



Unique Organizational Competencies of Brazilian Technological Innovation Centers

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Abstract

The general objective of this research was to identify the unique organizational competences of Brazilian Technological Innovation Centers (TICs). We developed a theoretical framework that deals with technological innovation centers and unique organizational competences. Empirical research consisted of two sequential phases, the first qualitative and the second quantitative. The qualitative phase consisted of semi-structured interviews that were chosen through non-probabilistic selection criteria. The quantitative phase made use of a survey questionnaire that was mailed to individuals responsible for the TICs participating in the National Forum of Managers of Innovation and Technology Transfer and the Intellectual Property Network of the State of Minas Gerais. The unique organizational competences encountered were: intellectual property; national patenting; consulting services rendered by individual professors or researchers; identification of the areas of excellence in research of scientific and technological institutions via the number of registered patents, the number of scientific publications, declared lines of research, and the presence of related research groups.

Keywords: Brazilian technological innovation centers; unique organizational competencies; census.

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Introduction

Aware of the economic impact generated by technological innovation, Brazil enacted the Law of Innovation (Lei de Inovação) 10,973/2004, on December 4, 2004. This law encourages innovation and technological research within productive environments through the institutionalization of technological innovation centers at public scientific and technological institutions, primarily in universities, which are responsible for managing all innovation policy.

This law states that each technological innovation center should have at least six minimum competences: (1) ensure the maintenance of institutional policy for stimulating the protection of invention, licensing, innovation, and other forms of technology transfer; (2) evaluate and classify the results that come from research activities and projects as a consequence of this law; (3) evaluate the request for independent inventors for the adoption of invention; (4) assess the desirability of and promote the protection of inventions developed at the institution; (5) assess the desirability of publicizing the inventions developed at the institute, subject to intellectual rights protection; (6) monitor the processing of requests for, and maintenance of titles of, intellectual property at the institution.

Even given these minimum competences it should be noted that certain problems persist in terms of identifying which internal, external, and internal/external factors are fundamental for full development and progress of these technological innovation centers. As such, research into unique organizational competences has the potential to enable to the identification of activities related to competences at technological innovation centers and rank the centers in terms of having superior performance.

In this context, this article's main objective is to identify and map the unique organizational competences at Brazilian technological innovation centers. We seek to reduce the scarcity of information as to which specific activities, among many that exist in these centers, can be defined as being unique or differentiating, since these are the competences which enable a center to achieve a leadership position within the market in which it acts.

To facilitate understanding of the theme under discussion, we chose to divide this article into six sections: introduction; technological innovation centers; unique organizational competences; methodological procedures; data analysis; and final considerations.

Technological Innovation Centers

Brazilian Technological Innovation Centers were instituted as a result of the Law of Innovation 10,973/2004, on December 4, 2004, as well as due to regulatory decree 5,563/2005, on October 11, 2005. Both of these laws offered norms for encouraging scientific and technological research and innovation in a productive environment, by recognizing the legitimacy of scientific and technological institutions (universities) in the innovation process (Cassiolato, Lastres & Maciel, 2003; Santos, 2009; Zawislak & Dalmarco, 2011).

Technological innovation centers have an evolutionary characteristic in relation to Brazilian universities. They were established with the charge of being responsible for promoting technological innovation that can be identified as directly resulting in activities developing products, processes, and markets (Burgelman, Christensen, & Wheelwright, 2001; Zahra, 1996; Zawislak & Dalmarco, 2011).

Under a neo-Schumpeterian perspective, technological innovation centers, as portrayed in literature specializing in science, technology, and innovation, emerged with the purpose of optimizing the management of technological cooperation between universities and companies. In order for a beneficial relationship between universities and companies to occur, the following premises must exist: the training of managers responsible for conducting cooperation between a university and companies; encouragement of meetings that engender discourse pertinent to the interests of private initiatives and a university; the publicizing of the image and potential the university has for participating in and promoting technological cooperation projects; the dissemination of knowledge to Brazilian companies about the possibility for working with Brazilian universities; the attraction of company interests to scientific research and research groups; and the existence of qualified agents for interaction between the university and the company that act as gatekeepers for the process of technological cooperation (Cunha, 1999; Cropley, Kaufman & Cropley, 2011; Plonski, 1999; Scheel, 2002; Segatto-Mendes & Sbragia, 2002; Stal & Fujino, 2005).

This kind of technological cooperation is best explained using demand pull theories, while minimizing the contributions of technology push theories due to the effective principle Triple Helix 3. This strengthens and aligns the institutional objectives held in common

between universities and companies, by deconstructing the rationality that technological autonomy belongs to Brazilian universities (Dosi, 2002; Etzowikz & Lyedesdorf, 2000; Eshan, 2008; Zawislak & Dalmarco, 2011).

Technological cooperation between universities and companies, when well structured and coherently managed, stimulate and strengthen research activity. According to Hagedoorn (1993), Segatto-Mendes and Sbragia (2002), and Santana and Porto (2009), technological cooperation can be understood as an inter-institutional arrangement that allows for the unification of research forces aimed at the public sector and private corporate activities. The promoted interactions end up furthering in improved synergy between the involved parts; which results in organizations that are more competitive in their respective fields of action.

Technological cooperation exists that have distinct institutional arrangements: between universities and companies; between research institutes and companies; between two or more universities; etc. Independent of the format of the arrangement and the actors involved in the process of cooperation established, all are connected to the work of the technological innovation centers. This work is initiated by the appropriation of knowledge generated by scientific and technological institutions (universities) (Asheim & Isaksen, 2002; Rocha, 1996).

The first organizational competence of a technological innovation center is developed when it is recognized as being responsible for the protection of the intellectual property regarding inventions resulting from university research, for the transfer of these inventions to industry, and their later diffusion to society, all through the concession of specific licenses (Burgelman, Maidique, & Wheelwright, 2001; Maehler et al., 2011; Toledo, 2009).

By endowing the act of capitalizing on the knowledge generated by scientific and technological institutions with legitimacy, the validity and legalization of a technological innovation center stops being questioned. Instead, other more relevant issues emerge, such as: how should universities divide income acquired through the licensing of patents with inventors; should universities allow this income to be applied towards covering the costs of managing the patents; and should universities employ excess funds towards financing new academic research (Fujino, Stal, & Plonksi, 1999; Segatto-Mendes & Mendes, 2006).

Among the activities performed by technological innovation centers, a few stand out:

- Technology transfer;
- Intermediation in the relationship between a university and companies;
- Research support;
- Administrative activities that sustain technological cooperation in negotiation;
- Registration of innovation processes and developed products;
- Dissemination of an ideology of innovation that is aimed at the business market. (Branca Terra, 2001; Burgelman, Maidique, & Wheelwright, 2001; Cunha, 1999; Dosi, 2002; Lotufo, 2009; Segatto-Mendes & Mendes, 2006; Segatto-Mendes & Sbragia, 2002; Scheel, 2002; Stal & Fujino, 2005; Zawislak & Dalmarco, 2011).

These activities can be classified between two primary axes: (a) technological interaction activities between scientific and technological institutions and two or more scientific and technological institutions; and (b) entrepreneurial activities, that seek to turn research results in to business ventures, through regulation of the internal innovation policies, registration of the knowledge generated by scientific and technological institutions, and support of research targeting business.

The performance of a technological innovation center is directly tied with its mission. The institutional mission symbolizes the steering wheel that guides the center's activities, which can consist of distinct missions, such as: emphasizing the garnering of royalties; developing spin-off companies; and prioritizing academic research (Branca Terra, 2001; Eshan, 2008; Link, Siegel & Bozeman, 2007; Lotufo, 2009; Siegel, 2004).

A majority of the Brazilian technological innovation centers are located in public (federal) scientific and technological institutions. This signals fulfillment of the Law of Innovation 10,973/2004. However, there is a disparity in the distribution of these centers throughout the country: 35% in the Southeast; 31% in the South; 18% in the Northeast; 10% in the Mid-West; and 6% in the North (Torkomian, 2009).

The centers mentioned in these percentages are members and founders of the National Forum of Managers of Innovation and Technology Transfer (Fórum Nacional

de Gestores de Inovação e Transferência de Tecnologia - FORTEC). This is a group that supports managers in carrying out their activities and meeting the demands for training and dissemination of good management practices (Santos, 2009). Altogether, in a survey realized in October, 2009, Brazil had 146 technological innovation centers, which are still in their initial stages of evolution. Their projects are financed by a government organization, the Financial Agency for Research and Projects (Financiadora de Estudos e Projetos - FINEP), and by the National Council of Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq) (Lotufo, 2009; Torkomian, 2009). The recent foundation of the centers means they still lack a culture of legitimacy in relation to the practices of technology transfer. This is what inspired our research of mapping the unique organizational competences of these centers. The implantation, maintenance, and consolidation of their activities present daily challenges that must be appropriately managed.

It is important to clarify that the Law of Innovation 10,973/2004 declares that each technological innovation center should have six minimum competences: (1) ensure the maintenance of institutional policy for stimulating the protection of invention, licensing, innovation, and other forms of technology transfer; (2) evaluate and classify the results that come from research activities and projects as a consequence of this law; (3) evaluate the request for independent inventors for the adoption of invention; (4) assess the desirability of and promote the protection of inventions developed at the institution; (5) assess the desirability of publicizing the inventions developed at the institute, subject to intellectual rights protection; (6) monitor the processing of requests for, and maintenance of titles of, intellectual property at the institution.

As each one of these competences is mandated by law, that are not considered to be unique or differentiating. This is because all centers are to clearly develop these minimum competences.

Unique and Differentiating Organizational Competences

The construction of the concept of these competences is associated with the comprehension of organizations as organized social systems indispensable to industrial societies (Le Deist & Winterton, 2005; Prestes Motta & Bresser Pereira, 1980). One of the theories that discusses these competences is resource based view of the firm (Penrose, 1959), for which competency is recognized as one of an organization's competitive advantages.

The principal presupposition of the resource based view is in the concept that the analysis of company growth is conditioned by internal resources, responsible for making the organization a reservoir of resources, through which the firm can create specific demands for their consumer markets (Barney, 1991; Penrose, 1959; Wernefelt, 1984). Based upon their internal resources, a firm formulates its strategy. As Mills et al. (2002) and Fleury and Fleury (2004) admonish, the resource based approach emphasizes the importance of prioritizing strategic planning based upon specific resources; in particular those that allow profits to be gained over the long-term.

The operationalization, identification, and evaluation of the concept of organizational competence, as well as the alignment of competences with organizational strategy, are concerns that are frequently related to the resource based view (Dierickx & Cool, 1989; Smith, 2008). Javidan (1998) and Leonard-Barton (1992) offered an operational explanation of the core competence concept that frames organizational competences as a category that approximates the organizations of its technological frontier. Phalalad and Hamel (1990) define a technological frontier as a set of technological abilities that allow a company to offer a specific benefit to its clients.

Javidan (1998), Finch-Lees, Mabey and Liefoghe (2005) and Freiling, Gersch and Goeke (2008), starting from a bottom-up perspective, elaborates the primary elements that constitute essential organizational competence: (1) the resources, admitted as necessary inputs and situated at the base of the perspective's hierarchy; (2) functional capacities, referencing the organization's ability to exploit its resources; (3) competences obtained through synergy stemming from the relationships between resources and capabilities; (4) the very "core competence", identified as that which offers potential access to a large number of markets by providing consumers with benefits competitors cannot easily provide.

The interactions between resources and capabilities develop a company's organizational competences (Mills et al., 2002; Smith, 2008; Teece, 2007). These are conceived from notions of an organization's complexity, differentiation, value adding practices, management practices, and capacity for innovation (Froelich & Bittencourt, 2007; Ruas, Dutra, & Becker, 2008).

Different management actions that are singularly focused on resources result in companies achieving different levels of performance, since the management actions applied based upon resources mobilize and combine organizational competences, which endow firms with differentiated or unique performance when added to organizational resources. The relationships between competences and resources, therefore results in specific activities that unite the relevant aspects of internal factors with the processes demanded by external factors. This allows for the organizational operations to aggregate economic value for the company and provides social value to the individual (Augier & Teece, 2008; Fleury & Fleury, 2001; Prahalad & Hamel, 1990; Ruas, 2005).

When a company's competitive factors are more intangible (experiences, culture, abilities) there is a greater distance in terms of marketing in relation to competitors. This refers to the fact that organizations cannot have the same resources, due to their systemic character, since they are socially constructed in a complex reality that inhibits their easy identification and imitation by competitors (Collis & Montgomery, 1995; Drejer, 2002). As resources are systemic, they need to be protected from being replicated through mechanisms of isolation, which in synthesis, are expressed in three distinct ways (Rumelt, 1984; Peteraf, 1993):

Causal ambiguity: when one or more valuable resources cannot be recreated or developed by the organization that possesses them; this implies that there is actually a problem in identifying the resources.

Path dependence: when historical trajectory and momentum prevent other companies with different histories from recreating the resources.

A dominance of tacit knowledge: when knowledge (as a resource) is difficult to codify, i.e. when it is difficult or impossible to turn tacit knowledge into explicit knowledge.

This article understands resources and capabilities as tangible and intangible internal, external, and internal/external factors. In order to develop unique organizational competences, resources and capabilities must contribute in a way that they are duly identified and differentiated from others; since it is through these that an organization seeks to differentiate itself in the competitive market where it participates (Barney, 1991; Freiling, Gersch & Goeke, 2008; Ruas, 2005; Teece, 2007).

Resources and capabilities contribute to the development of unique organizational competences, which gives the organization identity and allows for categorization of different marketing characteristics. These are responsible for conferring it with a privileged marketing position as compared to its competitors (Augier & Teece, 2008; Fleury & Fleury, 2001; Leonard-Barton, 1992; Prahalad & Hamel, 1990; Ruas, 2005). In the case of the Brazilian technological innovation centers, by identifying their respective unique organizational competences, we are trying to discover each one's competitive advantages, as well as their competitive advantages as a group.

The association of unique organizational competences' internal factors with external factors is justified by making reference to a specific instrument (technological innovation centers) that contribute to the advancement of a country in development. The technological contexts of countries in development include the intra, inter, and extra relations of State-industry-universities, conforming to the Triple Helix 1,2, and 3 (Etzkowitz & Lyedesdorff, 2000).

Because there is an understanding that organizations seek to improve their performance, and that this can be achieved through means of unique organizational competences, our article is interested in describing these competences for Brazilian technological innovation centers. Many of these centers were implanted after enactment of the Law of Innovation 10,973/2004. This is a situation that might have contributed to some daily managerial problems that can occur in the centers' management processes, which is why we undertook this research.

Methodological Procedures: Classification and Description of the Research

This research was conducted in two stages. The first was of a qualitative nature and the second quantitative. The qualitative procedures were defined by the manifestation of interest in complementing the minimum competences of the Brazilian technological innovation centers defined in the Law of Innovation. This gives the research a descriptive nature, which gained its form and applicability through the realization of multiple case studies developed at the Coordination of Technological Transference and Innovation, which is at the Federal University of Minas Gerais (UFMG), and at the Agency for Technological Innovation, which is located at the Mid-West State University of Parana (UNICENTRO).

The technological innovation centers at both of the scientific and technological institutes selected fit within the primary, non-probabilistic criteria: (1) public scientific and technological institutions, since these universities were obligated by the Law of Innovation to install such centers; (2) scientific and technological innovation centers that began their process of innovation before and after the Law of Innovation entered into effect.

So that the primary data could be collected, we undertook semi-structured interviews with the two centers mentioned during the period of August-October 2009. In order to develop the scripts for the interviews, we used secondary data taken from scientific works originating from post-graduate (Master and Doctorate) programs at institutions affiliated with the Brazilian Academy of Management (National Association of Research and Post-Graduate Education in Management - ANPAD) that in some way touched on organizational competences. This data was collected during the first semester of 2009, and resulted in 108 articles.

Of these 108 articles, 66 were directly related to discussions about organizational competence. Using the information found in these articles we developed a semi-structured interview script. As an additional source of primary data, we engaged in direct observation by participating in speeches and presentations at the XI Plenary Encounter and Reunion of the Intellectual Property Network of Minas Gerais. This conference was supported by the Coordination of Technological Transference and Innovation at UFMG. A few non-

structured interviews were performed with employees at this center, as well as with the director of the Agency for Technological Innovation at UNICENTRO.

Published qualitative data and confidential data were considered during the qualitative stage of the research. Both were taken from official sources linked with the two centers. Examples of the documents accessed include: websites, folders, magazines, registration documents, patents, and patent publications. There were three primary sources of evidence: direct observation, document analysis, and semi-structured interviews.

The data collected during the interviews were analyzed using the technique of content analysis, enabled by transcription of all interviews. This content analysis was combined with all of the other sources of evidence to allow for triangulation. After this qualification of the unique organizational competences at Brazilian technological innovation centers, we studied the causal relationships between these competences using a quantitative approach (the second stage).

The bases for the existence of comparative advantage between the technological innovation centers were approached during the quantitative research, which was operationalized using a survey. As we had the option of performing a census of the technological innovation centers, we didn't actually select the sample. The primary criterion of this intentional selection was that the technological and scientific institutions be participating in basic or applied research activities with either scientific or technological character (Torkomian, 2009).

The population of this census identified technological innovation centers at 94 public and 52 private scientific and technological institutions that participate in the National Forum of Managers of Innovation and Technology Transfer, as well as 20 that were installed in scientific and technological institutions that are part of the Intellectual Property Network of the State of Minas Gerais. In all, there were 157 centers researched, as some of the centers participate in both of the mentioned organizations. These centers are those that are responsible for managing the innovation and technology transfer processes between scientific and technological institutions, companies, and other universities.

The quantitative data collection period extended from November 2009, until February 2010. To collect this data, we created a semi-structured questionnaire composed of nominal and interval variables representing potential unique organizational competences, as well as their constituent factors. The questionnaire was sent to the e-mails of technological innovation center directors.

Initially, the collected data was submitted to descriptive analysis, through frequency distribution (f_i), which permitted the characterization of the centers studied. We identified the unique organizational competences through the observation of the relationships between their respective constituent factors by calculating the global means (M) and analyzing the variance between these means using the One Way ANOVA technique. These factors were also submitted for correlation verification with unique organizational competences through simple correlation statistical tests calculated by Pearson's bivariate correlation coefficient (r).

All of these methodological procedures were conducted with the intention of producing an answer to the general objective of this research: to identify the unique organizational competences at Brazilian technological innovation centers, and in the process test our three hypotheses:

H1: There exists a relationship between the factors (internal, external, and internal/external) that compose the unique organizational competences of Brazilian technological innovation centers.

H2: There exists a relationship between the material, financial, human, research support, and technological cooperation factors in the composition of unique organizational competences of Brazilian technological innovation centers.

H3: The material, financial, human, research support, and technological cooperation factors exercise influence over the unique organizational competences of Brazilian technological innovation centers.

Data Analysis

So that the discussion tied to the data analysis is apparent, we decided to divide this section into specific focuses: the analytical profile of the Brazilian technological innovation centers; the unique organizational competences at

Brazilian technological innovation centers; the composition of the unique organizational competences at Brazilian technological innovation centers; the correlation between the factors and unique organizational competences at Brazilian technological innovation centers (TICs).

Profile of the Brazilian Technological Innovation Centers

Out of all of the centers selected, only 40.12% resulted in valid responses for data analysis. In reference to the valid responses, of this 40.12% of the total, 30.57% were located at public scientific and technological institutes, 5.73% were supported by private initiatives, and 3.82% had a mixed nature.

As to the responses received from the technological innovation centers managed by private or mixed nature, we received very little information. This is justified by a few considerations: (a) the Law of Innovation 10,973/2004 does not mandate that institutions funded with private capital have such centers; (b) in terms of their general ratio to the number of public universities, the private and mixed institutions are significantly lower; (c) of those centers that integrate the National Forum of Managers of Innovation and Technology Transfer and the Intellectual Property Network of the State of Minas Gerais, the greater part maintain ties with public scientific and technological institutes; (d) the period we performed our research, from December 10, 2009, until February 19, 2010, coincided with the timing of end-of-the-year activities, as well as summer vacations for the centers funded with private money.

The centers researched were founded between 1960 and 2009. In a certain manner, this information is surprising, since Branca Terra (2001) commented that the 1970s was the decade that birthed offices of technology transfer between U.S. and Brazilian universities. 2008 was the year, according to the data collected, when the greater majority of technological innovation centers were founded. Another interesting item is that private centers only started to be founded in 2005, and mixed nature centers in 2006.

Of the valid responses, 37.87% of the individuals indicated that they were directly responsible for managing the technological innovation center where they worked. The establishment of the management activity as a priority over others can indicate the existence of advances in the

professionalization of technological innovation centers concerning the management of technological cooperation projects. This is considered a relatively continuous challenge faced by scientific and technological institutions (Mowery & Oxley, 1995; Plonski, 1999; Segatto-Mentes & Sbragia, 2002; Stal & Fujino, 2005).

As to the professional education of the managers, there was a inclination for the areas of Law (14.71%) and Management (10.29%). Out of the managers, 39.39% held PhDs, 18.18% Masters and Post-PhDs, and 12.12% had specializations with a bachelors degree completed. This level of academic education might indicate that scientific and technological institute and technological innovation center activities have a high potential for evolution in their entrepreneurial activities, since their managers have strong scientific appeal and high involvement in research activities (Kedia & Bhagat, 1988; Etzkowitz & Leydesdorff, 2000; Eshan, 2008).

Unique Organizational Competences at Brazilian Technological Innovation Centers

Table I displays the existence of four unique organizational competences among Brazilian technological innovation centers. These were identified through submitting primary data to One-way ANOVA variance testing between means with a level of significance (p) with values <0.05.

The competences categorized through this research are: intellectual property; national patenting; consulting services rendered by professors or individual researchers; and identification of areas of research excellence at scientific and technological institutes through the number of patents, publications, research groups, research lines, etc.

The organizational competences presented in Table I are assumed, by this study, as differentiating between Brazilian technological innovation centers, and as such, contribute to leadership positions for each of them (Ruas, 2005).

Unique Organizational Competence	TICs	N	Mean (M)	Standard Deviation (s)	S Square	DF	Square	F	Sig. (*)
Intellectual Property	Public	48	4.5000	1.07188	10.690	2	5.345	3.831	0.0272
	Private	9	3.5556	1.74005	83.722	60	1.395		
	Mixed	6	3.5000	1.04881					
	Total	63	4.2698	1.23401	94.413	62			
National Patenting	Public	48	4.3542	1.17581	13.616	2	6.808	4.176	0.0200
	Private	9	3.3333	1.65831	97.813	60	1.630		
	Mixed	6	3.1667	1.47196					
	Total	63	4.0952	1.34061	111.429	62			
Consulting Services	Public	48	3.4205	1.14433	10.340	2	5.170	4.312	0.0178
	Private	9	2.7778	0.97183	71.935	60	1.199		
	Mixed	6	2.1677	0.75277					
	Total	63	3.2093	1.15196	82.272	62			
Identification of Areas of Excellence	Public	48	4.1458	1.14835	11.989	2	5.995	4.679	0.0129
	Private	9	3.7778	0.97183	76.868	60	1.281		
	Mixed	6	2.6777	1.121106					
	Total	63	3.9524	1.19715	88.857	62			

Table I – Unique organizational competences among Brazilian TICs/ (*) p<0,05 = reference value for statistical significance.

Concerning the evolution of these centers in relation to the maintenance of institutional innovation policy at these scientific and technological institutions, we perceived that even though the reason for these centers' origins lies in problems managing technological cooperation between universities and companies, this wasn't a unique organizational competence that was identified (Branca Terra, 2001; Etzkowitz, 2004; Fujino, Stal, & Plonski, 1999; Plonski, 1999; Segatto-Mendes & Sbragia, 2002).

Composition of the Unique Organizational Competences at Brazilian Technological Innovation Centers

We divided the discussion on the composition of the unique organizational competences at Brazilian technological innovation centers into two sub-topics. The first is concerned with relationships between the factors and the unique organizational competences of the centers, and the second broaches the correlations between the factors and the unique organizational competences of these centers.

• Relationships between Factors and Unique Organizational Competences at Brazilian Technological Innovation Centers

At this moment, we proceed to analyze the first two of our hypotheses. Hypothesis (H1) defends the existence of a relationship among the factors (internal, external, and internal/external) that make up the unique organizational competences at Brazilian technological innovation centers.

Through the results obtained from One-way ANOVA analysis of the variance between means, we were able to verify that there are no statistically significant differences (p^*) between means considered equal between the internal factors ($F=1.094$; $Sig.=0.342$ where $p>0.05$), the external factors ($F=0.400$; $Sig.=0.672$ where $p>0.05$) and the external/internal factors ($F=0.651$; $Sig.=0.525$ where $p>0.05$). This completely rejects hypothesis H1, as shown in Table 2.

Factors	TICs	N	Mean (M)	Standard Deviation (s)	S Square	DF	Square	F
Internal	Public	48	55.8490	23.80498	2	607.842	1.094	0.342
	Private	9	53.0467	19.55888	60	555.678		
	Mixed	6	40.8128	27.00539	62			
	Total	63	54.0167	23.60849				
External	Public	48	49.9628	25.25685	2	249.827	0.400	0.672
	Private	9	52.5000	20.69118	60	625.268		
	Mixed	6	41.2500	28.66836	62			
	Total	63	49.4955	24.76200				
Internal/ External	Public	48	56.3633	27.50376	2	483.327	0.651	0.525
	Private	9	58.7654	20.30967	60	742.974		
	Mixed	6	43.7037	33.83815	62			
	Total	63	55.5008	27.10347				

Table 2 – Relationships among the factors (internal, external, and internal/external) that make up unique organizational competences at Brazilian technological innovation centers/ Source: empirical research.

If the means (M) of the internal, external, and internal/external factors were to be analyzed separately, we noticed that there isn't an emphasis on specific internal factors for explaining unique organizational competences at Brazilian technological innovation centers. Since the internal/external factors were found to be more related to the unique organizational competences studied, a relationship was assumed according to the definition of unique organizational competence adopted and previously defined in this article. The second hypothesis (H2) argued the existence of a relationship among the material, financial, human, research support, and technological cooperation factors in the composition of unique organizational competences at Brazilian technological innovation centers.

According to the results from the One-way ANOVA analysis of variance between means, we discovered that there weren't statistically significant differences (p^*) between the means of the three segments of technological innovation centers referenced (public, private, mixed). These were considered equal between material factors ($F=0.384$; $Sig.=0.685$ where $p>0.05$), financial factors ($F=0.510$; $Sig.=0.603$ where $p>0.05$), human factors ($F=0.978$; $Sig.=0.382$ where $p>0.05$), research support factors ($F=1.081$; $Sig.=0.346$ where $p>0.05$) and technological cooperation factors ($F=0.320$; $Sig.=0.727$ where $p>0.05$). These data are displayed in Table 3.

Factor Mean (M)	TICs	N	Mean (M)	Standard Deviation (s)	S Square	DF	Square	F
Material Factors	Public	23	50.6522	25.23996	2	276.120	0.384	0.685
	Private	2	55.0000	21.21320	26	718.614		
	Mixed	4	38.7500	37.50000	28			
	Total	29	49.3103	26.21083				
Financial Factors	Public	48	51.7708	29.32738	2	401.252	0.510	0.603
	Private	9	53.3333	21.50581	60	787.075		
	Mixed	6	40.0000	24.89980	62			
	Total	63	50.8730	27.83215				
Human Factors	Public	48	53.2212	25.74823	2	605.658	0.978	0.382
	Private	9	51.3333	19.12296	60	619.386		
	Mixed	6	38.1528	24.81126	62			
	Total	63	51.5164	24.87856				
Research Support Factors	Public	48	61.7956	25.56436	2	703.491	1.081	0.346
	Private	9	61.9048	20.84931	60	650.984		
	Mixed	6	45.7143	31.19393	62			
	Total	63	60.2797	25.54757				
Tech. Cooperation Factors	Public	48	54.2361	30.91269	2	298.668	0.320	0.727
	Private	9	55.3333	25.82634	60	932.815		
	Mixed	6	44.0000	33.82307	62			
	Total	63	53.4180	30.20528				

Table 3 – Relationships among the material, financial, human, research support, and technological cooperation factors in the composition of unique organizational competences at Brazilian technological innovation centers./ Source: empirical research.

Independent of their classification, the factors analyzed didn't show statistically significant differences as to unique organizational competences. It is important to point out that the mean (M) for the research support factors ($M_{\text{fatores_pesquisa}}=60.2797$) is the largest we found in relation to unique organizational competences, while the lowest mean belonged to material factors ($M_{\text{fatores_materiais}}=49.3103$).

According to Javidan (1998), Finch-Lees, Mabey and Liefoghe (2005) and Freiling, Gersch and Goeke (2008) contributions about the operationalization of organizational competence, such a situation might indicate that the material factors relate little to unique organizational competences, which indicates a greater linkage with intangible resources or with capabilities in general.

Correlations between the Factors and the Unique Competences at Brazilian Technological Innovation Centers

This section is dedicated to discussing the third hypothesis (H3), that the material, financial, human, research support, and technological cooperation factors exercise influence over the unique organizational competences of Brazilian technological innovation centers. In order to obtain a response for this hypothesis we applied a simple correlation test, calculated by using Pearson's bivariate correlation coefficient (r). Results showed correlations exist for the majority of the cases (r**, r***) which allows us to say that the financial (r=0.434, p<0.000), human (r=0.435, p<0.000), research support (r=0.453, p<0.000) and technological cooperation (r=0.454, p<0.000) influence unique organizational competences at Brazilian technological innovation centers. These correlations were statistically significant, as shown in Table 4. The results demonstrate that financial, human, research support, and technological cooperation factors tend to instigate unique organizational competences at Brazilian technological innovation centers, while material factors do not.

Means	Unique Organizational Competence	Material Factors	Financial Factors	Human Factors	Research Support Factors	Technological Cooperation Factors
Unique Organizational Competence	1.00					
Material Factors	0.08 10.67	1.00				
Financial Factors	0.434*** 0.00	0.407** 0.02	1.00			
Human Factors	0.435*** 0.00	0.34 0.06	0.678*** 0.00	1.00		
Research Support Factors	0.453*** 0.00	0.26 0.16	0.683*** 0.00	0.771***	1.00	
Technological Cooperation Factors	0.454*** 0.00	0.390** 0.00	0.735*** 0.00	0.739*** 0.00	0.760*** 0.00	1.00

Table 4 – Correlations between the material, financial, human, research support, and technological cooperation factors in the composition of unique organizational competences at Brazilian technological innovation centers.

Final Considerations

This article was developed with the intent of identifying unique organizational competences at Brazilian technological innovation centers. Through the methodology utilized, we identified the following unique organizational competences: intellectual property; national patenting; consulting services provided by individual professors or researchers; and identification of areas of research excellence at scientific and technological institutes through the number of patents registered, number of scientific publications, and expressed through research groups and lines of research.

To support and complement the general objective, we elaborated three research hypotheses: the first defended the existence of a relationship between internal, external, and internal/external factors contributing to the composition of unique organizational competences at Brazilian technological innovation centers; the second proposed the existence of relationships between material, financial, human, and research and technological cooperation support factors that lead to unique organizational competences at Brazilian technological innovation centers; and the third affirmed that these material, financial, human, and research and technological cooperation support factors exercise influence over the unique organizational competences encountered.

The first and second hypotheses were refuted while the third was mostly verified, as the financial, human, research support, and technological cooperation factors showed influence over unique organizational competences at Brazilian technological innovation centers.

The results from the field research allows characterization of the Brazilian technological innovation centers as primarily located at public scientific and technological institutes, with highly qualified directors (post-PhDs, PhDs, and Masters); a situation that suggests considerable incentive for research activities by these centers.

In relation to the unique organizational competences identified among the centers, we perceived a dominance of intellectual property over the other aspects (consulting services provided by individual professors or researchers; identification of areas of excellence in research at scientific and technological institutes through the number of patents registered, number of scientific publications, and expressed through research groups and lines of research).

Regarding the relationship among the internal/external factors and organizational competences we uncovered some considerations: (a) the internal/external factors strengthen causal ambiguity, or path dependence, and/or the dominance of tacit knowledge, all characteristics described by Rumelt (1984) as isolation mechanisms of organizational competences; (b) the internal/external factors indicate that the intensification of technological cooperation activities between scientific technological institutions, companies, and other scientific technological institutes.

As the research support factors show a higher mean (M) than the material factors, this implies that capabilities are more important for unique organizational competences, since: (a) when they are closer to the capabilities, heterogeneous and imitable characteristics are more evident; (b) they indicate the reasons why a specific technological innovation center has a greater competitive advantage; (c) they approximate intellectual resources, which can result in greater access to high-tech industrial organizations.

The influence of these factors, together with unique organizational competences, can be explained by the dominant technological context present in emerging countries, which still seek to overcome technological shortcomings by technological cooperation. It is worth highlighting that the primary tendency of the factors discussed here (financial, human, research support, and technological cooperation), due to their inherent intangibility, is to continuously make Brazilian technological innovation centers more distant from each other.

Among the principal contributions offered by this research, we underscore the methodological proposition related to the definition of the quantitative measuring procedure for unique organizational competences and their respective constituent factors. Since this research was conducted through a census, it can contribute to the discourse in the National Forum of Managers of Innovation and Technology Transfer and the Intellectual Property Network of the State of Minas Gerais about Brazilian technological innovation centers. It can further aid these agencies formulate strategic decisions tied to the segments of government and scientific and technological institutions. These decisions can delineate a differentiated future for Brazilian practices in technological cooperation.

We believe that this research leads to new questions, which could support future research in the area:

- What is the reality for technological innovation centers in developed countries in terms of their unique organizational competences?
- What factors can be associated with the constitution of these unique organizational competences in foreign technological innovation centers?
- What are the endogamous and exogamous factors of the research process regulated in scientific and technological institutions?
- How can the endogamous and exogamous factors of the research process regulated in scientific and technological institutions contribute to intellectual property in the universities that installed their innovation centers after the Law of Innovation 10,973/2004?

These questions draw attention to an extensive research agenda about the relationship between unique organizational competences and the management practices in Brazilian technological innovation centers. Different approaches and methods can be used in such research, which can offer a more consistent panorama so that the Brazilian community can promote more beneficial technological cooperation practices.

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