# Influence of Technical and Management Capacities on the Performance of Brazilian Software Development Firms

by

**Valter Moreno, Jr.**

Faculdades Ibmec-RJ

vmoreno@ibmecrj.br

**José Ricardo Monteiro Pinheiro**

Faculdades Ibmec-RJ

jose.pinheiro@al.ibmecrj.edu.br

**Keywords: MSME, Software Development, Organizational Performance, KBV, RBV**

## INTRODUCTION

Recent studies indicate that the global market for information technology (hardware, software and related services) was 1.43 trillion US$ in 2009, with 880 million US$ related to software and services (ABES, 2010). Also in 2009, the Brazilian market for Information Technology (IT) products has maintained the same position that it occupied in 2004, namely, it ranks sixth in the world. Specifically, in the segment of software and related services, the Brazilian market climbed from the 15th to the 12th position, registering the highest growth among the largest markets in the sector (150.8%). In both cases, the growth of the Brazilian market was more than three and a half times the global average.

However, the contribution of software developed in Brazil to the Brazilian software market (29%) and the volume exported (92 million US$) (ABES, 2010) are both still low when compared to other countries. India, for example, exported software valued at 40 billion dollars in 2008 (Carta Capital, 2009). An interesting fact is that the software industry, despite being regarded as high technology and thus dominated by developed countries, has opened up space for some emerging countries, in addition to Brazil, including China and India (Arora and Gambardella, 2006; Roselino, 2007).

One can infer that Brazilian software firms and associated services have considerable growth potential, whether by increasing their participation in the domestic market or by working more intensively on exports. Concerning exports, the world scenario for this market demonstrates a need for diversification of the globalized services sector, which thus far has been concentrated in a few countries. In this scenario, Brazil can become an alternative to India for outsourcing services for software development (Everest, 2009, p. 2.)

In accordance with these ideas, the Brazilian government has launched policies and programs within the last decade focusing on (a) the transformation of Brazilian exports of software and related services, (b) a significant expansion of the presence of national firms in the domestic market and a reduction in external dependence, (c) the decentralization of production, and (d) the creation of incentives for investment in technological advancement. In the documents that describe these initiatives, the software industry is characterized as a "strategic option," emphasizing the generation of knowledge, learning, and absorption of technological innovations as key elements of the desired increase in the competitiveness of Brazilian firms and, consequently, the attainment of the objectives outlined by the federal government (Governo Federal – MCT, 2007; Governo Federal – MDIC, 2008).

Such policies pay particular attention to the promotion of micro and small enterprises (MSEs) in Brazil, which, in 2005, accounted for 99% of formal firms in operation and generated 55% of formal employment in the country. In 2006, MSEs accounted for 20% of Brazilian GDP and 1.7% of exports. In the software development sector, 94% of firms are MSEs, and when medium-sized firms are considered, this percentage rises to 99% (ABES, 2009). It is worth remembering that most medium-sized firms today probably began their activities as micro- or small firms. Thus, these firms can be considered successful because they resisted the high mortality rates afflicting MSEs in Brazil (46% closed before completing three years of operation) (SEBRAE-SP, 2008).

Although the arguments presented by the Brazilian government in its proposals are reasonable, the effectiveness of decisions to allocate financial and human resources on a national scale would likely be greater if they were supported by appropriate empirical data and impartially analyzed from a scientific point of view. In that sense, the objective of this study is to develop and empirically test a model that explains the effects that connect technical, managerial and knowledge management to the performance of software development MSMEs (micro, small and medium enterprises). Following previous results (Patnayakuni et al., 2007; Ray et al., 2005; Wade and Hulland, 2004), we propose that such effects are mediated by the performance of the information system development process itself, which is considered essential for the activity/purpose of the firm.

Conceptually, the model is founded on the Resource-Based View (RBV) (e.g., Barney, 1991; Mata et al., 1995; Wade and Hulland, 2004) and the Knowledge-Based View (KBV) (Grant, 1996), focusing on the process of learning and absorptive capacity (Cohen and Levinthal, 1990). The complementarity of the two views (the RBV and the KBV) allows for a holistic view of the effects of knowledge on the organizations. In fact, Bogner and Bansal (2007, p. 186) mentioned that, “the search for competitive advantage based on knowledge is not a choice between ‘content’ and ‘process,’ but rather requires both.”

## THEORETICAL RATIONALE

### Resource-based View (RBV)

The RBV is an approach that has been widely used to analyze the relationship between the resources of organizations and their performance (e.g., Barney, 1991; Wade and Hulland, 2004).

Despite being a theoretical perspective that is usually more dominant in strategic management literature (Bharadwaj, 2000; Wade and Hulland, 2004), the RBV has been widely used in studies in Information Systems (IS) to determine the effects of IT on the performance of processes and/or organizations (Bharadwaj, 2000; Jeffers et al., 2008; Prasad et al., 2009; Ray et al., 2005; Tanriverdi, 2006; Wade and Hulland, 2004; Zhang et al., 2008).

The RBV assumes as a premise that organizations (Barney, 1991; Wade and Hulland, 2004): a) are composed of heterogeneous resources, that is, that resources are not evenly distributed between all firms, b) exhibit superior performance if these resources are rare, valuable, difficult to imitate and without substitutes. Thus, the RBV considers that the sources for competitive advantage lie within organizations (in their resources), not externally (in the environment).

This approach presents terminology difficulties, especially for the following terms: resource, asset, capacity and competence (Bharadwaj, 2000; Carmeli and Tishler, 2004; Ray et al. 2005; Wade and Hulland, 2004). This study will use the term capacity to define organizational resources that can influence the performance of the organization as a whole or in its processes, and will use the definition of Wade and Hulland: "Capacity can include skills, such as technical or managerial ability, or processes, such as systems development or integration. (2004, p. 109)."

### Capabilities

Among the skills assessed, intangibles have received more attention in studies using the RBV, as they are considered more conducive to generating a competitive advantage (e.g., Carmeli and Tishler, 2004).

Most studies that examine the relationship between capabilities and performance attempt to analyze the effect of not one but several capabilities, or of their scale, on the performance of organizations and/or their processes (Bharadwaj, 2000; Carmeli and Tishler, 2004; Prasad et al., 2009; Ray et al., 2005; Song et al., 2005).

This study will examine the following capabilities: (a) technical, specifically, the capacity for technical learning, (b) managerial, which has a broader perspective than just the capacity for IT management, and (c) IT-flexible infrastructure.

### Process performance and organizational performance

The effects of IT and other organizational skills are better perceived, identified or measured at lower operational levels than at the level of the organization as a whole, that is, at the process level (Jeffers et al., 2008; Melville et al., 2004; Prasad et al., 2009; Ray et al., 2005; Wade and Hulland, 2004).

In software development firms, information systems development (ISD) is of paramount importance. Patnayakuni et al. (2007) and Rus and Lindvall (2002) have emphasized that this process is knowledge-intensive and requires the integration of diverse and distinct expertise.

Based on what has previously been stated, we can infer that different types of knowledge (technical and managerial, for example) and other IT-inherent capabilities influence the performance of ISD. Likewise, it can be argued that the performance of this process acts as a mediating variable between the capabilities analyzed and organizational performance. One can thus establish the first hypothesis of the study:

H1: In ISD firms, the increase in performance of the ISD process improves the organizational performance.

**Managerial capacity**

Studies mention that IT management capacity is a source of better performance (Bhatt and Grover, 2005; Mata et al. 1995; Tanriverdi, 2006; Zhang et al., 2008). Carmeli and Tishler (2004) found that under a broader analysis, improved management capacity of the entire organization is related to better organizational performance. These authors mention that, "attaining superiority in a particular competitive market requires that the organization's top management possesses a broad set of complementary skills" (2004, p. 1260). With the objective of analyzing such skills, Basselier and Benbasat (2004) identified several dimensions of managerial capacity, which they term 'business competence'. Because this is an organizational capacity and is not specific to IT or ISD, one can infer that its effects, in contrast to other analyzed capabilities, will be better perceived in the organization as a whole and not necessarily within the process examined. As a result, the following hypothesis is proposed:

H2: ISD firms with greater managerial capacities have better organizational performance.

**IT-Flexible Infrastructure**

Some authors argue that IT infrastructure does not contribute to the performance of the process or the organization (Bhatt and Grover, 2005; Zhang et al., 2008). However, Ray et al. (2005, p. 630) emphasize that the focus should not be on the IT infrastructure itself, but on its level of flexibility. These authors define this construct as a means to "facilitate a rapid development and implementation of IT applications," which comprises "a complex set of technological resources carefully planned for and developed over time" (2005, p. 631). Although the authors have not identified any relationship between this IT capacity and the performance of the process analyzed, they point out that "despite the flexible IT infrastructure not having a positive impact on relative performance of the customer service process, it can present a positive impact in other company processes" (2005, p.643). Prasad et al. (2009), in turn, were able to identify a significant relationship between flexible IT infrastructure (which was considered one dimension of the capabilities related to IT) and business process performance.

It is logical to suppose that this capacity is important for the ISD process because it will enable the technological base for development to be tailored to the customers' needs in a shorter timeframe. The following hypothesis reflects this argument.

H3: ISD firms with a more flexible IT infrastructure have a better ISD process performance.

**Knowledge-based View (KBV)**

Knowledge has been thoroughly examined to verify whether and how it can contribute to better organizational performance. From the perspective of the RBV, as noted earlier, knowledge, among several other capacities, is treated as intangible. This approach seeks to assess knowledge that is valuable, rare, and difficult to imitate, and its relationship with the performance of processes and/or the organization (Ray et al., 2005; Song et al., 2005). The KBV approach, an extension of the RBV (Grant, 1996; Patnayakuni et al., 2007), considers knowledge and its management to be vital to organizational performance. Grant (1996, p.110) notes that knowledge is "the most strategically important of the firm's resources." Linderman et al. (2004) emphasizes that, "The knowing-doing gap in knowledge management argues that differences in firm performance comes less from differences in what firms know, but more from their ability to translate knowledge into action" (p. 592).

Unlike the RBV, which analyzes knowledge as a source of competitive advantage, the KBV examines the relationship between the processes of knowledge management (creation, integration, transfer, learning, implementation, and others) and the performance of the process and/or organization (De Luca and Atuahene-Gima, 2007; Lichtenthaler, 2009).

In the IS area, the KBV has been used to: (a) analyze situations for which outsourcing is more advantageous (Dibbern et al., 2008), (b) identify the factors that contribute to a better alignment between IT and business areas (Kearns and Sabherwal, 2007), and (c) identify the factors that improve the performance of ISD (Patnayakuni et al., 2007; Tiwana and McLean, 2005). Patnayakuni et al. (2007), for example, verify that the integration of knowledge positively influences the ISD process performance.

## Absorptive capacity

The KBV addresses various management processes of organizational knowledge, such as creation (Bogner and Bansal, 2007), transfer (De Luca and Atuahene-Gima, 2007), implementation (Grant, 1996), and learning (Cohen and Levinthal, 1990; Lane, Koka and Pathak, 2006; Lichtenthaler, 2009).

Processes that have received attention in recent years include learning and the capacity to absorb and apply new knowledge, termed 'absorptive capacity' (Cohen and Levinthal, 1990). Such a capacity is formed by identifying new knowledge, its assimilation by the entire organization, and its implementation for developing new knowledge and/or products. Lane et al., in a review of literature regarding this capacity, integrated all the knowledge acquired thus far and defined this construct as, "a firm's ability to utilize externally held knowledge through three sequential processes: (1) recognizing and understanding potentially valuable new knowledge outside the firm through exploratory learning, (2) assimilating valuable new knowledge through transformative learning, (3) using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning" (2006, p. 856).

These authors emphasize that, unlike "learning by doing," which allows firms to improve what they do, absorptive capacity allows for learning and doing new and very different things.

The importance of the learning process in software development firms is emphasized by Patnayakuni et al. (2007), Rus and Lindvall (2002) and Tiwana and McLean (2005). In the IS literature, studies have examined, for example, the various settings of absorptive capacity in supply chains (Malhotra, Gosain and Sawy, 2005) and the influence of the capacity in the assimilation of ERP systems (Liang, Saraf, Hu and Xue, 2007), as well as the cost of offshoring (Dibbern et al., 2008).

## Technical Knowledge

Some studies analyze how absorptive capacity may influence organizational performance (Lane et al., 2006; Lichtenthaler, 2009). Whereas Lichtenthaler (2009) found that absorptive capacity acts directly on organizational performance, Lane et al. (2006) argue that this capacity influences organizational performance by increasing accumulated knowledge. These authors acknowledge that there is a recursive relationship between accumulated knowledge and absorptive capacity: "

increased learning in a particular area enhances the organization's knowledge base in that area, which further increases its absorptive capacity and, thus, facilitates more learning in that domain" (Lane et al., 2006, p. 848). Because it has not been clearly defined whether the effect of absorptive capacity acts directly on performance or through accumulated knowledge, it can be inferred that the latter has a mediating effect, but of moderate intensity.

Some authors argue that increases in accumulated knowledge within organizations will improve their performance (Grant, 1996; Lane et al., 2006). However, as mentioned earlier, the effects of the capabilities are better perceived at the process level and not at the organizational level (e.g., Melville et al., 2004, Ray et al., 2005, Wade and Hulland, 2004). One can then establish the last two hypotheses of the study:

H4: ISD firms with greater absorptive capacity have superior accumulated technical knowledge.

H5: ISD firms with greater accumulated technical knowledge have perform better during the ISD process.

The aforementioned hypotheses are graphically represented in the structural model outlined in Figure 1.

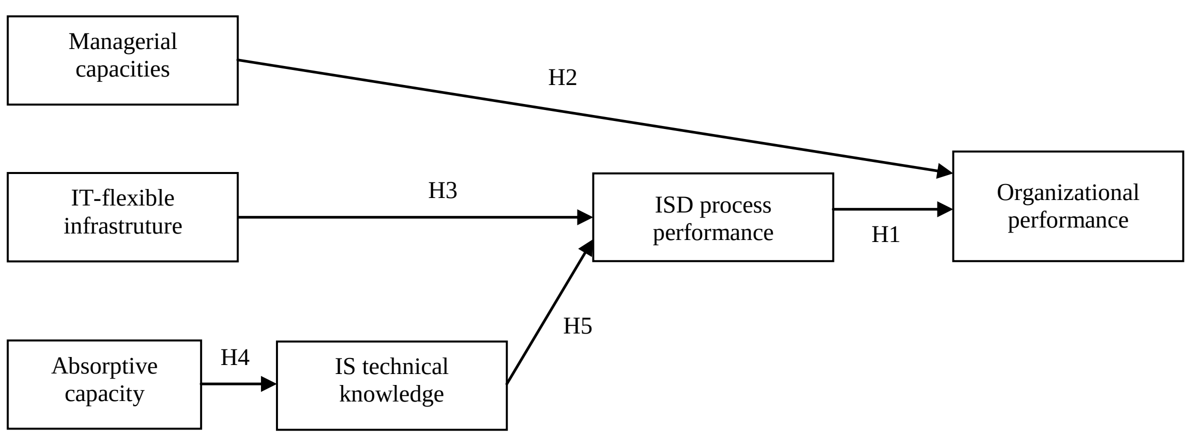


Figure 1. Proposed model

## RESEARCH METHODOLOGY

The data analyzed in this study were provided by the principal managers of Brazilian MSMEs, whose primary activity was software development. These data were collected through an electronic questionnaire, whose link was sent to the firms invited to participate in the research. The PLS (Partial Least Squares) method was used to analyze the data. The software used was SmartPLS version 2.0.M3. These points will be detailed in subsequent sections.

### Operationalization of the constructs of the proposed model

To test the model empirically, measurement scales were used that had been developed and adequately tested in previous studies.

Bassellier and Benbasat (2004) developed a third-order formative construct to measure managerial capacity, which was termed ‘managerial competence’ by the authors. This consists of two major dimensions: specific knowledge of the organization, and managerial and interpersonal knowledge. Given that the model in question is specific for the measurement of IS firm performance and that the respective managers have a reasonable knowledge about their own firms, the dimension ‘specific knowledge of the organization’ was considered of little importance to this study. Therefore, only the dimension ‘managerial and interpersonal knowledge’ of the construct devised by Bassellier and Benbasat (2004) was used in this study.

Although ‘managerial and interpersonal knowledge’ has several sub-dimensions (leadership, social networking, and interpersonal communication), the dimension does not comprise managerial knowledge in its essence; that is, the manager’s familiarity with topics such as strategic management, finance, marketing, and the capacity to envision new business opportunities. To meet this need, we have included a new sub-dimension based on the original scale, which we term ‘business knowledge’. Items that were developed to measure this were inspired by the measures of the constructs ‘business competence’, developed by Kollmann, Hasel and Breugst (2009), and ‘marketing capacity’, developed by Song et al. (2005).

Ray et al. (2005) and Xiao and Dasgupta (2009) developed scales to assess the construct ‘flexible IT infrastructure’. In this study, we adopted the Xiao and Dasgupta (2009) scale because it is more recent and was developed from the perspective of dynamic capabilities.

Lichtenthaler (2009) developed a third-order reflective construct to represent absorptive capacity, which closely follows the dimensions devised by Cohen and Levinthal (1990) and was synthesized using the integrated model of Lane et al. (2006). The Lichtenthaler construct consists of three further second-order constructs: (a) exploratory learning, (b) transformative learning, and (c) exploitative learning. The scales developed by the same author to measure absorptive capacity have been adopted in this study.

Although some scales exist to measure technical knowledge, most are not specific to IS issues (e.g., Song et al., 2005). In this study, we chose to adopt the scale developed by Kollmann et al. (2009), which generally reflects the updated content of the IS body of knowledge.

To evaluate the ISD process, we used the scale developed by Patnayakuni et al. (2007). These authors define ISD performance as a second-order formative construct, encompassing the dimensions of process performance and product performance.

Organizational performance is perhaps one of the most measured variables in organizational studies. Examples in the IS area are the scales developed by Bhatt and Grover (2005) and Zhang et al. (2008). In large part, the measurement of organizational performance is achieved via three indicators: sales, profitability, and market share. In this study, we adopted the scale described by Lichtenthaler (2009) because, in addition to accommodating the aforementioned indicators, it was developed to measure the performance of high-tech firms.

Figure 2 presents the constructs included in the proposed model and the scales used to measure them in more detail. It is noteworthy that Wade and Hulland (2004), in their literature review of the main IS articles that use the RBV, mention that some organizational factors usually influence organizational performance. Although not presented in Figure 2, we used one of these variables, company size, as a control variable in testing the model.

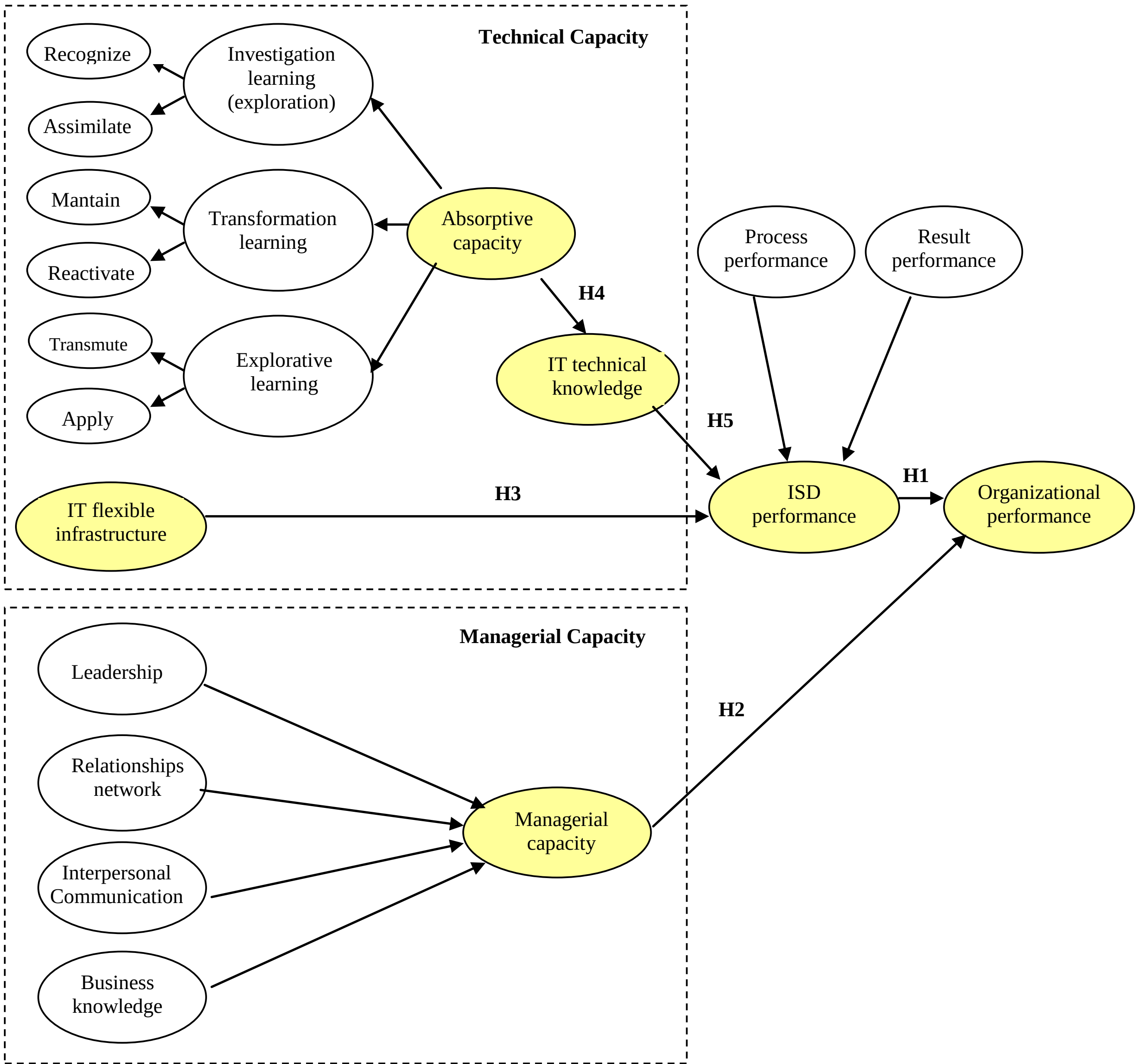


Figure 2. Detailed proposed model

## Data Collection

To obtain a representative sample of Brazilian MSMEs with software development as their core business, we created a single register of the contact data available on the websites of several associations (ASSESPRO, ABES, SOFTEX, SEPRO, SUCESU, FUMSOFT and ABRAGAMES) and industrial clusters (for example, Porto Digital, Pólo de Caxias do Sul, Pólo de Blumenau, Parque Tecnológico de Campina Grande, TECNOPUC). During the registration phase, we sought to identify the following minimum information: company name, website, email address, contact phone number, city, and state. The final registry included 3,164 firms from various regions of Brazil.

Data was collected via an electronic questionnaire that was available only to the firms invited to participate in the research. Before the final questionnaire was released to participants, a pilot test was conducted with IT professionals and IS business managers. From the comments received, some adjustments were made to scaled items to improve clarity.

E-mails containing a link to the final questionnaire were sent to the registered firms, emphasizing that the research was focused on software-developing MSMEs and that the principal manager of the organization should answer the questionnaire. This decision was based on the premise that, in firms with few employees, the manager would be fully able to evaluate his business with respect to the various aspects considered in this study (technical and managerial capacities and performance), having a global view of these.

Of the 3,164 firms invited, 450 fully completed the questionnaire. Of these, 323 were classified as firms that develop information systems (ISD), claim that this activity is responsible for most of its revenues and specify the type of product developed (for example, applications intended for end users or web sites). Because the study was directed to MSMEs, 23 firms were discarded because they fit into the category of large firms, as defined by the Brazilian Association of Software Firms (ABES - Associação Brasileira das Empresas de Software).

## DATA ANALYSIS AND RESULTS

### Sample characteristics

As expected, the majority of participating firms were small (57%), 29% were micro firms, and 14% were of medium size. Approximately 61% of firms had 20 employees or fewer, including the owner(s). Most firms (64%) had annual sales between US$ 140,000 and US$ 3 million.

There was a large concentration in southern and southeastern Brazil, where 64% of businesses were located. This result was also expected, as these are the most developed regions of the country, where most of the economically active population of Brazil is concentrated. However, it is important to highlight that 19 of the 26 Brazilian states were represented in the sample, denoting its reach. In terms of the area of operation, 54% stated that they operate throughout Brazil, and 20% globally. Only 11% were limited to municipal or state coverage.

Almost 60% of the managers who participated in the study were between 31 and 50 years of age, and only 18% were between the ages of 20 and 30. This result appears consistent with the fact that the sector showed a high rate of company formation in the 80s and 90s, with a subsequent stabilization during the period from 2001 to 2005 and a sharp decline between 2006 and 2010. Almost all respondents (93%) were owners or directors of their firms, with more than half (58%) having worked for at least nine years in the participating company and only 15% for less than three years. These data indicate that the analyzed firms were not, in most cases, newly established firms, as 46% of micro and small firms tend not to survive the first three years of operation (SEBRAE-SP, 2008).

The vast majority of respondents (91%) were male. In terms of the level of formal education, 94% had at least one undergraduate degree, 50% had done some type of graduate coursework (MBA, masters or doctorate), and 6% had only basic education (i.e., the 9-year mandatory education for children of ages 6-14). These results are consistent, as these were high-technology firms operating in highly turbulent environments, thus demanding high capacity from their managers.

As predicted, applications development for end users was the main activity of most firms (89%). Support activities (40%), systems integration (35%), IT consulting (34%), and training (33%) also appeared as part of the portfolio of services offered by the participants.

**Data analysis**

Before the measurement and structural models were evaluated, atypical observations were excluded from the sample, based on the Mahalanobis distance ($\alpha$=0.001) (Hair et al, 2005). The analysis of histograms, normal probability plots, and the Kolmogorov-Smirnov tests indicated that the vast majority of the variables were not normally distributed. Thus, the premise of multivariate normality required for the application of structural equation modeling techniques (SEM) was violated. However, as mentioned by Vinzi, Trinchera, and Amato (2010, p.48), "PLS-PM is considered a soft modeling approach, where no major premise (with respect to distributions, sample size, and scale of measurement) is required." Thus, we opted to use PLS to test the proposed model.

*Measurement model*

Once the model to be tested included hierarchical constructs, the measurement model was analyzed using a confirmatory factor analysis (CFA), as suggested by Wetzels et al. (2009). To that end, a null model containing all 14 latent first-order reflective variables, all interconnected, was specified in the SmartPLS. The software was configured such that the direction of the arrows that connected the variables was not taken into account (Tenenhaus and Hanafi, 2010, p. 101).

The matrix of cross-charges obtained from the analysis indicated that most of the 54 items related to the reflective constructs had a loading factor above 0.7, indicating that at least 50% of the variance of these items could be explained by the variance of their respective latent variables. Only two items showed loads below 0.7, and these were eliminated. Furthermore, an item from the "organizational performance" construct and two from the "flexible infrastructure" construct showed loads above 0.6 in the other construct and were also eliminated. After removing these items, we performed a second CFA, the results of which are presented in Table 1. To facilitate the visualization of this matrix, all the loads below 0.5 are concealed. It is worth noting that the results suggest that a good discriminant validity was obtained, as all items showed loads within their respective constructs that were larger than those in the others.

| | Recognize | Assimilate | Maintain | Reactivate | Transmute | Apply | Leadership | Relationships network | Interpersonal Communication | technical knowledge | Organizational performance | Infra-structure | ISD process performance | ISD result performance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAB11 | 0,747 | | | | | | | | | | | | | |
| CAB12 | 0,8394 | | | 0,5185 | | 0,5011 | | | | | | | | |
| CAB13 | 0,8176 | | | | | | | | | | | | | |
| CAB14 | 0,7724 | 0,5064 | | | | | | | | | | | | |
| CAB15 | 0,7721 | | | | | | | | | | | | | |
| CAB16 | | 0,7087 | | | | | | | | | | | | |
| CAB17 | | 0,8278 | | | | | | | | | | | | |
| CAB18 | | 0,8098 | | | | | | | | | | | | |
| CAB19 | | 0,8675 | | | | | | | | | | | | |
| CAB22 | | | 0,8124 | | | | | | | | | | | |
| CAB23 | | | 0,8483 | | | | | | | | | | | |
| CAB24 | | | 0,8428 | | | | | | | | | | | |
| CAB25 | | | | 0,7472 | | | | | | | | | | |
| CAB26 | | | | 0,7837 | | | | | | | | | | |
| CAB27 | 0,5689 | | | 0,8369 | 0,5282 | 0,5275 | | | | | | | | |
| CAB28 | | | | 0,7783 | 0,554 | 0,5671 | | | | | | | | |
| CAB31 | | | | | 0,8024 | 0,5287 | | | | | | | | |
| CAB32 | | | | | 0,8328 | 0,5882 | | | | | | | | |
| CAB33 | 0,5083 | | | 0,5637 | 0,8533 | 0,6729 | | | | | | | | |
| CAB34 | | | 0,5754 | 0,507 | 0,7479 | 0,5847 | | | | | | | | |
| CAB35 | 0,5126 | | | 0,5528 | 0,6523 | 0,8354 | | | | 0,5032 | | | | |
| CAB36 | 0,5588 | | | 0,567 | 0,623 | 0,8454 | | | | | | | | |
| CAB37 | | | | 0,5448 | 0,6414 | 0,8652 | | | | | | | | |
| CAB38 | | | | | 0,5118 | 0,7515 | | | | | | | | |
| CON11 | | | | | | | 0,7417 | | | | | | | |
| CON12 | | | | | | | 0,834 | | | | | | | |
| CON13 | | | | | | | 0,8469 | 0,5237 | | | | | | |
| CON14 | | | | | | | 0,7738 | 0,57 | | | | | | |
| CON21 | | | | | | | 0,6708 | 0,7495 | | | | | | |
| CON22 | | | | | | | 0,5707 | 0,77 | | | | | | |
| CON23 | | | | | | | | 0,7077 | 0,6292 | | | | | |
| CON31 | | | | | | | | | 0,8674 | | | | | |
| CON32 | | | | | | | | | 0,8784 | | | | | |
| CON33 | | | | | | | | | 0,8485 | | | | | |
| COT01 | | | | | | | | | | 0,8296 | | | | |
| COT02 | | | | | | | | | | 0,8428 | | | | |
| COT03 | | | | | | 0,5013 | | | | 0,892 | | | | |
| DOR01 | | | | | | | | | | | 0,883 | | | |
| DOR02 | | | | | | | | | | | 0,9033 | | | |
| DOR03 | | | | | | | | | | | 0,8481 | | | |
| INF03 | | | | | | | | | | | | 0,8065 | | |
| INF04 | | | | | | | | | | | | 0,8413 | | |
| INF05 | | | | | | | | | | | | 0,8685 | | |
| INF06 | | | | | | | | | | | | 0,8541 | | |
| ISD11 | | | | | | | | | | | | | 0,869 | |
| ISD12 | | | | | | | | | | | | | 0,8971 | |
| ISD13 | | | | | | | | | | | | | 0,7025 | |
| ISD21 | | | | | | | | | | | | | | 0,8252 |
| ISD22 | | | | | | | | | | | | | | 0,9179 |

Table 1. Matrix of loads in the constructs (AFC)

Table 2 presents the measures of composite reliability and convergent validity of all first-order reflective latent variables. It is observed that the measures are above the minimum values suggested (AVE>0.5; CR>0.7; $\alpha_C$>0.7) (Vinzi, Trinchera and Amato, 2010). Although the Cronbach's alpha values of the "relationships network" and "ISD_ result performance" constructs remain below the ideal limit, Chin (1998) argues that Composite Reliability(CR) is considered a better indicator of the reliability of a scale.

| First order latent variables | AVE | Composite Reliability | Cronbachs Alpha |
|---|---|---|---|
| Apply | 0.6815 | 0.8951 | 0.8433 |
| Assimilate | 0.6489 | 0.8803 | 0.8175 |
| Interpersonal Communication | 0.748 | 0.899 | 0.8318 |
| Technical knowledge | 0.7314 | 0.8908 | 0.8161 |
| Organizational performance | 0.7716 | 0.9102 | 0.852 |
| ISD Process performance | 0.6845 | 0.8656 | 0.7728 |
| ISD Result performance | 0.7617 | 0.8644 | 0.6956 |
| Infra-structure | 0.7105 | 0.9075 | 0.8648 |
| Leadership | 0.6404 | 0.8766 | 0.8123 |
| Maintain | 0.6966 | 0.8732 | 0.7835 |
| Reactivate | 0.6197 | 0.8668 | 0.7949 |
| Recognize | 0.6248 | 0.8926 | 0.8492 |
| Relationships network | 0.5518 | 0.7867 | 0.6052 |
| Transmute | 0.6563 | 0.884 | 0.825 |

Table 2. Measures of convergent validity and the reliability of composite variables

Table 3 presents the correlation among all first-order latent variables. The diagonals marked in bold represent the square of the AVE. According to Fornell and Larcker (1981), another way to assess the discriminant validity is to check that the average variance extracted (AVE) for a given latent variable is greater than the square of all of its correlations with all others. The results shown in the table also confirm that AVE has good discriminant validity.

| | Apply | Assimilate | Interpersonal Communication | Technical knowledge | Organizational performance | ISD Process performance | ISD Result performance | Infra-structure | Leadership | Maintain | Reactivate | Recognize | Relationships network | Transmute |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Apply | **0.826** | | | | | | | | | | | | | |
| Assimilate | 0.4633 | **0.806** | | | | | | | | | | | | |
| Interpersonal Communication | 0.4349 | 0.4703 | **0.865** | | | | | | | | | | | |
| Technical knowledge | 0.555 | 0.405 | 0.3867 | **0.855** | | | | | | | | | | |
| Organizational performance | 0.446 | 0.3101 | 0.3752 | 0.4721 | **0.878** | | | | | | | | | |
| ISD Process performance | 0.3567 | 0.2054 | 0.4639 | 0.3054 | 0.3717 | **0.827** | | | | | | | | |
| ISD Result performance | 0.3702 | 0.3652 | 0.4926 | 0.284 | 0.315 | 0.347 | **0.873** | | | | | | | |
| Infra-structure | 0.1819 | 0.1225 | 0.2314 | 0.2119 | 0.2487 | 0.2232 | 0.2417 | **0.843** | | | | | | |
| Leadership | 0.4191 | 0.1583 | 0.2581 | 0.3201 | 0.3115 | 0.3118 | 0.1838 | 0.1434 | **0.800** | | | | | |
| Maintain | 0.5051 | 0.4344 | 0.4835 | 0.4691 | 0.4546 | 0.3811 | 0.3604 | 0.1879 | 0.2567 | **0.835** | | | | |
| Reactivate | 0.6481 | 0.4499 | 0.4864 | 0.448 | 0.4916 | 0.4041 | 0.3771 | 0.215 | 0.3258 | 0.5172 | **0.787** | | | |
| Recognize | 0.5761 | 0.5719 | 0.469 | 0.5065 | 0.3899 | 0.2855 | 0.3745 | 0.1502 | 0.2581 | 0.4719 | 0.6054 | **0.790** | | |
| Relationships network | 0.508 | 0.3144 | 0.4986 | 0.3983 | 0.4304 | 0.3671 | 0.2889 | 0.1423 | 0.6482 | 0.4256 | 0.4926 | 0.4042 | **0.743** | |
| Transmute | 0.7386 | 0.4962 | 0.4615 | 0.4266 | 0.3452 | 0.2879 | 0.3206 | 0.219 | 0.2975 | 0.5027 | 0.6242 | 0.4999 | 0.4614 | **0.810** |

Table 3. Correlation matrix among the first-order latent variable

The analysis of the third-order reflective construct "absorptive capacity" followed the steps suggested by Wetzels *et al*. (2009). The AVE and CR values were calculated, taking into account the values of the load of the lower-order latent variables on the higher-order latent variables. To evaluate the significance of the loads, we used the bootstrapping technique with 1,000 re-samplings. The results indicate that the loads were significant ($p<0.001$). Furthermore, as can be observed in Table 4, all AVE and CR values were well above the ideal limits, supporting construct modeling as a third-order latent variable.

| | Hierarchical Model of Second Order | | | |
|---|---|---|---|---|
| | | **Exploratory learning** | **Transformative learning** | **Exploitative learning** |
| | AVE | 0.782 | 0.755 | 0.867 |
| | CR | 0.878 | 0.860 | 0.929 |
| | | | | |
| Loads | Recognize | 0.915 | | |
| | Assimilate | 0.853 | | |
| | Maintain | | 0.832 | |
| | Reactivate | | 0.904 | |
| | Transmute | | | 0.927 |
| | Apply | | | 0.935 |

| | Hierarchical Model of Third Order | | | |
|---|---|---|---|---|
| | | **Absorptive Capacity** | | |
| | AVE | 0.769 | | |
| | CR | 0.909 | | |
| | | | | |
| Loads | Exploratory learning | 0.864 | | |
| | Transformative learning | 0.874 | | |
| | Exploitative learning | 0.893 | | |

Table 4. Evaluation of the hierarchical construct “absorptive capacity”

*Structural Model*

One advantage of PLS is the possibility of using hierarchical constructs, provided that all first-order latent variables are of a single type (reflective or formative). In the proposed model, the construct “managerial capacity” is formed by four first-order latent variables, with three being reflective (Leadership, Relationships Network and Interpersonal Communication) and one formative (Business Knowledge). Therefore, it was necessary to replace the formative dimension by a reflective dimension in which the indicator corresponded to the average of the three original indicators of the scale.

Complying with Patnayakuni et al. (2007), we chose to configure the second-order type II construct "ISD performance" (Jarvis et al., 2003) as a first-order formative construct to facilitate modeling and make the model more parsimonious. Thus, the factorial scores of each first-order latent variable of the original construct were used as indicators in the new construct modeling. The scores were generated in a factor analysis performed using SPSS software, version 16.0.

Table 4 and Figure 3 present the test results of the proposed adapted model. Almost all the charges had high values, and all were statistically significant ($p < 0.001$). Most R2 values were also considerable, and, when combined with previous results, signal the good fit of the model. The model was observed to explain 24.2% of the organizational performance variance, 16.2% of the ISD performance, and 35.6% of technical knowledge. Thus, it appears that all of the hypotheses were corroborated by the analysis of the collected data.

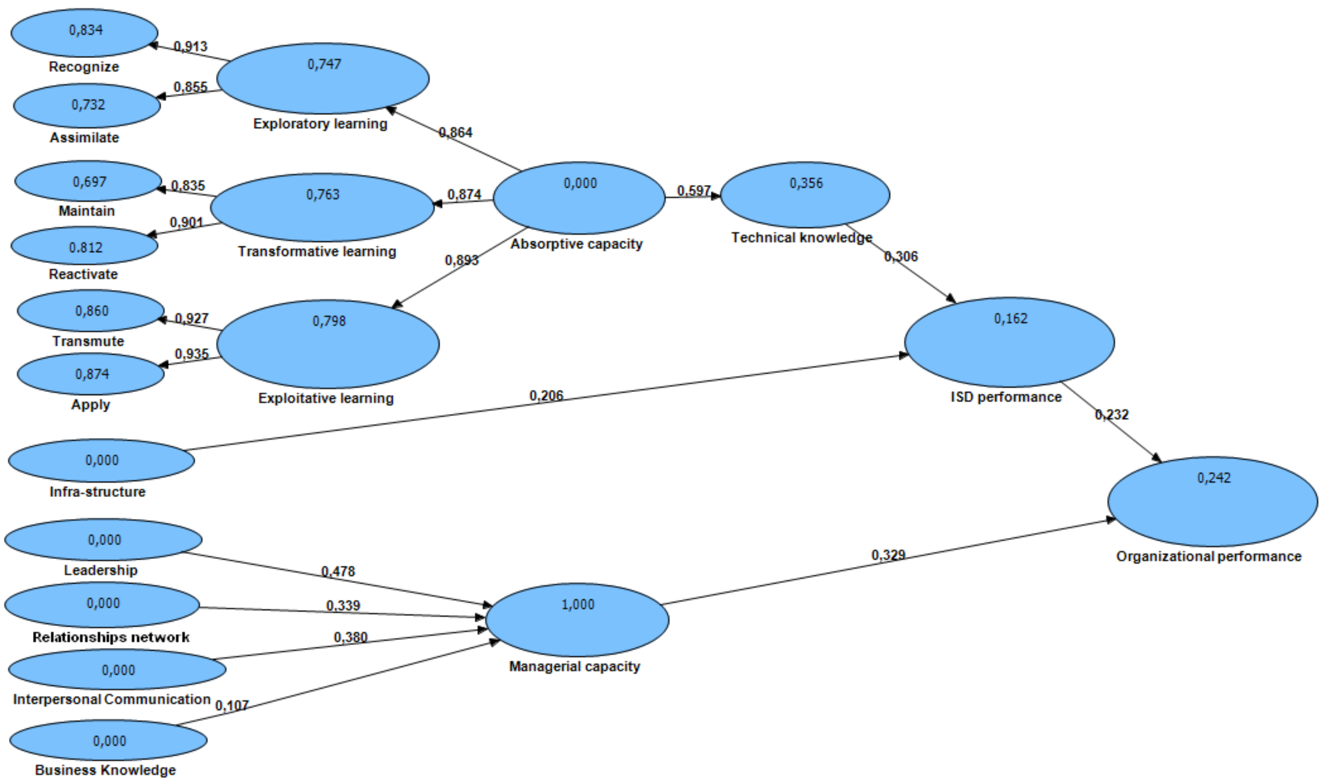


Figure 3. Results obtained for the structural model test

| | Original Sample (O) | Sample Mean (M) | Standard Deviation (STDEV) | Standard Error (STERR) | Statistic T (\|O/STERR\|) | p-value | sig. | |
|---|---|---|---|---|---|---|---|---|
| Exploration Knowledge -> Apply | 0,9349 | 0,9348 | 0,0084 | 0,0084 | 111,7072 | 6,664E-225 | 0,001 | *** |
| Exploration Knowledge -> Transmutate | 0,9275 | 0,9276 | 0,0092 | 0,0092 | 101,0809 | 1,161E-213 | 0,001 | *** |
| Investigation Knowledge -> Assimilate | 0,8555 | 0,855 | 0,0178 | 0,0178 | 48,1762 | 4,18E-133 | 0,001 | *** |
| Investigation Knowledge -> Recognize | 0,9133 | 0,9138 | 0,0081 | 0,0081 | 112,7234 | 6,352E-226 | 0,001 | *** |
| Transformation Knowledge -> Maintain | 0,8351 | 0,8347 | 0,0211 | 0,0211 | 39,5317 | 3,977E-113 | 0,001 | *** |
| Transformation Knowledge -> Reactivate | 0,9013 | 0,9023 | 0,0099 | 0,0099 | 91,3975 | 2,148E-202 | 0,001 | *** |
| Managerial Capacity -> Organizational Performance | 0,3286 | 0,3302 | 0,0652 | 0,0652 | 5,0437 | 8,4811E-07 | 0,001 | *** |
| Absorptive Capacity -> Exploration Knowledge | 0,8932 | 0,8934 | 0,013 | 0,013 | 68,4842 | 1,54E-170 | 0,001 | *** |
| Absorptive Capacity -> Investigation Knowledge | 0,8644 | 0,8641 | 0,0162 | 0,0162 | 53,3607 | 9,009E-144 | 0,001 | *** |
| Absorptive Capacity ->Transformation Knowledge | 0,8736 | 0,8737 | 0,0152 | 0,0152 | 57,5293 | 9,63E-152 | 0,001 | *** |
| Absorptive Capacity -> Technical Knowledge | 0,5968 | 0,5972 | 0,0387 | 0,0387 | 15,406 | 1,1175E-38 | 0,001 | *** |
| Interpersonal Communication -> Managerial Capacity | 0,3801 | 0,3758 | 0,0326 | 0,0326 | 11,6679 | 1,161E-25 | 0,001 | *** |
| Technical Knowledge -> ISD | 0,3056 | 0,309 | 0,058 | 0,058 | 5,2734 | 2,7828E-07 | 0,001 | *** |
| Business Knowledge -> Managerial Capacity | 0,107 | 0,1058 | 0,0136 | 0,0136 | 7,8615 | 9,5935E-14 | 0,001 | *** |
| ISD -> Organizational Performance | 0,2318 | 0,2363 | 0,0715 | 0,0715 | 3,241 | 0,00134342 | 0,005 | ** |
| Infrastrutura -> ISD | 0,206 | 0,2147 | 0,0577 | 0,0577 | 3,5733 | 0,00041867 | 0,001 | *** |
| Leadership -> Managerial Capacity | 0,4783 | 0,4783 | 0,0327 | 0,0327 | 14,6216 | 6,6636E-36 | 0,001 | *** |
| Relationship Network -> Managerial Capacity | 0,3391 | 0,3409 | 0,0207 | 0,0207 | 16,3931 | 3,5227E-42 | 0,001 | *** |

Table 5. Loads generated and their significances

## CONCLUSION

Based on two distinct theories, the RBV and the KBV, this study developed and tested a model to evaluate the effects of technical and managerial capacities on the performance of ISD and organizational performance. The model showed a good fit, explaining 24.2% of the variance in organizational performance and 16.2% of the performance of the ISD process. The study used a sample of 300 ISD MSMEs from various regions of Brazil.

The results suggest that the influence of managerial capacity on organizational performance is higher than that of ISD performance. Considering that the latter is influenced by technical capabilities (i.e., technical knowledge and flexibility of IT infrastructure), it is possible to infer that in the participating firms, management capacity has a greater effect on organizational performance than the technical capacity of the company. Of the four dimensions of management capacity analyzed, the most important appears to be Leadership, followed by Interpersonal Communication, Relationship Network, and Business Knowledge. These results emphasize the importance of having management teams at ISD MSMEs with great leadership skills, interpersonal communication skills, and a good network of relationships, even at the expense of the formal management knowledge domain.

In turn, the performance of the ISD process appears to be influenced more by absorptive capacity mediated by accumulated technical knowledge than by the flexibility of the IT infrastructure. These results endorse the various studies in the field of IS describing that the effects of IS-related capabilities are best perceived in terms of business processes (Jeffers et al., 2008, Melville et al., 2004, Prasad et al., 2009, Ray et al., 2005, Wade and Hulland, 2004). Furthermore, the results confirm the statement of Melville, Kraemer and Gurbaxani (2004, p. 292) that "IT impacts organizational performance through the processes of business." However, the least influence on the flexibility of the IT infrastructure endorses the main premise of the KBV that knowledge and its management have a greater influence on organizational performance than its other capabilities (Grant, 1996).

The results also support the arguments of Lane, Koka and Pathak (2006), and Cohen and Levinthal (1990) that absorptive capacity has three well-defined dimensions having the same degree of relative importance. Thus, the statement of Lichtenthaler (2009, p.840) is reinforced, namely, that "a balanced development of the learning process positively affects innovation and performance in dynamic and stable environments."

Furthermore, the analysis conducted here suggests that knowledge management in its dynamic form, as discussed in the KBV, effectively contributes to a better performance of the software development process in MSMEs. Considering that the analyzed firms operate mostly in constantly changing environments, where ISs are developed in ever-shorter periods and with increasing complexities, the dynamics of knowledge also tend to be very high. That is, a knowledge domain that is important during a given moment becomes quickly obsolete. Thus, the focus of these firms should not simply be on the accumulation of knowledge, but rather on the dynamics of constant learning (Linderman et al., 2004).

Institutional initiatives focused on increasing the competitiveness of software development MSMEs, such as those conducted by the Brazilian government and described in the introduction to this study, can benefit from the findings of this study. For example, incentives for the purchase of equipment and software (e.g., tax exemptions and special credit lines) tend not to be effective at enhancing skills associated with knowledge management. Specifically, knowing how to learn and translate the knowledge gained from such learning into practical and innovative solutions appears to be essential for the competitiveness of firms in the sector studied. Such skills, however, are probably better developed over the medium and long terms, during the education and training of individuals. Therefore, in developing countries, where political institutions and processes are not yet mature, the emphasis on investments that generate visible results in the short term and immediate political feedback can be a barrier to the establishment of a software development industry supported by competitive MSMEs.

It is important to highlight two limitations of the present study. First, knowledge processes taking place in organizations are inherently subjective, complex and dynamic. Although studies involving the quantitative measurement of such processes are well-known in the literature (e.g., Bhatt and Grover, 2005; Lichtenthaler, 2009; Zhang et al., 2008), they inevitably failed to capture all the richness that characterizes knowledge related activities in the workplace. Therefore, it is suggested that further qualitative, longitudinal studies be conducted to check the validity of the arguments and results described above. Second, the model proposed and tested in this study focuses on internal aspects of MSMEs. External factors, such as the institutional environment, country development status, cultural characteristics, and so on were not acknowledged. It is possible that by taking those factors into consideration, future studies of knowledge related processes and resources may be able to better explain their influence on firm competitiveness in a broader variety of contexts.

**REFERENCES**

1. ABES – Associação brasileira das empresas de software. Mercado Brasileiro de Software: panorama e tendências. São Paulo: ABES, 2010.
2. Arora, A.; Gambardella, A. (2006). From Underdogs to Tigers: The Rise and Growth of the Software Industry in Brazil, China, India, Ireland, and Israel. New York: Oxford.
3. Barney, J. (1991) Firm resources and sustained competitive advantage. Journal of Management,17, 1, 99-120.
4. Bassellier, G.; Benbasat, I. (2004) Business competence of information technology professionals: conceptual development and influence on IT – business partnerships. MIS Quarterly, 28, 4, 673–694.
5. Bharadwaj, A. (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Quarterly, 24, 1, 169-196.
6. Bhatt, G.; Grover, V. (2005) Types of Information technology capabilities and their role in competitive advantage: an empirical study. Journal of Management Information Systems, 22, 2, 253–277.
7. Bogner, W.; Bansal, P. (2007) Knowledge management as the basis of sustained high performance. Journal of Management Studies, 44, 1, 165-188.
8. Carmeli, A.; Tishler, A. (2004) The relationships between intangible organizational elements and organizational performance. Strategic Management Journal, 25, 13, 1257-1278.
9. Carta Capital (2009) É possível brigar com os indianos? Available at: http://www.cartacapital.com.br/app/materia.jsp?a=2&a2=7&i=4124.
10. Cohen, W.; Levinthal, D. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly, 35, 128-152.

11. De Luca, L.; Atuahene-Gima, K. (2007) Market knowledge dimensions and cross-functional collaboration: examining the different routes to product innovation performance. Journal of Marketing, 71, 1, 95-112.
12. Dibbern, J.; Winkler, J.; Heinzl, A. (2008) Explaining variations in client extra costs between software projects offshored to India. MIS Quarterly, 32, 2, 333-366.
13. Everest Research Institute (2009) The impact of the global economic downturn on outsourcing and offshoring. Everest.
14. Fornell, C. e Larcker, D. (1981) Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18, 39-50.
15. Grant, R. (1996) Toward a knowledge-based theory of the firm. Strategic Management Journal, 17, 109-122.
16. Governo Federal – MCT (2007) Ministério da Ciência e Tecnologia: Plano de Ação de Ciência, Tecnologia e Inovação (PACTI). Disponível em: http://www.mct.gov.br/index.php/content/view/66226.html.
17. Governo Federal – MDIC (2008) Ministério do Desenvolvimento, Indústria e Comércio Exterior: Política de Desenvolvimento Produtivo (PDP). Disponível em: http://www.mdic.gov.br/pdp/index.php/sitio/inicial.
18. Hair, J.; Anderson, R.; Tatham, R. e Black, W. (2005) Análise multivariada de dados. 5 ed. Porto Alegre: Bookman.
19. Jarvis, C.; Mackenzie, S. e Podsakoff, P. (2003) A critical review of construct indicators and measurement model misspecification in marketing and consumer research. Journal of Consumer Research, 30, 199-218.
20. Jeffers, P.; Muhanna, W.; Nault, B. (2008) Information technology and process performance: an empirical investigation of the interaction between IT an non-IT resources. Decision Sciences, 39, 4, 703-735.
21. Kearns, G.; Sabherwal, R. (2007) Strategic Alignment Between Business and Information Technology: A Knowledge-Based View of Behaviors, Outcome, and Consequences. Journal of Management Information Systems, 23, 3, 129–162.

22. Kollmann, T.; Hasel, M.; Breugst, N. (2009) Competence of IT professionals in e-business venture teams: the effect of experience and expertise on preference structure. Journal of Management Information Systems, 25, 4, 51-79.

23. Lane, P.; Koka, B.; Pathak, S. (2006) The reification of absorptive capacity: a critical review and rejuvenation of the construct. Academy of Management Review, 31, 4, 833–863.

24. Liang, H.; Saraf, N.; Hu, Q.; Xue, Y. (2007) Assimilation of enterprise systems: the effect of institutional pressures and the mediating role of top management. MIS Quarterly, 31, 1, 59–87.

25. Lichtenthaler, U. (2009) Absorptive capacity, environmental turbulence, and the complementarity of organizational learning process. Academy of Management Journal, 52, 4, 822–846.

26. Linderman, K.; Schroeder, R.; Zaheer, S.; Liedtke, C.; Choo, A. (2004) Integrating quality management practices with knowledge creation processes. Journal of Operations Management, 22, 6, 589-607.

27. Malhotra, A.; Gosain, S.; Sawy, O. (2005) Absorptive capacity configurations in supply chains: gearing for partner-enabled market knowledge creation. MIS Quarterly, 29, 1, 145-187.

28. Mata, F.; Fuerst, W.; Barney, J. (1995) Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis. MIS Quarterly, 19, 4, 487-505.

29. Melville, N.; Kraemer, K.; Gurbaxani, V. (2004) Information technology and organizational performance: an integrative model of IT business value. MIS Quartely, 28, 2, 283-322.

30. Patnayakuni, R.; Rai, A.; Tiwana, A. (2007) Systems development process improvement: a knowledge integration perspective. IEEE Transactions on Engineering Management, 54, 2, 286–300.

31. Prasad, A.; Heales, J.; Green, P. (2009) Information technology resources, complementaries and capabilities: towards a deeper understanding of leveraging business value from IT. Proceedings of the Fifteenth Americas Conference on Information Systems, Agosto, 6-9, São Francisco, CA, USA.

32. Ray, G.; Muhanna, W.; Barney, J. (2005) Information technology and the performance of the customer service process: a resource-based analysis. MIS Quarterly, 29, 4, 625-652.
33. Roselino, J. (2007) A Indústria de Software: o “modelo brasileiro” em perspectiva, 2007. Available at: http://www.finep.gov.br/PortalDPP/relatorio_setorial_final/relatorio_setorial_final_impressao.asp?lst_setor=17.
34. Rus, I.; Lindvall, M. (2002) Knowledge management in software engineering. IEEE Software, 26-38.
35. SEBRAE-SP (2008) 10 Anos de Monitoramento da Sobrevivência e Mortalidade de Empresas. São Paulo: SEBRAE-SP.
36. Song, M.; Droge, C.; Hanvanich, S.; Calantone, R. (2005) Marketing and technology resource complementarity: an analysis of their interaction effect in two environmental contexts. Strategic Management Journal, 26, 3, 259–276.
37. Tanriverdi, H. (2006) Performance effects on information technology synergies in multibusiness firms. MIS Quarterly, 30, 1, 57-77.
38. Tenenhaus, M e Hanafi, M. (2010) A bridge between PLS path modeling and multi-block data analysis. In: VINZI, V.; CHIN, W.; HENSELER, J. e WANG, H.. Handbook of partial least squares: concepts, methods and applications. New York: Springer.
39. Tiwana, A.; Mclean, E. (2005) Expertise integration and creativity in information systems development. Journal of Management Information Systems, 22, 13–43.
40. Vinzi, V.; Trinchera, L.; Amato, S. (2010) PLS Path modeling: from foundations to recent developments and open issues for model assessment and improvement. In: VINZI, V.; CHIN, W.; HENSELER, J. e WANG, H.. Handbook of partial least squares: concepts, methods and applications. New York: Springer.
41. Wade, M.; Hulland, J. (2004) The resource-based view and information systems research: review, extension, and suggestions for future research. MIS Quarterly, 28, 1, 107-142.
42. Wetzels, M.; Odekerken-Schroder, G. e Van Oppen, C. (2009) Using PLS path modeling for assessing hierarquical construct models: guidelines and empirical illustration. MIS Quarterly, 33, 177-195.

43. Xiao, L.; Dasgupta, S. (2009) Dynamic IT capability: an instrument development study. Proceedings of the Fifteenth Americas Conference on Information Systems, Agosto, 6-9, São Francisco, CA, USA.

44. Zhang, M.; Sarker, S.; Sarker, S. (2008) Unpacking the effect of IT capability on the performance of export-focused SMEs: a report form China. Info Systems Journal, 18, 4, 357-380.