The Influence of Company Size on Innovative Performance

Abstract

The present study sought to evaluate the influence of company size on the management of external sources of technological information. We conducted an empirical survey of innovative Brazilian companies in the industrial sector. Analysis of management and performance characteristics found significant differences between large companies and smaller organizations, particularly regarding management structure, technology access opportunities, external sources of technology information, and performance indicators. Our analyses highlight cooperation and external relationships as ways to maximize innovative activity, regardless of company size.

Keywords: innovation management, technology, company performance and size

1 Introduction

This study aims to understand the process whereby external sources of technological information are managed and understand innovative performance, focusing on practices adopted by companies according to their size, seeking to construct a theoretical and practical reference framework for the development of a sustainable technological innovation process.

Managing modes of access to technology, sources of technological information, and the interfaces between partners for innovation purposes increases corporate opportunities and performance. Companies are stepping up their use of alliances with external sources of information for innovation purposes, but an explicit management strategy is still lacking (Linder, Jarvenpaa and Davenport, 2003). Several organizational researchers have sought to ascertain the influence of company size on innovative activity (Kimberly, 1976 *apud* Greve, 2008). Internally, large organizations feature more elaborate and professional structures, less bureaucratic decision-making, and less flexibility towards change (Chen and Hambrick, 1995). Externally, these organizations have greater market power and greater influence on the spread of innovation (Boone, Carrol and Witteloostuijn, 2004).

Our survey was conducted in Brazilian companies in the industrial sector with innovative characteristics. Analysis of the practices adopted by these companies, as well as of the influence of their size throughout the technological innovation process, is a strategic theme for competitiveness in a globalized market. An understanding of the behavior of larger and smaller companies towards their management models and innovative performance allows the development of strategies to encourage corporate action.

2 Management of technological information for innovation

Exploitation of technology may occur in basically two ways. Internal exploitation occurs when the company obtains technology from its own products, processes, and operations. The other form occurs when the company obtains technology by external means. A core problem in optimizing the return on technological investment is that many companies approach the analysis and implementation of technology exploitation from a restricted, inward-looking standpoint. Few companies have a strategic view of external exploitation, examining when and how to sell technology to others or cooperate with others to exploit technology (Ford and Saren, 1996).

Only very few companies are able to construct core capabilities without importing knowledge from beyond its bounds, but externally absorbed success is as important as intramural activities and no more difficult. The ability of a company to recognize the value of new, external innovation, assimilate it, and apply it for commercial purposes is critical to its innovative capacity. Companies differ considerably in their ability to develop external knowledge, that is, to identify, access, and assimilate knowledge from external sources of information (Leonard-Barton, 1995). The benefits of knowledge depend not only on the competence of identifying and relating with a source of technology, but also (in fact, mostly) on the receiving company’s capacity to absorb it.

If current trends are an indication, the use of external sources of technological information will grow substantially over the next few years. Organizations are increasingly shifting their innovation focus to the use of external information sources, such as consumers, other companies, business partners, and universities. Industries seek to increase the participation of external sources in their innovative activity by means of venture capital, alliances, or technology acquisition. A strategy for the management of information sources for

innovation purposes not only helps the organization decide on a combination of internal and external sources, but also leverages current innovation. Few companies have a formal strategy for the management of information sources, seeking to manage the various available sources in an integrated manner and thus obtain superior results (Linder, Jarvenpaa and Davenport, 2003).

A company's capacity to expand its knowledge through the use of external sources of information derives from the combination of several relationships, which may be formal or informal. These relationships involve other companies, collaboration between companies, diffusion of technology between companies, and the networking capacities of R&D workers, who build individual relationships with scientists and engineers in other companies and organizations. The specific focus of innovation found in most companies has more to do with individual responsibility than with a corporate plan per se. Few companies have a clear corporate focus of innovation, and these rarely have an innovation model as their goal. The main advantages of using external sources of technological information include the creation of new opportunities, faster and more effective results, decreased innovation costs, easier priority setting, and encouragement of in-house innovation (Beltramo, Mason and Paul, 2004).

Chatterji (1996) devised a conceptual model of managing external sources of technological information, which are increasingly important for expanding the innovative capacity of a company. Each organization must develop and use a set of management practices that meet its specific interests. Based on the results of his research on the theme, Chatterji compiled a list of good industrial practices available to companies interested in starting to use external technology sources or expanding the effects of their existing use. The management of external sources of technological information must be carried out as part of an integrated management plan through the efforts of internal or external sources. Successful use

of external information sources requires a carefully planned approach to managing an increasingly important business practice; good practices are emerging from the R&D community. Companies interested in starting to use external sources of information or expanding their use of such sources must employ relevant practices that broaden their innovative capacity.

The use of external sources of technological information entails a few subtle (and problematic) limitations, including culture, rhythm, information flow, and work processes. Adopting a strategy for the management of innovation information sources entails devising a model of innovation management distinct from that adopted by most companies. With the use of such a strategy, marketing specialization and management of innovation channels should be more relevant to the success of innovation (Linder, Jarvenpaa and Davenport, 2003). Management of the innovation process must aim to capture more added value than internal development. Performance measurement is essential, even if conducted imperfectly. There are many ways to assess information sources for innovation, and companies must unite them by means of effective channels.

3 The influence of company size on innovative behavior

According to the theory of the firm, organizational decision-making is based on a multitude of factors, which are the result of internal bargaining and aspirations that determine corporate action. This goal is the aspiration level for measurement of organizational performance (Cyert and March, 1963, *apud* Greve, 2008).

The dominant managerial line of thought is based on the belief that company size affects corporate efficiency and legitimacy. The definition of a company’s size influences its corporate strategy. Organizations respond to decreased low performance with strategic and

operational changes, including new market entry, acquisition of external resources, and fostering R&D and innovation capacity (Greve, 2008).

Several studies have analyzed the relationship between company size and innovative performance. To some scholars, larger companies are more innovative. Some economists maintain that, in a perfect competition setting, these companies would have greater incentives for innovation. Finally, to others, large and small companies would each have their advantages and disadvantages to the innovation process (Macedo and Albuquerque, 1999).

Regardless of company size, the perspective of establishing an external relationship with other organizations has significant implications for corporate performance. Zaheer and Bell (2005) conducted a study seeking to identify whether companies with a superior network structure are more skilled at exploring their internal capacities to improve performance. Results showed that a company's innovative capacity and network structure improve performance. Although innovative capacity does not directly improve performance, innovative companies with a network structure do have superior performance.

To McEvily and Zaheer (1999), studies often consider the effects of networks, particularly their partners or structure, on performance. The value of the company derives from its connections and contacts, and is a function of research controlled by these contacts, of the company's ability to explore such research, and of the bonds built by partnerships.

Organizations vary in their capacity to develop, understand, or use innovation and knowledge. The key factor of improvement in a company's ability to use and benefit from externally acquired knowledge is its absorption capacity, which is frequently reflected by innovative capacity and ability to explore new knowledge (Cohen and Levinthal, 1990). Internal communication and cultural factors are additional influences on innovative capacity (Chandy and Tellis, 1998).

In order to explain a company's performance, one must consider its innovative capacity. While the networking structure of the company influences performance in the context of knowledge use and transfer, its effects may be made contingent upon the company's focus and change in its capacities. The value of a superior network structure lies in the capacity of the company to exploit knowledge obtained by means of its connections. By jointly examining the company's focus, its changes in capacity, and their joint effects on the value of the network structure, one may understand the factors that affect access to the exploitation of knowledge obtained through the company's network to influence company performance. The maintenance of partnerships creates more ideas for innovation, which may be used in the company's own operations to introduce, novel, innovative products and services that will improve performance (Zaheer and Bell, 2005).

A study by Cohen and Levinthal (1990) concluded that absorption capacity is critical to a company's innovation capacity. Absorption capacity can be defined as the company's ability to recognize the value of new and external information, assimilate them, and apply them for commercial purposes. Companies with high absorption capacity tend to be proactive and skilled at taking and using opportunities; companies with low absorption capacity tend to be more reactive (Darso, 2001).

According to Costa and Cunha (2001), technological capability may be measured by several indicators, all of which concern infrastructure, the training and capability of R&D human resources, external sources of technology acquisition, and results obtained. In their study of companies in the metallurgy, mechanics, and electronics sectors, the authors identified industrial automation, technology generation capacity, number of R&D employees, importance assigned to the R&D function, and percentage of annual earnings invested in R&D as the main indicators.

One of the main obstacles to the analysis of innovative corporate behavior concerns the availability of data. To Sbragia, Andreassi and Kruglianskas (1998), the indicators presented by several countries are quite incipient and limited. Several international institutions have made efforts to create and define common indicators.

The concepts and indicators listed above show the ever-greater importance of creating mechanisms to evaluate innovative activity as a means of ensuring corporate development and competitiveness.

Analyzing the behavior of companies according to their size, their innovative activity, and their performance allows the identification of specificities inherent to each type of organization. Identification of these singularities points to the need to create and use indicators that are adequate to the company's reality, and that will maximize its innovative capacity and its performance.

4 Methods

This quantitative study was conducted by means of a survey. According to Babbie (1999), surveys are conducted to obtain descriptive statements on a population. We administered a data collection instrument to several Brazilian companies in the industrial sector, seeking to identify corporate behavior towards the management of external sources of technological information and innovative performance, according to company size, among sample participants.

4.1 Conceptual model

Based on the study objectives, on the concepts and information obtained from our theoretical foundations, and on knowledge acquired during the exploratory stage of our research, we devised a basic conceptual model for the study, comprising a set of variables related to the management of external sources of technological information and to innovative performance. The model is illustrated in Figure 1.

Insert Figure 1 about here

4.2 Data collection and analysis procedures

The study universe comprised Brazilian companies in the industrial sector featuring innovative characteristics and evidence of emphasis on innovative activity. This choice of sample was informed by the fact that it is in such companies that practices for the management of external sources of technology information occur most effectively. The survey sample was drawn from the member databases of the National Association for Research, Development and Engineering of Innovative Companies (*Associação Nacional de Pesquisa, Desenvolvimento e Engenharia das Empresas Inovadoras,* ANPEI) and the Technological Management Program (*Programa de Gestão Tecnológica,* PGT) of the Fundação Instituto de Administração.

The questionnaire was geared at heads of technology, directors, or CEOs of ANPEI and PGT member companies. Questionnaires were sent by email, or retrieved from a website. Considering our sample, we obtained a high response rate: out of 191 companies, 72 questionnaires were received, for a response rate of approximately 38%. Data were processed

with the aid of Microsoft Excel and the SPSS software package. To assess the validity of the assumptions that guided this study, we performed quantitative, descriptive, univariate analyses, based on the frequency observed for each component variable and indicator of the theoretical model we devised.

5 Analysis of results

The influence of environmental characteristics on the process whereby external sources of technological information are managed was assessed by means of a descriptive analysis of company profiles and indicators for independent and dependent variables, according to company size.

To assess the influence of company size on the management of external sources of technological information, companies were categorized into two subsamples: larger companies and smaller companies. We then conducted analyses of the independent and dependent variables in each group of companies, seeking to identify differences and similarities between small and large companies.

The criteria used in creating categories for the dichotomous variable was based on number of employees, according to the classification employed by the Brazilian Institute of Geography and Statistics (IBGE), which considers companies with 500 or more employees as “large”. Using this classification, companies were divided into two groups, as shown in Table 1 below.

Insert Table 1 about here

We processed the survey data, beginning with the characteristics that make up the profile of each company in the sample. We then present the values of the variables related to management of external sources of information and the values of the component variables of innovative performance, according to company size.

5.1 Company profile

Table 2 shows the predominant profile of sample companies according to size.

Insert Table 2 about here

Most studied companies operated in highly technologically sophisticated sectors. The main differences observed between the two groups include the participation of foreign capital and the existence of export activity, both of which occur predominantly in large companies. Cooperation with other companies, research institutions, and universities for innovation purposes is also mostly found in large companies. Generally speaking, the profiles of both groups of companies are adequate for identification of the characteristics defined as the purpose of this study.

5.2 Management of external sources of technological information

We assessed the management of external sources of technological information by evaluating the intensity with which several practices that characterize corporate behavior, according to company size, were adopted. These characteristics concerned: the types of means of access to technology; the types of sources of technological information; the criteria that guide the choice of external sources of technological information; the factors that hamper the

process by which external sources of technological information are contracted; the company's relationship with its partners in project management; and the benefits of the partnership or collaboration in innovative activities.

5.2.1 Identification of means of access to technology and sources of technological information

Companies' access to technology, according to size, was analyzed through modes of access and the types of sources of technology information. Data obtained are shown in Tables 3 and 4 below.

Insert Table 3 about here

Comparison of smaller and larger companies based on the data in Table 3 shows that corporate behaviors towards access to technology are very similar in both groups. Universities are the most frequently used means of access to technology, and constitute an important source of technology generation. Partnerships with other companies and with suppliers are also used quite often. Furthermore, buying on specifications stood out, due to the possibility of making the technology comply with previously established standards. Larger companies also hire external consultants. The high cost of using this mode of access to technology makes its adoption unfeasible for smaller organizations. Establishing partnerships with competitors as a means of access to technology is poorly regarded by small and large companies alike, reflecting traits of the dominant corporate culture, which sees no advantage in collaborative activity. Investing and purchasing technology are not in current practice either, as little importance is afforded to venture capital and risk capital, joint ventures, and patent and license acquisition. This could be indicative of a lack of knowledge on the use of such modes

of access. Another explanation could be the risks and difficulties – cultural, legal, bureaucratic, and financial – involved in using them.

Data in Table 4 allow comparison of large and small company behaviors towards the types of use of technological information sources.

Insert Table 4 about here

The main sources of technological information employed by companies are similar, regardless of company size. The main internal sources of information are R&D departments and other company departments. Notable external sources are: suppliers; fairs and exhibits; universities and other centers for higher education; the adoption of technological, health, safety, and environmental standards; and the technical and scientific literature. These results corroborate the conclusions of several researchers who have stated that companies' main sources of technological information are primarily internal in origin. Porto, Prado and Plonski (2003) corroborate this argument, concluding in their studies that internal sources of technological information are those most used by Brazilian companies. External relationship sources, which are used with medium intensity, include: visits to other companies in the group, other organizations, or licensors; participation in scientific conferences, and membership in scientific bodies and trade associations; online databases; and consumers. These results converge with the conclusions of Fleury and Fleury (1997), by showing that the literature and technical visits are among the foremost sources of information used by Brazilian companies. The use of clients as a source of information is found predominantly in smaller companies. The greater structural agility of smaller organizations, as well as their proximity to clients, makes adoption of this source of information more effective in such organizations. Larger companies were also found to use networking, research institutions, visits to other

companies and licensors, and scientific and trade conferences as sources of information. The superior administrative and financial structure of larger companies more effectively favors the use of relationship opportunities and participation in the external community. Companies in general afford little importance to technology obtained from outsourcers. These results confirm the argument noted in the prior research question – that companies have little experience in the acquisition of technology from licensing and patents due to the difficulties and risks inherent to such practices. Lead users and community networks are quite specific sources and are still poorly known and experimented with by companies. Joint analysis of modes of access to technology and sources of information employed broadly confirm a trend towards greater use of internal sources, regardless of company size.

5.2.2 Deciding on whether to use external sources of technological information

Aspects concerning the decision on whether to use external sources of technological information among sample companies were verified by means of an analysis of the criteria that guide selection of external sources of technological information, as shown in Table 5.

Insert Table 5 about here

Expertise is the main criterion that influences the choice of external sources of technological information, confirming the strategic importance of knowledge and specialization in generating product and process value for innovative companies. Reputation/image and performance also influence decision-making. The credibility of the information source brings safety to the legal aspects involved, and performance assessment ensures that contracts and partnerships will be maintained or discontinued. Strategic aspects, such as cost and time, also determine the selection of a certain type of source of technological

information. The opportunity to access and obtain information is also considered, stressing the importance of having an efficient networking structure and adopting technological surveillance instruments seeking to detect and capture such opportunities. Larger companies are also concerned with risk and service flexibility, as the establishment of partnerships with specialized external sources entails major investments, which makes risk assessment a key ingredient. In smaller companies, decision-making is little influenced by risk and flexibility matters, which may be justified by less access opportunities and the lower volume of resources involved. Location is also not highly valued by companies, which leads us to suppose that organizations tend to value expertise and other aspects independently – regardless of where the source of information is located. The main criteria adopted by companies are strategic in origin. To Leonard-Barton (1995), the main aspects that drive the technology acquisition process are access to technological potential, assessment of the source's expertise, and company location. Our results corroborate this assessment of the importance of source expertise, a widely used criterion, but diverge on the matter of location, which is little used by companies as such. Due to their structural specificities, larger companies consider a larger number of criteria to be important.

5.2.2 Organization for the management of external sources of technological information

Table 6 summarizes the behavior of companies, according to size, regarding aspects that influence the process by which external sources of technological information are contracted.

Insert Table 6 about here

Aspects regarding process coordination, copyright, trademark, and patent protection, lack of communication, establishment of technology licensing deals, legislation and standards, and high contracting cost are obstacles encountered specifically by smaller companies. A lack of specialized personnel is commonly encountered by companies, as well as excess bureaucracy, which hampers the formalization of partnerships. The ability to negotiate with partners (or lack thereof) was not found to be an obstacle to corporate activity. The main limitations to contracting external sources of technological information, particularly in smaller companies, are structural, legal, and those concerning relationships between partners. This is fundamentally explained by the lack of a specific structure and specialization to face new challenges surrounding the search for information and technology outside the company.

5.2.3 Management of the interface between partners in innovative activity

The factors identified as making activities with partners easier or more difficult during project management will be discussed in the following section, based on analysis of the data in Table 7 below.

Insert Table 7 about here

Information exchange and a similar level of technology are core elements to the success of a partnership due to the need for adopting a common language and maintain compliance with standards. A prior relationship and geographic proximity influence trust and communication between partners. The existence of performance control mechanisms allows identification of contributions and responsibilities, thereby strengthening existing relationships. Factors that hamper or complicate relationship with partners are common to

both groups of companies (small and large). Loss of knowledge was not found to be a cause for concern. Transfer of corporate culture elements was not a specific concern for larger companies, as interfacing with partners implies exchanging knowledge and culture elements.

The Advantages of partnerships/collaboration to innovative activity are showed in Table 8.

Insert Table 8 about here

Companies establish partnerships seeking mainly to improve their image, optimize product development with decreased risk, and achieving effective absorption of technology. Larger companies consider access to financial resources and qualified personnel to be a benefit of partnerships relatively less important as do the smaller companies.

5.3 Innovation Performance

The corporate performance, is based on the evaluation furnished by the respondent about the intensity of the evolution of the main indicators of innovative activity of their enterprises in the period of 2006 – 2007. Data obtained are shown in Tables 9.

Insert Table 9 about here

Analysis of the evolution of these indicators shows that, for large and small companies alike, new product participation and reduction of the costs of technological innovation had the highest values during the 2006–2007 period. The total number of

undergraduate- or graduate-level technicians connected with the company had a higher evolution among large companies, which is justified by their greater demand for specialized labor. These data suggest that larger companies are expanding their capacity for product and process innovation, and points to easier assessment of the evolution of these indicators. Companies considered the evolution of the number of patents obtained in Brazil and abroad to be very low. This may mean that, despite evidence of increasing competitiveness, companies (regardless of size) do not invest in patenting, due to cultural and legal factors.

6 Conclusions

Our analysis of the aspects that management process of external sources of technological information revealed simportant similarities and differences in corporate behavior, depending on company size.

The types of modes of access to technology and the types of sources of technology information were quite similar in both groups. Differences were basically in the number and variety of options adopted, which were superior in larger companies. The main modes of access and sources of information were found to be internal in origin, and collaborative and associative activity is still incipient, regardless of company size. The criteria that guide selection of external sources of technological information were also similar, although smaller companies were found to select a greater number of criteria. The structure of smaller companies is less capable of absorbing cost and investing. The number of factors hampering the contracting of external sources of technological information is higher among smaller companies as well; as these companies' managerial and financial structures are less structured and professionalized, they face greater management obstacles. The number of factors that make the relationship between partners easier is higher among large companies, and there is

greater differentiation of the type of factors. The number of factors that hamper partnerships and the number of benefits brought by partnerships and collaborations are both higher among small companies, because the establishment of partnerships maximizes the effects of innovative activity.

These results corroborate our initial idea that *larger companies make more effective use of practices related to the management of external sources of technological innovation.* Due to their more robust organizational structure, these companies are more independent to carry out innovative activity, have access to a greater number of opportunities, and have greater difficulty in managing partnerships – the latter due to the high number of demands made and relationships established.

As for corporate performance, the number of assessed indicators was more significant among large companies. Data suggest that these companies are expanding their capacity for product and process innovation, and may also indicate that companies find it easier to assess the evolution of indicators. The evolution of the number of patents in Brazil and abroad over the past five years was considered very low by both groups of companies. This may mean that, despite evidence of increased competitiveness, companies, regardless of size, are not investing in the pursuit of patents, due to cultural and legal factors. The performance indicators of larger companies were superior to those of smaller companies, due to their structural advantage for innovative activity.

As already mentioned, the larger companies because they have a stronger and more complete structure show a higher innovative performance. Their stronger organizational structure and access to financial resources allow them to conduct more innovation activities and to access a greater number of external opportunities what provide them comparative advantages in relation to the smaller companies.. It should be also mentioned that it is necessary to develop more mechanisms to permit the companies explore more effectively

external sources for technological information when conducting projects aiming at successful innovative efforts. s.

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FIGURE 1

Conceptual model of the study

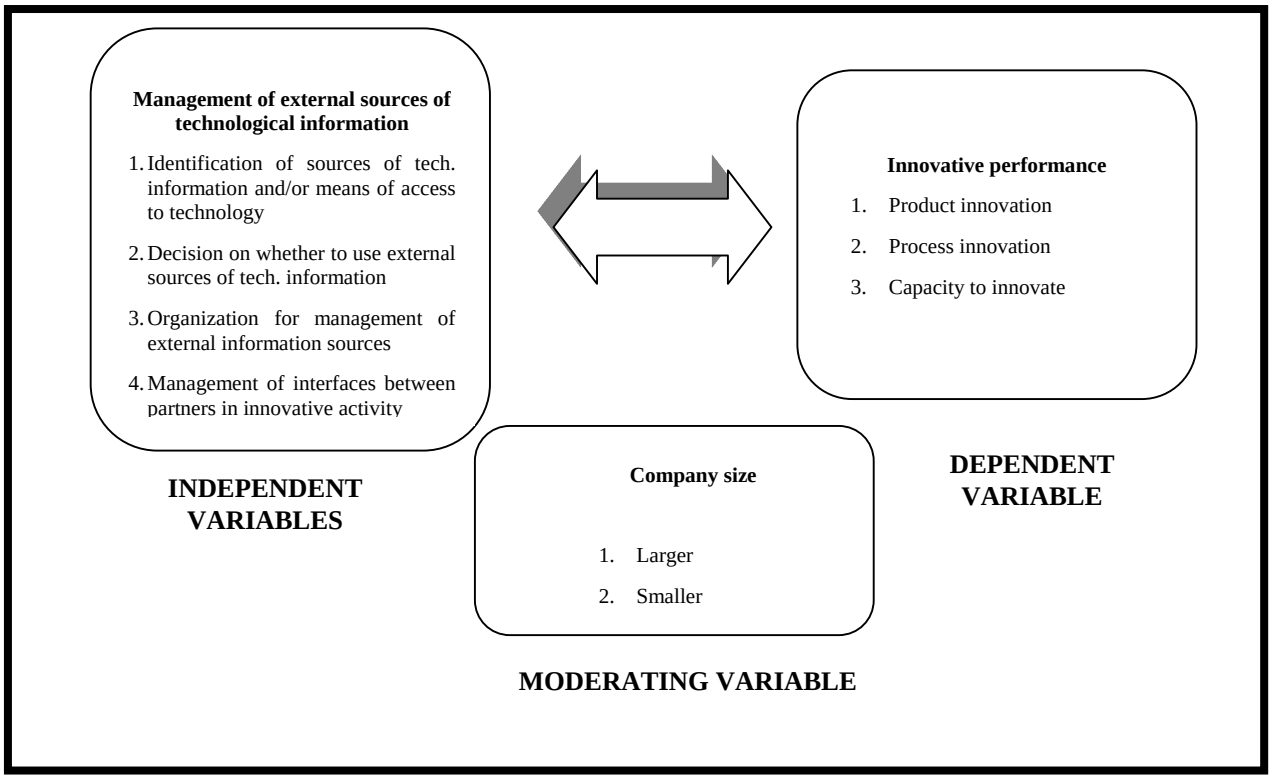

TABLE 1

Company size

Company size	N	%
Small (499 employees or less)	25	34.7
Large (more than 499 employees)	47	65.3
Total	72	100

TABLE 2

Profile of sample companies, according to size

Indicator	Small Company	Large Company
Sector	Instruments, Optics and Automation, Chemistry, Rubber and Plastics	Electronics and Telecom, Auto/Auto parts, and Machinery and Equipment
Number of employees	100 to 499 employees	>2000 employees
Gross operating income	<R$ 150.000.000	>R$ 1.000.000.000
Controlling interest	Domestic	Domestic (49%) and Foreign (45%)
Participation of foreign capital	No foreign capital	>50% (Europe, Asia, U.S.)
Export participation towards gross operating income	Most companies of this size do not export (up to 10%)	Up to 50%
Type of innovation	Product and process innovation	Product and process innovation
Main responsibility for innovative activity	Company itself	Company, in cooperation with other companies and/or research institutions or universities
Main function (area) in charge of managing innovative activity	R&D department	R&D department

TABLE 3

Modes of access to technology, according to size

Modes of access	Frequency (%) of occurrences of the intensity of use of the access mode										
	Smaller companies					Larger companies					Total
	VL	L	M	H	VH	VL	L	M	H	VH	
Buying on specifications	8.7	13.0	34.8	26,1	17.4	7.9	7.9	10.5	18.4	28.9	100
Subcontracting	29.4	5.9	29.4	29,4	5.9	29.7	24.3	29.7	8.1	8.1	100
Licensing	43.8	6.3	12.5	25,0	12.5	39.4	12.1	30.3	12.1	6.1	100
Partnership w/ other cos.	15.8	–	31.6	31,6	21.1	22.0	19.5	24.4	24.4	9.8	100
Partnership w/ competitor	61.5	38.5	–	–	–	59.4	31.3	9.4	–	–	100
Partnership w/ suppliers	5.6	5.6	38.9	38,9	11.1	7.0	23.3	23.3	32.6	14.0	100
Venture capital	81.8	9.1	–	–	9.1	65.0	25.0	10.0	–	–	100
Strategic alliance	31.3	6.3	37.5	31,3	18.8	30.0	33.3	20.0	10.0	6.7	100
Joint venture	58.3	16.7	8.3	–	16.7	56.5	17.4	13.0	13.0	–	100
Cooperation networks	17.6	17.6	29.4	11,8	23.5	35.3	17.6	23.5	14.7	8.8	100
Acquisition of other cos.	45.5	9.1	18.2	27,3	–	34.3	28.6	31.4	2.9	2.9	100
Acquisition of licenses	47.1	29.4	5.9	–	17.6	53.1	25.0	18.8	–	3.1	100
Acquisition of patents	61.5	23.1	15.4	–	–	44.4	37.0	14.8	–	3.7	100
Risk capital	63.6	9.1	9.1	9,1	9.1	62.5	20.8	12.5	4.2	–	100
Universities	14.3	–	28.6	42,9	14.3	11.1	13.3	31.1	26.7	17.8	100
Consultancy outsourcing	23.8	19.0	23.8	33,3	–	18.2	18.2	29.5	27.3	6.8	100
R&D subcontracting	43.8	6.3	18.8	18,8	12.5	31.3	21.9	21.9	18.8	6.3	100
Interest forums	35.3	17.6	11.8	35,3	–	15.8	28.9	23.7	23.7	7.9	100
Consortia	71.4	14.3	7.1	7,1	–	35.5	22.6	25.8	12.9	3.2	100

* VL = very low; L = low; M = medium; H = high; VH = very high.

TABLE 4

Types of sources of technological information

Sources of information	Frequency (%) of occurrences of the intensity of use of the source										
	Smaller Companies					Larger Companies					Total
	VL	L	M	H	VH	VL	L	M	H	VH	
R&D department	–	8.7	13.0	26.1	52.2	4.4	8.9	4.4	22.2	60.0	100
Other departments	4.8	9.5	9.5	66.7	9.5	6.5	2.2	37.0	39.1	15.2	100
Suppliers	9.5	9.5	9.5	52.4	19.0	4.5	15.9	22.7	40.9	15.9	100
Fairs and exhibits	4.0	8.0	32.0	44.0	12.0	4.3	15.2	26.1	34.8	19.6	100
Universities/higher ed.	13.0	8.7	26.1	34.8	17.4	4.3	17.4	21.7	34.8	21.7	100
Adoption of standards	22.7	4.5	22.7	40.9	9.1	10.0	17.5	20.0	32.5	20.0	100
Sci/tech literature	4.0	24.0	24.0	32.0	16.0	6.5	10.9	30.4	28.3	23.9	100
Clients	4.2	8.3	25.0	33.3	29.2	7.0	27.9	20.9	27.9	16.3	100
Networking	18.2	9.1	31.8	22.7	18.2	11.6	18.6	20.9	30.2	18.6	100
Research institutions	19.0	19.0	19.0	23.8	19.0	6.7	28.9	13.3	26.7	24.4	100
Visit to other cos./lcnsr.	42.1	10.5	36.8	10.5	–	14.0	14.0	37.2	20.9	14.0	100
Sci./trade conferences	12.5	12.5	33.3	29.2	12.5	6.7	11.1	28.9	26.7	26.7	100
Scientific/trade assns.	22.7	31.8	22.7	22.7	–	4.5	22.7	29.5	27.3	15.9	100
Online databases	21.7	13.0	30.4	17.4	17.4	9.3	25.6	25.6	25.6	14.0	100
Consumers	25.0	15.0	20.0	20.0	20.0	18.9	24.3	29.7	10.8	16.2	100
Visit to other group cos.	38.5	7.7	30.8	–	23.1	12.5	20.0	17.5	25.0	25.0	100
External. contracting	19.0	38.1	28.6	14.3	–	24.4	36.6	24.4	9.8	4.9	100
External. consultants	18.2	22.7	31.8	22.7	4.5	9.1	36.4	29.5	13.6	11.4	100
Competitors	19.0	33.3	23.8	19.0	4.8	5.0	32.5	20.0	35.0	7.5	100
Testing/cert. institutes	12.5	25.0	25.0	29.2	8.3	5.0	32.5	30.0	20.0	12.5	100
Practice community	38.5	46.2	7.7	–	7.7	36.7	43.3	10.0	6.7	3.3	100
Other cos. in group	7.7	30.8	15.4	30.8	15.4	16.2	27.0	18.9	21.6	16.2	100
Other companies' R&D	35.0	30.0	15.0	15.0	5.0	37.8	24.3	27.0	10.8	–	100
Training centers	38.1	28.6	19.0	14.3	–	31.7	34.1	24.4	7.3	2.4	100
Outsourcing/subcontr.	47.1	41.2	11.8	–	–	30.8	20.5	30.8	7.7	10.3	100
Community networks	46.2	46.2	–	–	7.7	46.7	40.0	10.0	3.3	–	100
Licns./pat. acquisition	37.5	25.0	18.8	12.5	6.3	34.3	28.6	14.3	17.1	5.7	100
Lead users	38.5	30.8	–	15.4	15.4	46.2	15.4	19.2	15.4	3.8	100

TABLE 5

Criteria that guide the choice of external sources of technological information

Criteria	Frequency (%) of occurrences of the intensity of use of the criterion										
	Smaller Companies					Larger Companies					Total
	VL	L	M	H	VH	VL	L	M	H	VH	
Expertise	–	–	4.5	50.0	45.5	–	–	4.7	32.6	62.8	100
Reputation/image	12.5	4.2	16.7	50.0	16.7	–	2.3	14.0	58.1	25.6	100
Performance	–	–	33.3	37.5	29.2	–	2.3	13.6	52.3	31.8	100
Cost	4.0	8.0	32.0	44.0	12.0	–	4.5	40.9	43.2	11.4	100
Time	13.0	8.7	26.1	43.5	8.7	2.4	4.8	33.3	47.6	11.9	100
Risk	13.6	9.1	40.9	31.8	4.5	2.3	9.1	36.4	43.2	9.1	100
Opportunity	–	4.2	29.2	41.7	25.0	2.3	4.7	37.2	37.2	18.6	100
Service flexibility	4.2	16.7	33.3	29.2	16.7	2.4	19.0	38.1	31.0	9.5	100
Location	23.8	9.5	47.6	14.3	4.8	17.1	43.9	26.8	9.8	2.4	100

TABLE 6

Aspects influencing the contracting of external sources of technological information

Aspects influencing the contracting process	Frequency (%) of occurrences of the intensity of the influencing aspect										
	Smaller Companies					Larger Companies					Total
	VL	L	M	H	VH	VL	L	M	H	VH	
Coordination issues	8.7	–	17.4	60.9	13.0	11.9	38.1	14.3	26.2	9.5	100
Lack of specialized staff	4.3	8.7	13.0	52.2	21.7	10.0	22.5	17.5	30.0	20.0	100
Excessive bureaucracy	8.3	4.2	16.7	25.0	45.8	7.0	18.6	30.2	30.2	14.0	100
Copyright, trademark, pats.	10.0	15.0	5.0	30.0	40.0	9.5	23.8	31.0	31.0	4.8	100
Lack of communication	8.7	21.7	13.0	30.4	26.1	12.8	23.1	30.8	28.2	5.1	100
Tech licensing deals	5.0	20.0	25.0	30.0	20.0	12.5	25.0	47.5	12.5	2.5	100
Legislation and standards	9.1	18.2	31.8	18.2	22.7	14.3	26.2	33.3	23.8	2.4	100
Cost of contracting process	8.3	20.8	12.5	25.0	33.3	9.8	29.3	41.5	14.6	4.9	100
Lack of negotiating skills	26.1	21.7	8.7	13.0	30.4	20.0	25.0	27.5	25.0	2.5	100

TABLE 7

Relationship with partners throughout project management

Relationship with partners	Frequency (%) of occurrences of the intensity of the facilitator/barrier										
	Smaller Companies					Larger Companies					Total
	VL	L	M	H	VH	VL	L	M	H	VH	
Facilitators											
Information exchange	–	–	45.8	37.5	16.7	–	–	28.3	54.3	17.4	100
Similar level of technology	–	8.7	17.4	60.9	13.0	–	9.3	25.6	44.2	20.9	100
Prior relationship	–	8.3	29.2	41.7	20.8	–	4.3	10.9	45.7	39.1	100
Partner expertise	4.3	–	13.0	56.5	26.1	–	2.2	4.4	37.8	55.6	100
Performance control	16.7	12.5	33.3	20.8	16.7	2.3	6.8	31.8	52.3	6.8	100
Geographic proximity	13.0	26.1	17.4	34.8	8.7	4.4	24.4	35.6	31.1	4.4	100
Barriers											
Different work pace	4.3	21.7	17.4	21.7	34.8	4.8	16.7	21.4	47.6	9.5	100
Lack of coordination	–	33.3	25.0	29.2	12.5	11.9	26.2	11.9	33.3	16.7	100
Inflexibility of org. structure	13.0	21.7	13.0	26.1	26.1	11.9	21.4	23.8	33.3	9.5	100
Lack of qualified personnel	–	20.8	20.8	37.5	20.8	11.9	23.8	16.7	23.8	23.8	100
Transf. corp. culture elements	4.3	30.4	17.4	30.4	17.4	9.8	31.7	39.0	12.2	7.3	100
Fear loss of knowledge	8.3	33.3	25.0	8.3	25.0	23.8	31.0	23.8	14.3	7.1	100

TABLE 8

Advantages of partnerships/collaboration to innovative activity

Advantages of partnerships and collaboration	Frequency (%) of occurrences of the intensity of the benefits										
	Smaller Companies					Larger Companies					Total
	VL	L	M	H	VH	VL	L	M	H	VH	
Image improvement	4.3	8.7	21.7	43.5	21.7	–	26.2	16.7	50.0	7.1	100
Optimized product dev.	–	9.1	13.6	59.1	18.2	4.7	14.0	25.6	41.9	14.0	100
Dev. and absorption of tech.	–	13.0	30.4	34.8	21.7	2.3	4.5	27.3	50.0	15.9	100
Use of IT/tech res. facilities	4.3	13.0	34.8	34.8	13.0	6.8	11.4	27.3	43.2	11.4	100
Fin. resources/qualified HR	8.7	8.7	17.4	43.5	21.7	–	6.8	45.5	36.4	11.4	100
Improved market potential	–	4.5	36.4	40.9	18.2	4.5	15.9	25.0	36.4	18.2	100

TABLE 9

Evolution of indicators

Indicators	Frequency (%) of occurrences of the intensity of the volution of the indicators along the period 2006-2008										
	Smaller Companies					Larger Companies					
	VL	L	M	H	VH	VL	L	M	H	VH	Total
New prod. participation towards total sales	16.7	5.6	27.8	38.9	11.1	3.1	28.1	25.0	34.4	9.4	100
Total no. of undergrad/ grad. level technicians employed	21.1	10.5	31.6	21.1	15.8	2.9	11.8	41.2	29.4	14.7	100
Cost reduction in tech. process innovation	5.9	41.2	41.2	5.9	5.9	3.6	17.9	28.6	39.3	10.7	100
Nr.. patents obtained in Brazil	66.7	–	22.2	11.1	–	33.3	18.5	18.5	22.2	7.4	100
Nr.. patents obtained abroad	66.7	11.1	11.1	11.1	–	33.3	33.3	16.7	4.2	12.5	100