in the Brazilian context are scarce. The use of IT has increased exponentially in developing countries over the past 15 years, especially in Brazil (Meireles, 2015) and China (Dedrick, Kraemer, & Shih, 2013), in which the number of computers and Internet users are significant. In this line of thought, the model

can be tested in large companies in developing countries, from the perspective of IT and business managers, to compare IT performance over the years.

The results of the survey in Brazil are compared with results from research on IT capabilities in other developed and developing countries. This cross-country analysis can be explained by two aspects, namely: i) studies show that characteristics of countries (e.g., economic, social) could potentially affect IT business value (Dedrick et al., 2013; Lin & Chiang, 2011); ii) the results on IT value in different countries and over time present notable differences (e.g., Chae et al., 2014; Ong & Chen, 2013); ii) there are few studies referring to IT capabilities in Brazil.

We present the model with the research hypotheses in the next section. The research method addresses collection and analysis procedures as well as variables. Next, the results are analyzed and discussed, based on previous literature. Additionally, we present a cross-country analysis in the results section. The last section presents conclusions, limitations and research recommendations.

2 IT capabilities and performance: research model

The concept of IT capabilities in this study is derived from Bharadwaj (2000), who defined these capabilities as the ability of the firm to "mobilize and develop IT-based resources, in combination or co-presence with other resources and capabilities." Studies from the 2000s until recently have intensively mentioned original research carried out by Bharadwaj (2000). This because it is tuned to the assumptions of Resource-Based View (RBV), which makes understandable the relationship tests between the technological capabilities and organizational performance (e.g. Ray, Barney & Muhanna, 2004; Kim, Shin, Kim & Lee, 2011). Additionally, models/concepts about IT capabilities are predominantly adapted from the original study by Bharadwaj (2000), e.g.: Garrison, Wakefield, & Kim (2015); Chae, Koh, & Prybutok (2014); Liu, Ke, Wei, & Hua (2013); Chen & Tsou (2012); Lu & Ramamurthy (2011); Park, Im, & Kim (2011).

Therefore, we adopt the three dimensions of IT capabilities used by Bharadwaj, namely: IT infrastructure capabilities, IT human capabilities, and IT intangible capabilities. These dimensions are also adapted from recent studies (e.g Hartono et al., 2010; Kim et al., 2011), and a fourth dimension was added: IT reconfiguration capabilities (Pavlou & El Sawy, 2010; Wu, 2010). This approach enables: i) continuous assessment of IT capabilities and reduction of the problems of the binary nature in the measures, predominantly in the magazines' rankings; ii) increase the scope of investigation, including firms with different levels of IT capabilities; and iii) comparative studies, before or after the research (Santhanam & Hartono, 2003).

The complementarity that integrates measurement of IT capabilities is aligned to RBV, whereas such capabilities become difficult for replication by competitors (Barney, 1991, 2001; Chen & Tsou, 2012), to the extent that they are sets of unique organizational resources, built over time and in connection with the history, culture and experience of the firm (Bharadwaj, 2000). The concept of IT capabilities adopted in this research covers aspects of IT ambidexterity, for it includes the ability to explore new IT resources (IT reconfiguration) and existing IT resources (Lee, Sambamurthy, Lim, & Wei, 2015).

2.1 Research model and hypotheses

In accordance with the research model (Figure 1), we propose in this research that IT capabilities directly and positively influence: i) the quality of information; and ii) performance processes.

Information quality is defined as adequate information for use, and its attributes are divided into four aspects: (i) validity; (ii) utility; (iii) reliability; and (iv) usability (Lee, Strong, Kahn, & Wang, 2002).

According to Hartono et al. (2010), there is a positive relationship between IT infrastructure capabilities and the quality of shared information in the supply chain. In this line, the theoretical perspective of Dynamic Capabilities has also been used in studies about IT value, enabling: i) understanding IT capabilities as those which renew the resource base; and ii) the inclusion of the "information" resource between constructs "IT capabilities" and "organizational performance" (Hartono et al., 2010).

First-order Dynamics Capabilities explain how new resources are created and how the existing resource stocks are reconfigured in order to generate competitive advantages and performance in changing environments (Ambrosini & Bowman, 2009).

Information quality is reported in literature as a unique resource for organizational management. For Nevo and Wade (2011), IT assets deliver value to the business due to their ability to contribute to the shaping of strategic resources linked to IT, and the quality of information meets the requirements of this type of resource (Barney, Wright, & Ketchen Jr., 2001; Nevo, Wade & Cook, 2007). Therefore, we present the first research hypothesis:

> **H1:** *Higher levels of IT capabilities (ITC) improve information quality (IQ).*

From the Resource-Based View perspective, information contributes to organizational performance when it is a specific resource of the firm (Barney, 1991). Studies conducted in the supply chain (Costa & Maçada, 2009; Li & Lin, 2006) have highlighted the relationship between organizational efficiency and sharing of quality information by chain partners. Hartono et al. (2010) found that the quality of shared information affects the operating performance of the chain, when there are high IT capabilities.

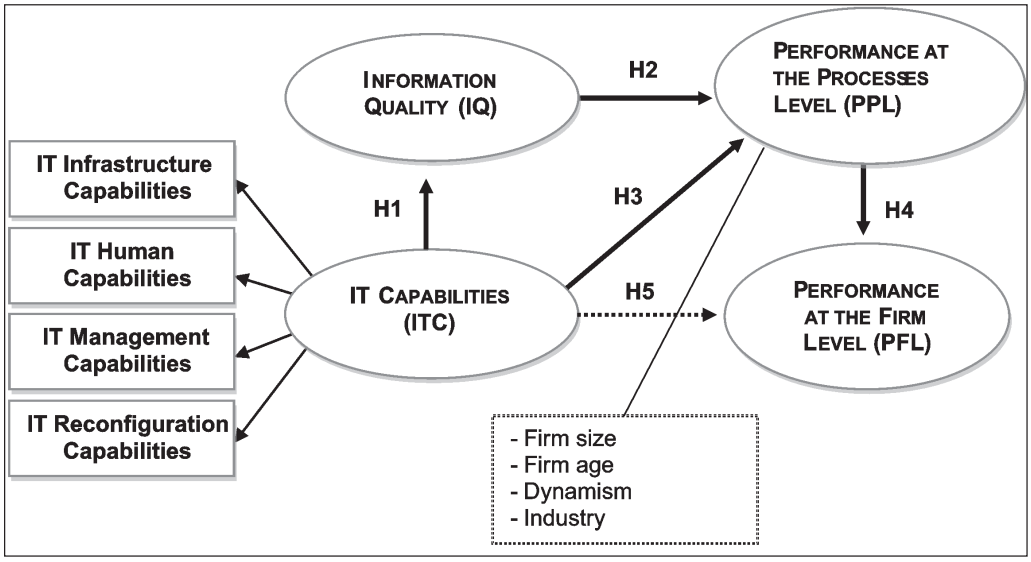

Figure 1. Research model

Source: Adapted from "Valor das capacidades de TI: Impactos sobre o desempenho de processos e de firma nas organizações brasileiras", by D. D. L. Oliveira and G. D. Oliveira, 2013.

For Gorla, Somers, & Wong (2010), information quality is positively associated with organizational performance, measured mostly by measures of organizational processes that require information quality directly.

Performance at the processes level. Processes represent a firm's actions or routines in performing business purposes or objectives (Ray, Barney, & Muhanna, 2004). The study considers three specific processes adopted by Tallon (2010): i)

relationship with customers; ii) production and operations; iii) improvement of product/services (Tallon & Kraemer, 2007).

From the results that associate information quality and performance (e.g Gorla et al., 2010; Hartono et al., 2010), and the demand to relate resources linked to IT and performance processes (Chen & Tsou, 2012), we present the following hypothesis:

> **H2:** *Higher levels of information quality (IQ) improve performance at the processes level (PPL).*

Research adopting assumptions of RBV and Dynamic Capabilities to analyze the IT business value has advocated the use of performance measures below the level of the firm (Chen & Tsou, 2012; Kim et al., 2011; Ray, Muhanna, & Barney, 2005). Studies of the field show that IT tends to initially have an impact on organizational processes (Cano & Baena, 2015; Tallon, 2010) and, next, on financial measures (Tallon & Kraemer, 2007) and organizational agility (Lee et al., 2015) at the firm level. Another reason lies in the fact that the aggregate values of a firm result from other variables, besides those related to IT (Ting-Peng, Jun-Jer, & Chih-Chung, 2010).

To support arguments about the relationship between IT capabilities and intermediate performance measures, we conducted a previous analytical study in order to identify in literature the type of association between IT capabilities and performance. Based on keywordsi linked to IT value and capabilities, we identified 44 articles published in the Web of Knowledge and EBSCOhost databases between the years 2007 and 2011. We found that, in recent articles, researchers made intermediate performance measures (e.g. business processes, innovation) a priority, combined with firm performance measures (e.g. profitability, efficiency).

Business processes are the first level of IT impact, given that they use IT resources and capabilities directly (Tallon, 2010). Chen et al. (2014) identified a positive relationship between IT capabilities and processes' agility in the context of Chinese firms. In the same vein, another study found that IT capabilities influence customer service and service process innovation (Chen & Tsou, 2012; Chen et al., 2015).

In Dynamic Capabilities assumptions, organizational capabilities focus on the strength and expertise of the firm as to adapting, integrating and reconfiguring resources (Augier & Teece, 2008; Chen, Sun, Helms, & Jih, 2008), and these capabilities contribute to improve firm performance by improving organizational routines such as business processes (Chen & Tsou, 2012; Protogerou, Caloghirou, & Lioukas, 2012). Therefore, we present hypothesis H3:

> **H3**: *Higher IT capabilities (ITC) improve performance at the processes level (PPL).*

Industry variables. In addition to hypothesis H3, four intervening variables which reflect industry characteristics are considered (Khallaf, 2012): i) firm size; ii) firm age (time of operation); iii) dynamism of the sector; iv) type of industry. Demand for these variables is reported in recent studies (e.g. Chae et al., 2014), justifying the need to understand the mechanisms of IT impact on performance.

Firm size is an indicator of past performance and may affect the current performance (Ortega, 2010), although null results have been observed (Kim et al., 2011). The operation time can offer firms competitive advantage and enhanced performance (Ortega, 2010), although there are results that do not support this relationship (Oliveira & Maçada, 2013).

For industries with high levels of dynamism, IT capabilities contribute to improvements in products and operational processes (Lee et al., 2015; Ortega, 2010). This dynamism reflects the level of changes occurred and the consequent need for a firm to answer them promptly (Nevo & Wade, 2011); however, there are some mixed results in literature (e.g., Protogerou et al., 2012; Stoel & Muhanna, 2009).

From a theoretical perspective, the dynamic capabilities of firms are fostered by environmental dynamism (D.-Y. Li & Liu, 2014). Dynamism as a moderator in the relationship between IT capabilities and performance (Stoel & Muhanna, 2009) enables an understanding that firms operating in more dynamic environments have more advantages from dynamic capabilities.

According to Stoel and Muhanna (2009), the industry in which the firm operates can also influence the relationship between IT capabilities, IT resources and performance. Byrd and Byrd (2010) found greater impact of IT capabilities on performance in manufacturing firms, if compared to service firms. However, G. Kim et al. (2011) found opposite results; additionally, it is also possible to identify zero impact of this variable in the relationship (Oliveira & Maçada, 2013).

The mixed results mentioned above could be justified by the fact that studies have examined the effect of these variables directly on the aggregate performance of the firm, and not at the processes level, such as we are proposing.

2.2 Mediation of performance at the process level

We propose that performance at the process level mediates the relationship between IT capabilities and firm performance. Firm performance indicates the aggregate performance and can be represented by: i) executives' measures of perception (Tallon & Kraemer, 2007) or ii) objective measures of performance drawn from firms' financial statements (Chae et al., 2014), the same essence as measures of perception. In this research, firm performance is a construct measured by measures of perception adapted from Tallon and Kraemer (2007).

Two studies published in the early 2000s, based on secondary data from the 1990s, demonstrated the positive and direct relationship between IT capabilities and firm performance (Bharadwaj, 2000; Santhanam & Hartono, 2003) [ii]. The first one (Bharadwaj, 2000) was published in 2000, with data between 1991 to 1994, from the magazine's ranking, and performance measures based on profit and cost. They concluded that IT leaders had better performances than the control sample (not leaders). Three years later, Santhanam and Hartono (2003) replicated the initial research of Bharadwaj (2000), with some methodological changes, confirming the results about the impact of IT capabilities on firm performance.

However, studies that followed in the 2000s and beginning of the following decade began to show mixed results for the direct relationship between IT capabilities and performance at the firm level (Ting-Peng et al., 2010).

Masli et al. (2011) identified a positive relationship between higher IT capabilities and performance of the firm from 1988 to 2007 – but highlighted a trend towards reducing the impact of IT capabilities on performance from 1999 on, justified by the crisis in the companies "dot.com" and the short life of competitive advantage driven by IT. Byrd and Byrd (2010) found a positive impact of IT on profitability and the reduction of some cost indicators, but zero impact on indicator "cost of goods sold by sales revenue." Additionally, Quan (2008) analyzed the impact of IT on profitability and cost variables, identifying a partial positive impact on profitability and no impact on cost measures.

Recently, Chae et al. (2014) replicated the studies of the early years 2000 [(Bharadwaj, 2000; Santhanam & Hartono, 2003)] with American organizations. Based on secondary data (2001-2004), the authors found that performance indicators (based on profit and cost) of the leading firms in IT capabilities are no better than those of firms that are not leaders. Consequently, they did not detect the sustainability of IT capabilities in the following years (2005-2007). This null association was also confirmed in Brazilian firms (Oliveira & Maçada, 2013), considering that high IT capabilities are dissociated from a firm's best measures of performance (such as ROI, ROA, sales growth etc.).

An answer to the different results presented in these studies can be found in studies that

inserted mediating variables to capture IT value, preceding firm performance (Garrison et al., 2015; Mithas, Ramasubbu, & Sambamurthy, 2011; Tallon & Kraemer, 2007). This logic is based on the fact that firm performance can be influenced by many variables, and IT is just one of them (Ting-Peng et al., 2010) – which implies complexity in capturing IT value (Fink, 2011). It also supports Tallon's (2010) view, and studies by G. Kim et al. (2011) and Y. Chen et al. (2014) that identify the positive impact of some (isolated) IT capabilities on processes' performance and the indirect impact on firm performance.

Therefore, we present hypotheses H4 and H5:

H4: *Higher performance at the processes level (PPL) improve performance at the firm level (PFL).*

H5: *Performance at the processes level (PPL) mediates the effect of IT capabilities (ITC) on performance at the firm level (PFL).*

3 Method

3.1 Data collection and informants

The procedures of data collection and the informants are presented in Table 1, in the respective stages of the research – embracing consultation of experts and survey.

Studies in Information Systems have adopted consultation of experts before testing models, especially in order to build and validate the collection instrument (e.g., Wang & Wang, 2009). Additionally, the perception of managers concerning IT impacts at the levels of processes and firm has been found to present similar results to studies using objective metrics for assessment of IT performance (Tallon, 2013; Tallon & Kraemer, 2007). This recurrent practice confirms surveys as a reputable methodological approach to analysis of IT business value.

Table 1
Phases and stages of research

Stages	Procedures
Consultation of experts	
Evaluation of variables' permanence	Three IS researchers participated in this stage, all of them with recent publications in the field and with experience in research/teaching (Nevo & Wade, 2011).
Survey	
Pre-test survey	Pre-test survey checked the clarity in content of items, response time and related observations (Gable, Sedera, & Chan, 2008; G. Kim et al., 2011). Participants: two IS/IT researchers and a researcher from the business field.
Pilot survey	Applied to professionals from the IT and business fields to refine the measurement model and confirm the constructs (Gable et al., 2008; Maçada, Beltrame, Dolci, & Becker, 2012). Informants: students and students from postgraduate courses (specialization and master's degree) in IT and administration in Brazil. 144 professionals from the IT and business fields participated.
Full survey	Held with IT and business managers in profit organizations. The research sample for model testing is made up of the 500 largest companies in Brazil, based on "Best and Biggest" 2012 ranking by *Exame* magazine (Abril, 2012). We sent the survey to the firms' addresses and followed-up by e-mail (Fink, 2011; Kmieciak, Michna, & Meczynska, 2012). Each company received four copies of the survey to mitigate the single response bias. Many organizations claimed they could not allow their employees to participate in the research, or inability to answer because this information belongs to its Strategic Plan (Bradley, Pratt, Byrd, Outlay, & Wynn Jr., 2012). Valid responses of the complete survey: 150 observations from large companies – criteria of the Brazilian Ministry of Development, Industry and Foreign Trade (MDIC); 57 observations of the sample come from ranking companies (2.9% return); 93 other observations are from the pilot survey (Angeles, 2009; Lunardi, Becker, & Maçada, 2010). When the invariance of the measure model in subsamples was confirmed, we treated them as one single sample.
Cross-country analysis	The results of this research in Brazil were compared with results of studies on the business value of IT capabilities conducted in developed and developing countries over the past five years. We present this analysis in the results section.

3.2 Variables and measurement

IT capabilities are measured by four constructs: (i) IT infrastructure – involving IT assets (hardware, software and data), systems and their components, communications facilities and network, and applications (Hartono et al., 2010); (ii) IT human capabilities – covering the technical and managerial skills in the field of technological knowledge (Park, Im, & Kim, 2011); (iii) IT management capabilities – covering assets linked to knowledge, customer orientation and synergy (Bharadwaj, 2000), and the alignment of skills between IT and the business fields (G. Kim et al., 2011); (iv) and IT reconfiguration capabilities – referring to the ability to adapt resources and IT capabilities to the firm's business needs and market (Pavlou & El Sawy, 2010).

Information quality is a first-order construct, with four items that measure the adequacy of the information for use, seen from the perspective of the product (validity and utility) and service (reliability and usability) (Lee et al., 2002).

Performance at the processes level is measured by six items, including three processes: production and operations, customer relations and improving the product/service (Tallon & Kraemer, 2007).

Performance at the firm level is measured by increase in profit and market share (Tallon, 2010).

The constructs of the model are measured by Likert scale of 7 points, 1 being "strongly disagree" and 7 "strongly agree" or similar expressions.

Industry variables are measured as follows:

i. Firm size – number of employees (Tian, Wang, Chen, & Johansson, 2010);
ii. Firm age (operating time) – years in the market (Oliveira & Maçada, 2013);
iii. Environmental dynamics – the degree of changes in the market environment of companies (Nevo & Wade, 2011), measured by the Likert scale (1 to 7 – from stable environment to dynamic environment);
iv. Industry – trade/service firms versus manufacturing firms (Byrd & Byrd, 2010).

3.3 Measurement model and validation

We adopted Structural Equation Modeling for data analysis, verifying suitable intrinsic assumptions, namely: (i) independence of observations, (ii) data normality, (iii) outliers analysis and (iv) multiple indicators. The ratio of five observations per variable was also maintained (Hair, Anderson, Tatham, & Black, 2005).

The bias of nonresponse was analyzed based on t-test for the firm's performance variables, considering initial (pilot study) and final (full study) observations, as was done before (Schmiedel, Vom Brocke, & Recker, 2014). No significant differences were observed for these variables.

In order to validate the measurement model, confirmatory factor analysis (CFA) was used before structural model tests (Bradley et al., 2012), as well as analysis of adjustment indexes. We used software SPSS AMOS (v.20s) for data analysis.

Considering that data was collected for independent and dependent variables from the same respondents (Hsu, Chu, & Lo, 2014), bias of common method was analyzed in this study. We adopted the single factor Harman test (Podsakoff, Mackenzie, Lee, & Podsakoff, 2003). All items of the instrument were entered in the factor analysis of main components with Varimax rotation (Siponen, Adam Mahmood, & Pahnila, 2014). None of the factors were dominant and the analysis revealed five factors with eigenvalues greater than 1, and the factors with the greatest variance represent 20.3% and 18.3%. Total variance was 73%.

In addition to minimum factor loading (>0.50; p<0.001) for the measurement model, the indexes of the second-order model are within the recommended limits (χ^2/df = 1.587, CFI = 0.947; TLI = 0.940; IFI = 0.948; PCFI = 0.834, RMSEA = 0.063). For PCFI, a value greater than 0.60 is recommended; for the RMSEA, <0.08 is recommended; the other indexes are >0.90 (G.

Kim et al., 2011; Sharma, Mukherjee, Kumar, & Dillon, 2005). Additionally, the reliability coefficient for the model constructs are between 0.87 and 0.97, as recommended in literature (Hair et al., 2005).

The convergent validity of the constructs (Table 2) was calculated considering the Average Variance Explained (AVE> 0.50), according to Fornell and Larcker (1981).

Table 2
Convergent and discriminant validity (first-order model)

Constructs	1	2	3	4	5	6	7
1. IT Infrastructure Capabilities (ITC)	0.94						
2. IT Human Capabilities (ITHC)	0.65	*0.87*					
3. IT Management Capabilities (ITMC)	0.55	0.78	*0.89*				
4. IT Reconfiguration Capabilities (ITRC)	0.52	0.73	0.72	*0.88*			
5. Information Quality (IQ)	0.62	0.66	0.68	0.62	*0.95*		
6. Performance at the Processes Level (PPL)	0.43	0.59	0.63	0.58	0.50	*0.89*	
7. Performance at the Firm Level (PFL)	0.29	0.42	0.48	0.48	0.30	0.48	*0.89*

Notes: The values on the main diagonal are the square root of Average Variance Explained (AVE). Values below the main diagonal are correlations among the constructs.

For the discriminant validity, we found that the square root of the AVE in each factor exceeded the correlation between each pair of factors (Farrell, 2010; Tallon, 2010). The discriminant validity in second-order models is analyzed when there are more than a second-order construct (Koufteros, Babbar, & Kaighobadi, 2009); this is less relevant in this research, considering the high correlations between constructs (first-order).

4 Results and discussion

The key informants are professionals in big companies and are characterized by size, age and business sector of the companies (Table 3).

Table 3
Demographic data by activity field

Characteristics	IT managers	Business managers	n	(%)
Firm size				
From 80 to 999	37	15	52	34.6
1,000 to 4,999	41	13	54	36.0
5,000 to 9,999	19	03	22	14.7
Over 10,000	16	06	22	14.7
Firm age (operating time – years)				
Up to 05	02	01	03	2.0
From 06 to 15	19	07	26	17.3
16 to 30	31	08	39	26.0
Over 30 years	61	21	82	54.7
Industry				
Trade/services	77	24	101	67.3
Manufacturing	36	13	49	32.7
Total	**113**	**37**	**150**	**100.0**

4.1 Testing hypotheses

The structural model (Figure 2) shows that H1 is supported (β = 0.77; p <0.001), indicating that IT capabilities contribute to the information quality. In contrast, H2 is not supported (β = -0.08; p = 0.54) – signaling to null association between information quality and processes performance.

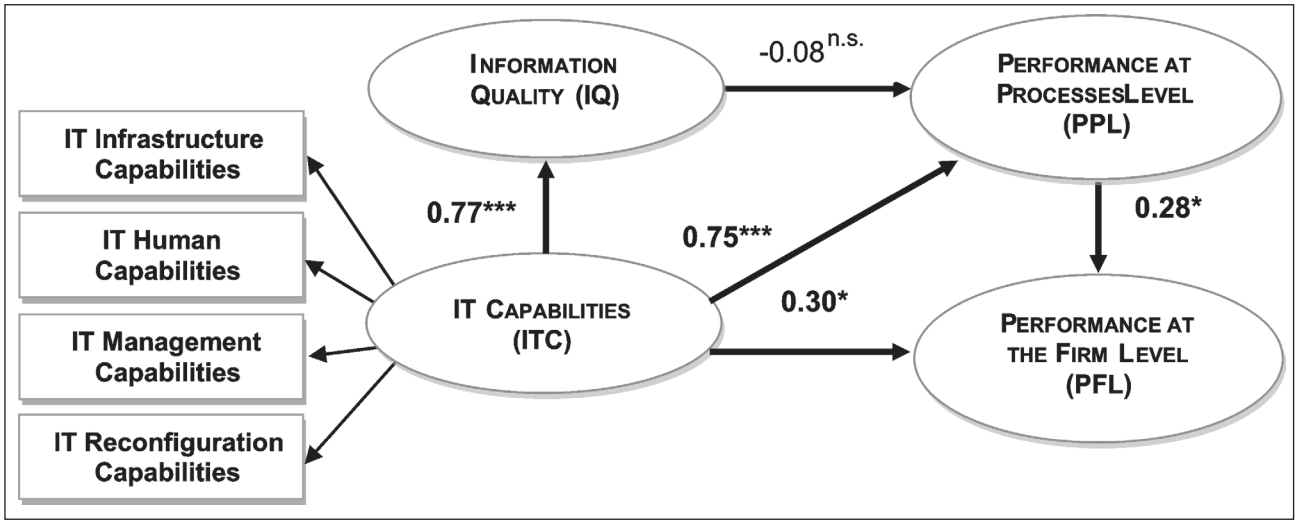

Figure 2. Hypotheses results.
*p<0.05; **p<0.01; ***p<0.001. n.s. Non-significant (p>0.05).

Additionally, it is noted that H3 is supported (β = 0.75; p <0.001), which means the positive impact of IT capabilities on process performance. H4 also confirms the positive impact of the processes performance on firm performance (β = 0.28; p <0.05). IT capabilities explain 48% of the variance in processes performance. The variance of the firm's performance (R^2 = 0.28) is explained by IT capabilities and performance at the processes level.

4.2 Mediation tests

In order to conclude about the mediation of "process performance" (H5 – Table 4), four conditions are demanded (Baron & Kenny, 1986; Hartono et al., 2010), jointly: (1) the predictor variable (ITC) positively impacts the mediator (PPL); (2) the mediator variable (PPL) positively impacts the dependent variable (PFL); (3) the predictor variable (ITC) positively impacts the dependent variable (PFL); (4) the impact of the predictor variable (ITC) on the dependent (PFL) is reduced or not significant when inserting the mediator (PPL) in the model.

Table 4
Mediation tests

Relationship	Model (1)	Model (2)	Model (3)	Model (4)
Antecedent of the impact of ITC on PPL				
ITC ⇨ IQ[a]	0.78**	0.78**	0.77**	0.77**
ITC ⇨ PPL[a]	0.75**	0	0	0.75**
IQ ⇨ PPL	-0.08 n.s.	0	0	-0.08 n.s.
Impact of ITC on PFL, mediated by PPL				
ITC ⇨ PPL	0.75**	0	0	0.75**
PPL ⇨ PFL[a]	0	0.48**	0	0.28*
ITC ⇨ PFL	0	0	0.49**	0.30*
R^2				
PPL	0.48	-	-	0.48
PFL	-	0.23	0.24	0.28
χ^2/df	1.642	1.846	1.848	1.589
CFI	0.949	0.923	0.923	0.947
TLI	0.942	0.914	0.913	0.940
IFI	0.949	0.924	0.924	0,948
PCFI	0.832	0.824	0.823	0.836
RMSEA	0.066	0.075	0.075	0.063

[a] **ITC**: Information Technology Capabilities; **IQ:** Information Quality; **PPL:** Performance at the Processes Level; **PFL:** Performance at the Firm Level. * p<0.05; ** p<0.001; n.s. Non-significant (p>0.05).

In this case, the conditions are satisfied, with the exception of (4), in which the impact of the predictor on the dependent variable is reduced, concluding that there is partial mediation of the processes performance in the relationship between IT capabilities and firm performance.

4.3 Tests of industry variables

For the variable "size" and "firm age", the sample was divided equally into two groups of firms (greater and lesser in size, and newest and oldest), according to the number of employees and operating time (years), respectively. For dynamism, the sample was divided between two groups: "high" and "low" dynamism, similar to the procedure adopted by Protogerou et al. (2012). For the type of industry, firms were categorized into trade/services firms (n = 101) and manufacturing firms (n = 49). Through parametric (t-test for dynamism) and nonparametric (Mann-Whitney test for age and firm size) tests, the mean differences among groups were confirmed (p <0.001). Moderation results are presented in Table 5.

Table 5
Moderation tests: multi-groups analysis

Path	Firm size		Firm age		Dynamism		Industry	
	Larger	Smaller	Larger	Smaller	High	Low	Trade/Serv	Manuf.
ITC ⇨ PPL	0.72**	0.79**	0.72*	0.81**	0.59*	0.89**	0.58**	1.56**

Note. * p<0.01; ** p<0.001.

For three moderating variables (firm size, firm age and dynamism), we compared the models with fixed factor weights and free weights, concluding about the invariance of the measurement model (χ^2dif, with p> 0.05) between groups. The same analysis was performed for the variable "industry", revealing that the model is variant (χ^2dif, p <0.05), indicating that some items have different loadings between groups.

Additionally, we tested the equivalence of structural models with fixed coefficients and free structural coefficients. In the three variables (firm size, firm age and dynamism), structural models for the two groups (in each moderator) are invariant, which indicates that the coefficients of the trajectories are similar to firms among the groups.

In order to confirm the industry's coefficient, considering the apparent difference, a Z test was undertaken, indicating that IT capabilities exert greater impact on processes in manufacturing firms than on processes in trade/service firms.

4.4 Discussion

We found that IT capabilities are positively associated with information quality (H1), which converges with the assumptions of Dynamic Capabilities with regard to its role in the reconfiguration of the resource base (Augier & Teece, 2008; Chen et al., 2008). We observed that IT capabilities also meet the concept of incremental dynamic capabilities, which are the first level of capabilities defined by Ambrosini, Bowman, & Collier (2009).

In the context of studies on IS success, Gorla et. al., (2010) corroborate the impact of information quality on process performance, although reduced. In this research, this effect was not observed. An interpretation for rejecting H2 focuses on the wide availability of IT resources and the ease of access to the same resources among firms, as well as standardization of ERP and rapid adoption of web technologies (Chae et al., 2014). This reality favors the volume of data and information for management with similar levels of quality, limiting the impact of the "information" resource to the routine decisions, not directly verifying improvements on business processes due to the higher levels of information quality. This finding is consistent with results from Soto-Acosta and Meroño-Cerdan (2008) referring to the reduction of the strategic role of IT assets [isolated], given the trend towards standardization in the "output" level (information) within organizations. Therefore, information quality can be understood as an assumption for operation (Thouin, Hoffman, & Ford, 2009).

For hypothesis H3, we found that higher levels of IT capabilities improve process performance. This result is convergent with literature (Chen et al., 2014; Kim et al., 2011). Regarding production processes, IT contributes significantly to improving the production and service volumes as well as improved productivity for operational work (Tallon & Kraemer, 2007). Toward improving products/services, IT capabilities are effective in reducing the time of launch of new products and services, and contribute to the quality of products/services (Bradley et al., 2012; Tallon, 2010). In the relationship with customers, IT capabilities contribute to attraction, retention and customer support in the sales process (Chen & Tsou, 2012).

The impact of IT capabilities on process performance signals the status of these capabilities

as a "resource" (Barney, 1991; Nevo & Wade, 2011). As opposed to isolated IT resources [they rarely create value for the business] (Park et al., 2011; Soto-Acosta & Meroño-Cerdan, 2008), IT capabilities are developed over time by experience, and tend to be local and specific to the organization, accumulated by interpersonal relationships – which makes them difficult to acquire and complex to imitate (Bharadwaj, 2000).

Literature has defended the positive relationship between process performance and firm performance (Chen & Tsou, 2012; Chen et al., 2014), which we confirmed. In this case, the partial mediation of performance at the process level to the relationship between IT capabilities and firm performance (H5) supports the assumption of IT benefits, primarily, at the business processes level (Bradley et al., 2012; Garrison et al., 2015; Iyer, 2011; Mithas et al., 2011; Soto-Acosta & Meroño-Cerdan, 2008; Tallon, 2010).

The insertion of moderating variables in the relationship between IT capabilities and performance contributes to the understanding of the impact mechanisms of IT (Mithas et al., 2011). Regarding firm size, we found that structural trajectories (ITC ⇨ PPL) are similar between larger and smaller firms (Kim et al., 2011), although this differs from studies that indicate a positive association (K. Kim, Xiang, & Lee, 2009; Muhanna & Stoel, 2010). These results enable us to understand that isolated amount of resources and standardized IT [captured by size] are not the elements that provide competitive differential (Thouin et al., 2009; Ting-Peng et al., 2010), but the way resources are gathered and used in the organizations in terms of internal IT capabilities do so (Soto-Acosta & Meroño-Cerdan, 2008).

As for firm age (operating time), the null result is in agreement with Oliveira and Maçada (2013), considering that new players can also establish sufficient IT capabilities to bring benefits to business processes. The null result for dynamism corroborates the assumption that dynamic capabilities contribute to processes, both in stable environments and in dynamic environments (Eisenhardt & Martin, 2000; Protogerou et al., 2012).

With regard to industry, there was a significant difference ($p < 0.05$) between the groups, since the impact of IT capabilities is higher in manufacturing firms. This result is close to the results found by Byrd & Byrd (2010) and diverges from Kim et al. (2011). One interpretation of our results is that production companies use IT directly in their critical processes, and many of these processes do not involve human participation. Additionally, the production of tangible products facilitates planning and alignment between business and technology, strengthening IT value (Byrd & Byrd, 2010). It is noteworthy that the above studies considered the industry's impact on firm level; however, we tested the industry's effect on the relationship between IT capabilities and performance at the processes level.

4.5 Results of Brazil versus other developed and developing countries

Studies referring to IT business value are prevalent in developed countries [research in developing countries is reduced]. Brazil is a developing country, with the world's sixth economy. Some particularities are be noteworthy, namely: its continental dimension (8.5 million km2), the adoption of a single language throughout its territory (Pozzebon, Diniz, & Reinhard, 2011), its low investment in R&D (compared to Japan, USA, Finland etc.) and its incipient innovation and patents (Ministério da Ciência, Tecnologia e Inovação [MCTI], 2012). Next, we highlight in this section the similarities and differences between this research and other studies carried out in other (developed and developing) countries.

Similarities. For the relationship between IT capabilities and information quality, this study is in line with the results of Hartono et al. (2010) with Korean firms, whose conclusion is that IT

infrastructure capabilities contribute to higher levels of information quality. Our study extends this finding, arguing that IT capabilities (human, management and reconfiguration) contribute to the quality of organizational information.

The improvement of processes through IT capabilities, as we found in this study, is also supported by studies with firms in Korea (Kim et al., 2011), Taiwan (Chen & Tsou, 2012) and China (Chen et al., 2014). In addition, these studies confirmed, based on survey research (applied to managers), the total mediation of business processes in the relationship between IT capabilities and firm performance. This research with Brazilian companies also found the mediation of "processes", however, partially. The improvement in business processes is justified by the direct use of IT at this organizational level (Tallon, 2010), both in [processes] considered strategic, as well as at tactical or operational level.

When we analyzed industry characteristics (firm size and age), we found that the results confirm those by studies of Kim et al. (2011) and Chae et al. (2014) in the context of Korean and American firms, respectively. Unlike other studies, our research tested the impact of IT on business processes in companies of differences in size and ages – identifying a similar impact among groups. This procedure allows for removing the potential effects of economic, tax and cultural differences in aggregate measures of a firm across countries.

Differences. We found a difference between our results and those of Hartono et al. (2010) for the relationship between information quality and performance in the supply chain. Our study found no association between those variables. Thus, we encourage further research to relate the effects of information quality on activities or strategic processes, as in studies in organizations that are intensive in information (e.g., banking industry, insurance etc.).

The studies conducted by Oliveira and Maçada (2013) with Brazilian firms and Chae et al. (2014) with American firms, recently, show the dissociation between larger IT capabilities and firm performance. Those studies examined the direct relationship between IT capabilities and aggregate measures of performance. For Chae et al. (2014), this dissociation is based on the standardization of ERP and on the rapid adoption of web technologies, which means the possibility of access by all firms to IT resources and the construction of related capabilities. Our results propose and strengthen a stream of research that contributes to capturing IT value at the firm level: the inclusion of intermediate measures that capture the direct and effective use of IT within organizations. The results indicate the partial mediation of organizational processes in the relationship between IT capabilities and firm performance, partially, confirming previous studies that defend indirect impact of IT on firm performance (Chen & Tsou, 2012; Garrison et al., 2015; Kim et al., 2011).

Differently from Lee et al. (2015), who found the moderating effect of dynamism on the relationship between IT and organizational agility measures [indicating that the impact of IT is greater in highly dynamic environments], our results with Brazilian firms does not confirm this moderation. Those authors present a potential response to differences in the study field, stating that their results may be subject to the specific characteristics of Chinese economy. The compared results raise additional research opportunities in emerging countries.

Partial mediation, as well as the dissociation between IT capabilities and firm performance in previous studies, are incentives for the consideration of cross-country aspects that can distinguish IT business value in future research. Obtaining answers to certain questions would be relevant to literature about IT value, such as: do the (social, economic, cultural etc.) characteristics of countries interfere in the relationship between IT capabilities and performance measures of companies (whether aggregate or intermediate)? If so, what are these characteristics, what is the intensity of their influence and what are the conditions in which this influence occurs?

5 Conclusions, limitations and recommendations

5.1 Conclusions

The impact of IT capabilities on information quality allows us to infer that these capabilities favor the attribution of value and meaning to the data generated – enabling them to cause judgment changes in managers when making in decisions. In theory, this result is supported by Dynamic Capabilities, which defends the role of organizational capabilities in renewing the resource base (Ambrosini et al., 2009).

The results show that business processes directly capture the value of IT capabilities, as defended by recent studies. With regard to IT benefits on firms, we concluded that the internal capabilities impact performance aggregate measures through performance of business processes, confirming the indirect impact as a potential explanation for the null results identified directly at the firm level (Chae et al., 2014; Oliveira & Maçada, 2013).

The Resource-Based View corroborates the results by stating that internal resources explain differences in firms' performances, when associated with strategic processes (Chen & Tsou, 2012; Qu, Oh, & Pinsonneault, 2010). From these findings, we infer that business processes represent dependent variables that capture the direct value of IT – responding to the demands of previous research (Kmieciak et al., 2012; Lu & Ramamurthy, 2011).

Therefore, it appears that differences in results at firm level could be related to methodological issues – especially those referring to the choice of independent (IT investment, IT capabilities, IT resources etc.) and dependent (firm innovation processes, operational performance) variables. In this research, we observed that the inclusion of business processes as a mediating construct was effective for capturing IT value indirectly in firm performance measures.

The results presented contribute to the academic and management aspects, mainly in three ways, for they allow: i) by means of the scale used, the model to be replicated in other research contexts (national, international) and incremental improvements of IT capabilities on firm performance to be assessed (Chae et al., 2014; Santhanam & Hartono, 2003); ii) intermediate performance indicators to de identified, associated with the use of IT, and the concentration of energy of organizations in the measurement of IT effects on business processes, rather than directly searching for improvements in profit measures, productivity, final cost reduction (at firm level); iii) the model to be adopted for horizontal analysis of IT performance in large companies, from the perspective of business and IT managers.

5.2 Limitations and recommendations

This research used as a sample IT and business managers in big Brazilian companies in order to test the research model. We disregarded possible differences in the fields of activity among trade, production and services sectors. The results could be different if fields of activity were considered [e.g., information-intensive companies – banks, insurance companies (Maçada et al., 2012); firms operating in the food or automotive supply chain (Hartono et al., 2010)].

In addition, this research considers only one second-order construct (IT capabilities), making TI discriminant validity analysis by traditional means unfeasible (Koufteros, Babbar, & Kaighobadi, 2009). To reduce this restriction, we proceed to the analysis of discriminant validity for the first-order model, which fully meets the criteria set by Farrell (2010).

The results are restricted to large companies, considering that they have consolidated IT fields, understand the dimension of the role of technology in business strategy and may have specific cultural characteristics. Thus, given the different characteristics of small and medium enterprises (Zhang, Sarker, & McCullough, 2008), as well as those inherent to countries

(Dedrick et al., 2013), the results should be analyzed with caution.

Therefore, future research would be relevant to analyze: i) the complementarity/ integration of IT resources/capabilities and other organizational resources/capabilities, as stated in literature (Fink, 2011); ii) the application of the research model to other cultures and in specific sectors of activity, for comparison of results; iii) the extent of the impact of the IT capabilities model to small and medium-sized enterprises; (iv) the cultural, economic and social characteristics, based on the cross-country perspective, that can affect the IT business value.

Notas

[1] We used the following keywords in this research: *"IT-capabilit*" or "technology-capabilit*" or IT-competenc* or technology-competenc* AND "performance*" or "benefit*" or "impact*" AND "RBV" or "RBT" or "resource".*

[2] Bharadwaj's (2000) study has 847 citations in the *Web of Science* database and 895 citations in all other databases. Santhanam and Hartono's (2003) research has 218 citations in the *Web of Science* database and 229 citations in all other databases (2015, September).

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Definition of research problem	√	√	
Development of hypotheses or research questions (empirical studies)	√	√	
3. Development of theoretical propositions (theoretical Work)	√		
4. Theoretical foundation/ Literature review	√	√	
5. Definition of methodological procedures	√	√	
6. Data collection	√		√
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