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# Patterns in the Use of Cooperative Agents for Innovation in the Brazilian Manufacturing Industry

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## ABSTRACT

This research aims to identify clusters of business segments for the use of cooperative agents for the development of innovations in the manufacturing industry of Brazil. Data from 2008 of Pesquisa de Inovação Tecnológica - PINTEC (Survey of Technological Innovation) were analyzed by cluster analysis technique, in order to facilitate the grouping of industries present in the PINTEC's data from the patterns of cooperation shown between companies and other agents of innovation. In this sense, there was a larger low valuation of the external cooperation agents, mainly universities and research centers, indicating an innovation model that is still far from the concept of open innovation. On the other hand, the information networks and consumers and suppliers stood out as important innovation agents.

**Keywords**: Innovation. Cooperation. Manufacturing industries. PINTEC. Cluster analysis.

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## 1 INTRODUCTION

The interest in verifying the importance of technological innovation as the driving force behind development and competitiveness of companies, regions and nations has provided various political and academic discussions. In the search of the answers to the different stages of economic development of nations around the world, Landes (1998; 2003) pointed out the scientific knowledge and technological capacity as answers to the advantage of certain nations over others, shedding new light on the reasons why poor countries are poor and the rich are rich, previously explored by Smith (1996).

Corroborating with the importance of innovation for the development of economies, Epstein and Prak (2008) showed how, in the Middle Ages, the different forms of innovation activities within the guilds, craftsmen associations of the time, directly affected the development of the European economy. Similarly, Forbes and Wield (2003) present numerous examples in the XIX and XX centuries of newly industrialized countries whose economy grew by developing organizational innovations. In addition, Braczyk, Cooke and Heidenreich (2005) via a series of studies carried out in Europe, North America and East Asia, Whitaker and Cole (2006) in Japan, Crouch and Voelzkow (2009), in Germany, and Kou (2010), China, also confirm the economic value of innovation development.

However, it must be recognized that despite it been proved essential for the development and transformation of the economies, the innovation process has undergone changes over time. Initially considered as a phenomenon driven only by basic science, in the post World War II period the innovation model began to incorporate new elements, increasing its level of complexity, as shown by Dodgson, Gann and Salter (2008). The last stage of this development is a model that involves the concept of open innovation, as proposed by Chesbrough (2003; 2012), in which the development strategy starts from the interaction between different actors, internal and external to the organization, in a dynamic collaborative network, marked by Lenz-Cesar and Heshmati (2012, p. 221) by the "complexity of the dynamics involved and heterogeneity of its agents." Hence the importance of considering the networks whose focus are the transfer of knowledge and the promotion of innovations, been this model a trend that favors overcoming the challenges inherent in the complexity of the innovation process and its heterogeneity, as emphasized m Edwards-Schachter, Castro-Martínez and Fernández-de-Lucio (2011) and Qi (2011).

Therefore, it is necessary, at first, the identification of agents that would be essential for the promotion of innovations, such as suppliers, universities and other companies. This identification, however, cannot be given in general terms since the heterogeneity, which is characteristic of the innovation development process, points to differences in its agents both between sectors and between economies (BELL; PAVITT, 1993; HOBDAY, 1995).

Thus, recognizing the need for further studies aimed at identifying the cooperative agents in the innovation process, especially in the context of emerging economies, this research aims to identify business segments *clusters* according to the use of cooperative agents for the development of innovations in the manufacturing industry of Brazil. Were used, as well as data from 2008 of the Survey of Technological Innovation (PINTEC) conducted by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* - IBGE), with the support of the Financier of Studies and Projects (*Financiadora de Estudos e Projetos* - FINEP) and the Ministry of Science, Technology and Innovation, that contains information about the innovation process characteristics in companies that are part of the Brazilian manufacturing industry. As a quantitative analysis technique of such data, the cluster analysis was used in order to enable the grouping of the various sectors of the manufacturing industry present in the PINTEC's data from the patterns of cooperation between the appointed companies and other innovation actors.

Moreover, it is expected that this study will contribute with other investigations in the innovation studies to enable the construction of a general framework of the innovation process characteristics in the Brazilian manufacturing industry, especially in terms of innovation agents. In addition, identification of present patterns of cooperation in different sectors that make up the national manufacturing industry can be even help in formulating corporate strategies and public policies towards the particularities of each sector analyzed, thus favoring significant technological advances to organizations and the society, as well as changes in terms of services, products, processes, and even cultural aspects.

## 2 CONCEPTS AND INNOVATION TYPOLOGIES

Schumpeter (1939; 1997), is considered the first scholar to address the importance of innovation for economic development of a society, whose ideas constitute the theoretical basis of the approaches developed since then (CANTNER; GAFFARD; NESTA, 2009), characterizes this phenomenon as a process of new combinations in the sense that "To produce means to combine materials and forces within our reach. To produce other things, or the same things by a different method, means to combine these materials and forces differently" (SCHUMPETER, 1997 p. 76). Thus, innovation is defined as "the creation of a new production function" (SCHUMPETER, 1939, p. 84).

Another very widespread definition of innovation is in the Oslo Manual, developed by the Organisation for Economic Co-operation and Development (OECD) that presents as "is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations "(OECD, 2005, p. 55). This definition highlights the scope of forms that comprise the innovative process. In addition, it emphasizes the need of implementation to characterize the innovations, both for marketing in the case of product innovations, or for its use by the organization, in the case of process innovations.

Depending on the strength of transformation with consumers, sometimes advocated as drives of innovative process (BRANDON, LU, 2008), innovations can be classified as incremental or radical. If the innovation represents an increase of improvements in a given product, it is characterized as incremental innovation. Moreover, radical innovation is that in which "breaks the bounds of incremental innovation, bringing a productivity jump and starting a new technological path" (TIGRE, 2006, p. 74) being, thus, able to "create a new market" (CROSLIN, 2010, p. 6). McDaniel (2002) calls these innovations of evolutionary and revolutionary, respectively.

Bessant, Stamm and Moeslein (2011) address a similar rating but mainly related to the of innovations’ development process, distinguishing them from continuous or discontinuous innovations. Continuous innovations are similar to the incremental, in that they do not break with the existing technologies, being the result of the activities that make up the organizational routine. On the other hand, the discontinuous innovations require a break with established procedures, being known as destructive or disruptive innovations (CHRISTENSEN, 1997). However, this type of innovation occurs independently from the organization‘s technological capability accumulation level, common in the promotion of other types of innovation, as shown by Miranda and Figueiredo (2010).

Unlike previous ratings, focused on the degree of impact of innovative, Tidd, Bessant and Pavitt (2008) present a typology of innovations related to the object that holds innovation. Thus, innovation can be classified as: product innovation, where processing occurs in the goods or services of an organization; process innovation, when there is a change in the way in which goods or services are produced and delivered; position innovation, which occurs by opening new markets; and paradigm innovation, which constitute the mental models that guide the activity of a given organization.

Another type is highlighted by Chesbrough (2003; 2012), Herzog and Leker (2010) and Koulopoulos (2009), which distinguishes innovations between closed innovation and open innovation. The closed model values the control as a success factor for innovation that, in this case, occurs in its entirety only through internal resources of the organization. In contrast, open innovation uses concepts and technologies external to the organization, mainly relying on resources from other companies and the market as a whole, "in a process that combines internal and external ideas on platforms, architectures and systems" (CHESBROUGH, 2012, p. 21), creating a new economic model “in which the onus is reversed to a wider community of motivated individuals with incentives to contribute" (KOULOPOULOS, 2009, p. 103).

Regarding risks inherent in the innovation process, Dodgson, Gann and Salter (2008) warn that these risks are ignited by various types of uncertainty that, by its own characteristics, are immeasurable. These uncertainties may be related to the development of superior technologies, market behavior, social, cultural or political characteristics, speed and transmission time, besides the complexity of organizational and innovative environments. The advance of such complexity can be observed by the transformations of the innovative process itself within organizations. Figure 1, below, presents five types of innovative process at different stages of development, called generations.

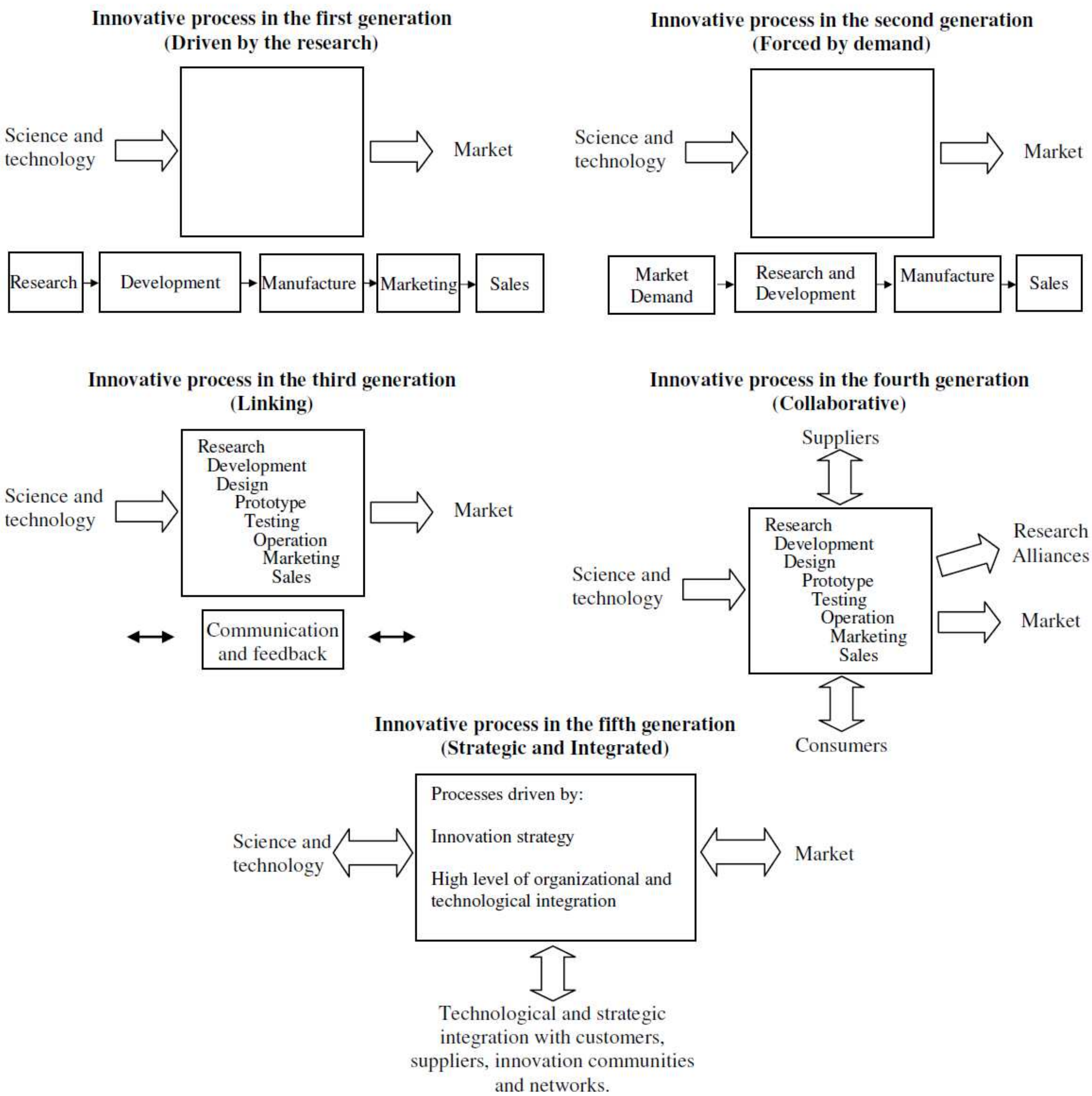



Figure 1 - Developments in the innovation process.
Source: Dodgson, Gann and Salter (2008).

Facing these different models of innovation, it is important to note the lack of a good model in all respects. As claimed by Berkun (2010), the belief that there is a handbook for innovation is nothing more than a myth, myth in which is selling fast, but is pure fantasy. In this respect, Webb (2011) states that hardly an innovation can be treated as reachable through a general revenue, it is important to create an innovative culture for its actions. Thus, several other factors are important in understanding the innovation process, been highlighting the understanding of its sources or agents.

## 3 INNOVATION AGENTS AND SOURCES

The starting point of every innovation is, according Berkun (2010), the biggest question surrounding the innovative process. Drucker (2011) argues that innovation is related to certain sources whose use would depend on the perception of opportunity by the entrepreneur. The author presents seven main sources of innovation: the unexpected; the incongruity; process needs; structural changes in the sector or market; demographic changes; changes in perception; and finally, new knowledge, scientific or not. It is noteworthy that among the sources given there are differences with respect to its reliability and predictability, and the unexpected considered the source of lower risk innovations and results of time.

Following an approach more focused on the relationships between the involved agents, Baldwin and Von Hippel (2012) characterize the sources of innovation from its relationship within the innovative process with the other agents in a functional perspective. Thus, the same innovative agent can act as a user, supplier or manufacturer of an innovation, depending on its relations with other users and companies. However, in the specific case of innovations whose source is the user, Schulz (2009) highlights the benefits that organizations receive in the usage of user communities, organized mainly through social networks, as idea generators, problem-solvers and drivers of the dissemination of innovations process.

In this context, Dodgson, Gann and Salter (2008) state that recognizing the sources of an innovation is one of the most important issues for managers, who invest time and resources in the search for these opportunities. The authors indicated the suppliers, the organization itself and the universities, as the main sources of innovation, as well as government agencies, commercial and academic publications, commercial and professional associations, exhibitions, conferences, patent analysis and various networks and communities. It is worth mentioning one contingent feature of some of the cited sources, such as publications, that are commonly considered more from the diffusion of innovation point of view, are here treated by the authors as a source. So what stands in relation to elements of this type is that, for agents not related to innovation, the further dissemination of the latter in publications or events, according to Dodgson, Gann and Salter (2008, p. 135), is an "important exchange of knowledge source".

In addition, Brynteson (2010) highlights the identification of opportunities as the main source of new technologies. These opportunities, according to Maital and Seshadri (2007), may suggest changes in terms of user preferences, market structures and regulations. Moreover, Sherwood (2002) and Denti and Hemlin (2012) highlight the importance of organizational culture and leadership performance in the production of innovations.

In order to create a classification model, Tiger (2006) distinguishes the innovations between endogenous or exogenous to the organization. The sources of innovation, therefore, are structured under a variety of mechanisms involving internal processes, such as R&D and quality programs, and external processes, such as consulting, obtaining licenses and acquisition of coded information. Table 1, below, shows the major internal and external sources used by organizations.

| **Sources of innovation** | **Examples** |
|---|---|
| Own technological development | R&D, reverse engineering and experimentation. |
| Technology transfer contracts | Licenses and patents, contracts with universities and research centers. |
| Embedded technology | Machinery, equipment and embedded software. |
| Codified knowledge | Books, manuals, technical journals, Internet, fairs and exhibitions, application software, courses and educational programs. |
| Tacit knowledge | Consulting, experienced HR recruitment, customer information, internships and practical training. |
| Cumulative learning | Process of learning by doing, using, interacting, etc. properly documented and disseminated in the company. |

Table 1 - Sources of innovation used by most companies.
Source: Tiger (2006).

From a less generalist approach, Tidd, Bessant and Pavitt (2008) assert that different sectors have different innovative sources. Thus, the suppliers of equipment and inputs would be the main source of primary and manufacturing sectors; consumers, in the fields of instruments, machinery and software; internal technological activities in the chemical, electronics, transport and machinery sector; and, in the medicaments sector, basic research. Dodgson, Gann and Salter (2008) corroborate this variation by sector and also complement it by pointing out a variation of the sources of innovation by countries.

Finally, it should be noted that it is implied in the discussion presented that innovation agents are considered themselves as sources of innovation. Thus, sources of innovation are not only non-human elements (LATOUR, 2000) present in this interaction, such as books, manuals, machinery and software. On the contrary, the sources that stand out in this process are the human actors, such as R&D teams, suppliers and users.

## 4 COOPERATION RELATIONS IN INNOVATION PROCESS

"Innovation is not a solo flight," stated Koulopoulos (2009, p. 14). Through this expression, the author intends to emphasize the importance of collaboration in the innovation process of the XXI century. The growing development of innovations through collaborative action, called 2.0 or open innovation, makes this be defended as an attractive proposal including the economic, compared to the traditional innovation process, called solitary innovation by Trigo and Vence (2012).

Analyzing sectors such as equipment manufacturing and high-tech enterprises, Wang, Qi and Liu (2012) note the importance of this integration phenomenon that goes beyond organizational boundaries and promotes increased business competitiveness by learning and innovation. The innovative process in cooperation networks allows organizations to leverage external innovation capabilities to them, claims Haisu and others (2010). Such innovation networks are therefore networks which aims to promote joint efforts among its partners for the development of new technologies (DOOLEY; O'SULLIVAN, 2007). The resulting innovation is classified by the OECD (2005, p. 27) as collaborative innovation, which "requires the active cooperation with other companies or research institutions in technological activities", and can be constructed including the participation of companies from different countries, such shown by Liuhto (2011) and De Faria and Schmidt (2012).

Stefik and Stefik (2004) assert that the contraction of creative minds for a given organization is not sufficient to leverage the innovative process. More important than this practice is the formation of collaborative networks, including among workers from different organizations, these networks being considered by Novkovic and Holm (2012) as the basis of organizational innovation itself. Therefore, Tuomi (2002) highlights the evolution of communication tools and interaction via the Internet as responsible for the dissemination of creative and collaborative development models.

Regarding to the size of the companies, Leiponen and Byma (2009) and Robinson and Stubberud (2011) pointed the small and medium enterprises as organizations that require a higher level of interaction with other companies and research institutions because they develop more specialized activities. In this sense, the types of cooperation developed by these companies end up influencing in their intellectual protection strategies, so that companies developing innovations in partnership with universities prioritize the use of patents as a protection mechanism, while companies with little investment in R&D prefer the use of trade secret strategies.

Bosch-Sijtsema and Postma (2009) claims that the cooperation networks for innovation aims at mutual benefits for participants in terms of building more stable and long-term relationships, technological resources sharing and dissemination of knowledge. This phenomenon is developed by relationships based on competence and mutual trust, making all this knowledge in these relations, whether formal or informal, become part of the total knowledge of the organization. Thus, as shown by Kogut (2008), costs related to the creation of new products would be below those of companies that operate individually. In addition, participation in these networks would still be driven by the competitiveness of the industry, technological opportunities and production complementary innovations, as shown by Hayton, Sehili and Scarpello (2013).

Hussler and Rondé (2009) also confirm the importance of networking in promoting innovations, especially the open innovation, demonstrating the highest level of benefits that the networks brought to the innovative capacities of the participating companies compared to the Internal development techniques:

> What really matters to innovate is the ability to execute cooperative relations and integrate it in a dynamic network (local or regional) of innovative actors. Hence organizations not only need to open their innovative processes as ideas floating around in the environment. They also have to work to build and manage a rich set of active network connections and relationships so as to be able to make use of the research and development that may be outside of its borders (HUSSLER; RONDE, 2009, p. 2).

Almeida, Mello and Etzkowitz (2012), analyzing the production of innovations in Brazilian incubators networks, point out the importance of their role in promoting innovation in social enterprises that focus on working in social exclusion issues, poverty and unemployment. In this context, social entrepreneurship appears as the result of interactions among government, university, private sector and NGOs (nongovernmental organizations). Also within the environmental innovation companies the cooperation networks stand out, as highlighted by Cainelli, Mazzanti and Zoboli (2011), Wagner and Llerena (2011) and De Marchi (2012), even with a level of importance and greater usage than in other innovative companies.

Zeng, Xie and Tam (2010) and Xie (2012), however, alert for low perceived influence of government and political factors in the production of cooperative innovation, especially in emerging economies. Thus, we must recognize the need for development of public policies on innovation in order to meet the needs of cooperatives to develop new technologies.

## 5 RESEARCH METHODOLOGY

This study uses a quantitative research approach, developing it from the analysis of the secondary data. According to Malhotra (2006), some advantages of its use would be the development of new approaches to a problem, enabling the identification of key variables, even though it was collected by a distinct goal of the research in question. In this research, secondary data collection was made in the databases from Survey of Technological

Innovation (PINTEC) conducted by the Brazilian Institute of Geography and Statistics (IBGE) with the support of the Brazilian Funding Authority for Studies and Projects (FINEP) and the Ministry of Science, Technology and Innovation. PINTEC, which, according to the IBGE (2010), has its conceptual basis based on the third edition of the Oslo Manual, aims to build the technological activities indicators of domestic enterprises, involving aspects such as innovative behavior, innovation strategies and its results.

For this study, we used the latest research available in the database, from 2008, involving a total of 106,862 Brazilian companies, distributed in the extractive industries, manufacturing and services, and, as the focus of research has centered at manufacturing industries, the number of companies that made up the sample of 37,791 companies. The analysis of such data was cross-sectional study in a situation where "the data is collected at a single point in time and synthesized statistically "(HAIR JR. et al., 2007, p. 87).

In order to enable a consistent statistical approach with the research proposal at this stage of research, we opted for the use of cluster analysis technique that, according to Corrar, Paulo and Dias Filho (2009, p. 325), "Is one of the multivariate analysis techniques that its primary purpose is to gather objects, based on their characteristics." As a result of its application, there is a classification of objects, which in this case are the processing industries, according to similarities they have with each other, generating groups with a high degree of internal and external high homogeneity heterogeneity.

Moreover, as guided by Fávero, Belfiore, Silva and Chan (2009), this technique stars from the analysis of the variables used for the objects grouping. In this study, these variables are the percentage amounts of the innovations developed by industries from the usage of a determined innovation agent, and for each innovation agent, companies had to determine the amount of developed innovations. Thus, been these variables presented in percentage terms, another advantage of using this research is the absence of the need for data standardization, since they are all within the same numerical pattern. In Table 2, below, is presented the different types of manufacturing industries of this research, as well as innovation agents.

| **Types of industries** | **Innovation agents** |
|---|---|
| 1. Food products manufacturing<br>2. Beverage manufacturing<br>3. Textiles manufacturing<br>4. Clothing items and accessories manufacturing<br>5. Preparation of leather and manufacture of leather goods, travel items and footwear<br>6. Wood products manufacturing<br>7. Pulp, paper and paper products manufacturing<br>8. Printing and reproduction of recorded media<br>9. Coke, oil products and biofuels manufacturing<br>10. Chemicals manufacturing<br>11. Pharmachemical and pharmaceuticals manufacturing<br>12. Rubber and plastic manufacturing<br>13. Non-metallic mineral products manufacturing<br>14. Metallurgy<br>15. Metal products manufacturing<br>16. Computer equipment manufacturing, electronic and optical products<br>17. Machinery, appliances and equipment manufacturing<br>18. Machinery and equipment manufacturing<br>19. Motor vehicles, trailers and bodies manufacturing<br>20. Other transport equipment manufacturing<br>21. Furniture manufacturing<br>22. Various products manufacturing<br>23. Maintenance, repair and installation of machinery and equipment | 1. (R&P) Research and Development Department<br>2. (OAE) Other areas of the company<br>3. (OEG) Another group company<br>4. (FOR) Suppliers<br>5. (C&C) Customers and consumers<br>6. (CON) Competitors<br>7. (EC) Consulting firms and independent consultants<br>8. (UNI) Universities or other higher education centers<br>9. (IP) Research institutes or technology centers<br>10. (CCP) Professional training centers and technical assistance<br>11. (IT) Institutions of tests, trials and certifications<br>12. (CEP) Conferences, meetings and specialized publications<br>13. (F&E) Fairs and exhibitions<br>14. (RI) Computerized information networks |

Table 2 - Objects and variables in the cluster analysis.
Source: Prepared by the authors.

Among the different types of manufacturing industries present in the data from PINTEC, only the tobacco products industry was not included in the survey for not presenting values of high degree of importance to the research instituted agents or technology centers (IP) and Professional training centers and technical assistance (CCP), which would compromise the results of the statistical analysis used, since the cluster analysis technique is extremely sensitive to missing data. It is worth noting that as aid software to quantitative research, Microsoft Excel (version 2012) and IBM SPSS (version 21) were used.

## 6 PRESENTATION AND DISCUSSION OF RESULTS

Starting from the collection of secondary data in the databases of PINTEC, in a survey conducted in 2008, the present study includes a set of 37,791 companies that make up the Brazilian manufacturing industry, and have implemented some product innovation and/or process in the period surveyed. In order to identify clusters of business segments for the use of cooperative agents for the development of innovations in the manufacturing industry in Brazil, the clusters analysis was applied, considering as cases the types of manufacturing industries presented in the PINTEC's survey as variables and participant agents of the innovation process, presented earlier.

Initially, we checked possible multicollinearity problems between variables, which could affect the cases grouping results. The correlation coefficients are shown in Table 3 below.

**Table 3 - Correlation Analysis Between Variables**

| | **R&D** | **OAE** | **OEG** | **FOR** | **C&C** | **CON** | **EC** | **UNI** | **IP** | **CCP** | **IT** | **CEP** | **F&E** | **RI** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **R&D** | 1 | ,249 | ,484 | ,035 | -,028 | -,003 | ,135 | ,656 | ,817 | -,112 | ,544 | ,560 | ,155 | ,408 |
| **OAE** | ,249 | 1 | ,574 | ,040 | ,007 | -,312 | -,009 | ,198 | ,287 | -,026 | ,297 | ,206 | -,193 | -,321 |
| **OEG** | ,484 | ,574 | 1 | -,058 | ,038 | ,002 | -,087 | ,242 | ,368 | -,120 | ,156 | ,139 | -,045 | ,052 |
| **FOR** | ,035 | ,040 | -,058 | 1 | ,000 | ,455 | -,085 | ,240 | -,168 | ,491 | -,057 | ,403 | ,450 | ,368 |
| **C&C** | -,028 | ,007 | ,038 | ,000 | 1 | ,259 | ,082 | -,102 | -,011 | ,178 | ,034 | -,103 | ,194 | ,068 |
| **CON** | -,003 | -,312 | ,002 | ,455 | ,259 | 1 | -,178 | ,312 | -,097 | ,376 | -,179 | ,221 | ,379 | ,139 |
| **EC** | ,135 | -,009 | -,087 | -,085 | ,082 | -,178 | 1 | ,416 | ,364 | ,016 | ,380 | -,282 | -,258 | -,054 |
| **UNI** | ,656 | ,198 | ,242 | ,240 | -,102 | ,312 | ,416 | 1 | ,782 | ,266 | ,558 | ,501 | ,145 | ,216 |
| **IP** | ,817 | ,287 | ,368 | -,168 | -,011 | -,097 | ,364 | ,782 | 1 | ,095 | ,597 | ,404 | ,066 | ,170 |
| **CCP** | -,112 | -,026 | -,120 | ,491 | ,178 | ,376 | ,016 | ,266 | ,095 | 1 | -,147 | ,276 | ,598 | ,286 |
| **IT** | ,544 | ,297 | ,156 | -,057 | ,034 | -,179 | ,380 | ,558 | ,597 | -,147 | 1 | ,393 | ,076 | ,004 |
| **CEP** | ,560 | ,206 | ,139 | ,403 | -,103 | ,221 | -,282 | ,501 | ,404 | ,276 | ,393 | 1 | ,492 | ,532 |
| **F&E** | ,155 | -,193 | -,045 | ,450 | ,194 | ,379 | -,258 | ,145 | ,066 | ,598 | ,076 | ,492 | 1 | ,523 |
| **RI** | ,408 | -,321 | ,052 | ,368 | ,068 | ,139 | -,054 | ,216 | ,170 | ,286 | ,004 | ,532 | ,523 | 1 |

Source: Prepared by the authors.

Correlation levels are generally low or acceptable to the multicollinearity absence assumption between these variables, with only one of the coefficients above 0.8 (R&D and IP = 0.817). Thus, recognizing the importance of these two variables, we opted for maintaining it, being applied the cluster analysis with all the variables used in the research.

Because of its advantages, we chose to use the hierarchical furthest neighbor clustering, appointed by Valli (2002, p. 81) as an agglomerative method in which "all groups start with one individual. Individuals with same characteristics are, then, gradually united until all individuals are in a single group". Its use increases the chances of obtaining more balanced and less internally dissimilar groups. In addition, it was established an interval in number of acceptable groups with a minimum of two groups and a maximum of five. The results of this analysis are presented in Table 4 below.

**Table 4 - Agglomeration Planning Table**

| Stage | Combined Cluster | | Coefficients | Stage cluster is shown first | | Next stage |
|---|---|---|---|---|---|---|
| | Cluster 1 | Cluster 2 | | Cluster 1 | Cluster 2 | |
| 1 | 10 | 16 | ,162 | 0 | 0 | 12 |
| 2 | 12 | 14 | ,168 | 0 | 0 | 7 |
| 3 | 1 | 4 | ,173 | 0 | 0 | 5 |
| 4 | 18 | 21 | ,190 | 0 | 0 | 11 |
| 5 | 1 | 3 | ,192 | 3 | 0 | 9 |
| 6 | 7 | 9 | ,224 | 0 | 0 | 13 |
| 7 | 12 | 15 | ,229 | 2 | 0 | 10 |
| 8 | 5 | 19 | ,234 | 0 | 0 | 11 |
| 9 | 1 | 13 | ,256 | 5 | 0 | 16 |
| 10 | 8 | 12 | ,280 | 0 | 7 | 15 |
| 11 | 5 | 18 | ,289 | 8 | 4 | 15 |
| 12 | 10 | 17 | ,299 | 1 | 0 | 17 |
| 13 | 7 | 23 | ,307 | 6 | 0 | 18 |
| 14 | 2 | 22 | ,318 | 0 | 0 | 19 |
| 15 | 5 | 8 | ,328 | 11 | 10 | 19 |
| 16 | 1 | 6 | ,373 | 9 | 0 | 21 |
| 17 | 10 | 11 | ,392 | 12 | 0 | 20 |
| 18 | 7 | 20 | ,418 | 13 | 0 | 20 |
| 19 | 2 | 5 | ,467 | 14 | 15 | 21 |
| 20 | 7 | 10 | ,575 | 18 | 17 | 22 |
| 21 | 1 | 2 | ,605 | 16 | 19 | 22 |
| 22 | 1 | 7 | ,660 | 21 | 20 | 0 |

Source: Prepared by the authors.

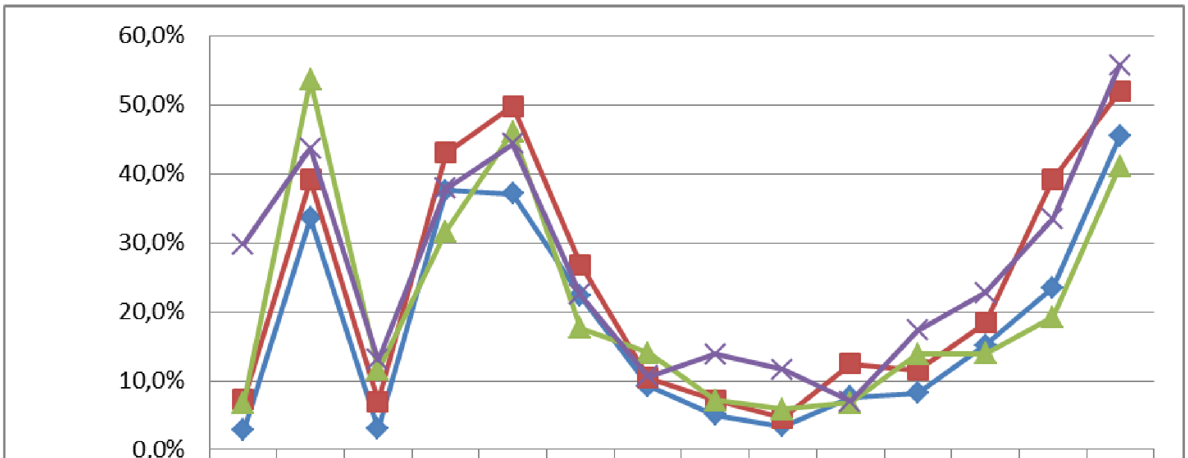
The choice of the number of groups occurred by applying a simple stop criteria that considers the values of the coefficients between steps, identifying a moment of sudden increase. It is noticed that from step 19 to step 20 was the most significant increase in this ratio (0.467 to 0.575). Thus, the stop is in the stage preceding this increase (step 19), where the solution is of four groups. In Table 5, which follows, the components of each group are presented.

| | |
|---|---|
| **Group 1 (5 industries)** | 1. Food products manufacturing<br>3. Textiles manufacturing<br>4. Apparel and accessories manufacturing<br>6. Wood products manufacturing<br>13. Non-metallic mineral products manufacturing |
| **Group 2 (10 industries)** | 2. Beverage manufacturing<br>5. Preparation of leather and manufacture of leather goods,<br>8. Printing and reproduction of recorded media<br>12. Rubber and plastic manufacturing<br>14. Metallurgy<br>15. Metal products manufacturing<br>18. Machinery and equipment manufacturing<br>19. Motor vehicles, trailers and bodies manufacturing<br>21. Furniture manufacturing<br>22. Various products manufacturing |
| **Group 3 (4 industries)** | 7. Pulp, paper and paper products manufacturing<br>9. Coke, oil products and biofuels manufacturing<br>20. Other transport equipment manufacturing<br>23. Maintenance, repair and installation of machinery and equipment |
| **Group 4 (4 industries)** | 10. Chemical products manufacturing<br>11. Pharmachemicals and pharmaceuticals manufacturing<br>16. Computer equipment, electronic and optical products manufacturing<br>17. Machinery, appliances and equipment manufacturing |

Table 5 - Classification of industries in groups.
Source: Prepared by the authors.

Processing a group variance analysis (ANOVA) to determine if there are significant differences between the variables, all showed lower levels of significance than 0.05. Thus, it is not necessary a new processing data with the same variables. This test proves important because they have been kept the variables R&D and IP that, as pointed out earlier, showed a high degree of correlation between them, which could hinder the construction of the groups. However, with low levels of significance found between the variables, it can be considered that there was no harm in maintaining of these two variables, a new analysis without their inclusion is not necessary.

By interpreting the four groups found, it is observed that the solution reasonably comprises the differences between groups, given the distances between the four groups. The chart shown in Figure 2 below, presents the means of each variable for the four groups and allows observing the differences between them.




| | P&D | OAE | OEG | FOR | C&C | COM | EC | UNI | IP | CCP | IT | CEP | F&E | RI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group 1 | 2,8% | 33,6% | 3,0% | 37,6% | 37,1% | 22,3% | 9,2% | 5,0% | 3,4% | 7,6% | 8,2% | 15,1% | 23,5% | 45,4% |
| Group 2 | 7,3% | 39,1% | 7,0% | 43,0% | 49,8% | 26,8% | 10,4% | 7,2% | 4,6% | 12,5% | 11,5% | 18,4% | 39,2% | 51,9% |
| Group 3 | 6,8% | 53,6% | 11,5% | 31,6% | 46,1% | 17,6% | 14,0% | 7,2% | 5,9% | 6,8% | 13,8% | 13,9% | 19,2% | 41,1% |
| Group 4 | 29,8% | 43,7% | 13,0% | 37,8% | 44,3% | 22,5% | 10,6% | 13,8% | 11,6% | 7,0% | 17,3% | 22,7% | 33,5% | 55,7% |

Figure 2 - Diagram of the means of group profiles.
Source: Prepared by the authors.

In general, there is a similar behavior of groups in relation to the cooperation agents in the innovation process. However, from the individual analysis of each of these agents, it is possible to see some aspects that are worth mentioning. First in relation to internal agents to the organization, which are the research and development department (R&D) and other areas of the company (OAE), it is observed that the latter is much valued by the companies surveyed than the first. For the R&D variable, only Group 4, that consisted of companies from the chemical and electronic sectors, presented a reasonable mean of its value in the innovation process (29.8%), thus been part of Group 1, composed of food sector and clothing companies, with the lowest average (2.8%). Also on the variable OAE, Group 1 is characterized as the one that least realizes the importance of other areas of the company in developing innovations (33.6%), been part of Group 3, the pulp and oil products companies were the ones with the highest mean value for participation of other areas of the company in the innovation process (53.6%).

Regarding external agents to the company, stands out in terms of value within the innovation process the computerized information networks (RI) variables, customers and consumers (C&C) and suppliers (FOR), with research institutes (IP), universities (UNI) and other group companies (OEG) as the minor variables for the process. In this context, Group 4 had the higher mean value for the RI (55.7%) variable, followed by Group 2 (51.9%). For consumers and customers, also Group 2, comprised by companies in the beverage industry, automobiles and various products, it stands out with higher mean value of these agents in the innovation process (49.8%), and Group 1 with worst mean (37.1%). With regard to suppliers, are also the companies in the Group 2 that stand out positively (43.0%), followed by companies in the Group 4 (37.8%) and Group 1 (37.6%).

With regard to the least important agents for companies in developing innovations, Group 4 was presented the highest value rate of the research institutes, universities and other group companies (IP = 11.6% = 13.8 UNI % and OEG = 13.0%), and Group 1 with the worst mean in the three variables (IP = 3.4%, UNI = 5.0% and OEG = 3.0%). In summary, Table 6, below, provides an overview of cooperative characteristics for each of the groups.

| Groups | Cooperation patterns |
|---|---|
| Group 1: food products, textiles, clothing, wood and minerals companies. | Group with the worst average index of cooperation (18.3%), standing out only in cooperation with suppliers and professional training centers and technical assistance. |
| Group 2: companies of beverages, machinery, vehicles, furniture, metal and leather products, metal, rubber, plastic and printing. | Second best group regarding the average index of cooperation (23.5%), standing out from others in cooperation with suppliers, customers or consumers, competitors, professional training centers and technical assistance and participating in fairs and exhibitions. |
| Group 3: pulp, paper, equipment, and oil products and biofuels companies. | Third group regarding the average index of cooperation (20.7%), especially in the context of internal cooperation with other areas of the company, also having a good standard of cooperation with customers or consumers. |
| Group 4: chemical, pharmaceuticals, computers, electrical and electronic companies. | Group with the best average index of cooperation (26.0%), especially in relations with R&D department, universities, research institutes, test institutions, stakeholder conferences and networks. |

Table 6 - Collaborative innovation patterns in groups.
Source: Prepared by the authors.

Thus, the characteristics presented by the different groups that make up the Brazilian manufacturing industry indicate weak points in this cooperation, as reflected in the low cooperation rates presented. In this sense even universities and research institutes are commonly pointed among the leading developing agents of the innovative process in business, as presented by Tigre (2006) and Dodgson, Gann and Salter (2008), the low valuation of these by companies shows a still incipient relationship. Also in relation to cooperation arising from other companies, unlike presented by Stefik and Stefik (2004), that defend this cooperation as even more important than hiring new employees for a given organization, this was one of the least present agents in development of innovation in enterprises.

Internally, the highlight was the participation of other sectors of the company in the development of innovations, while the outer part, prevailed the use of computerized information networks, whose importance was previously highlighted by Tuomi (2002) as largely responsible for the dissemination and strengthening collaborative links between innovation actors. With regard to relations with customers and consumers, highlighted by Brandon and Lu (2008) and Schulz (2009), had great appreciation by the companies analyzed asserts an innovation model highly focused for these agents, similar to the collaborative model of innovative process presented by Dodgson, Salter and Gann (2008), which also play a critical role suppliers.

Finally, in relation to the R&D department, the little appreciation of their participation in the innovation process, especially among the group companies 1, 2 and 3 tends to indicate low innovative potential of this companies, since, as showed by Miranda and Figueiredo (2010), the share of R&D department in the development of innovations, although not been constituted as exclusive agent in the process, tends to gain more importance as companies accumulate more innovative capacity and approach the technological frontier.

## 7 FINAL CONSIDERATIONS

Aiming to identify clusters of business segments for the use of cooperative agents for the development of innovations in the manufacturing industry in Brazil, this study could, by using PINTEC's data from 2006 to 2008, build a general framework of cooperation observed in different sectors of the industry. In this sense, there was a larger low valuation of the external cooperation agents, mainly universities and research centers, indicating a general model of innovation still far from the concept of open innovation or innovation 2.0, defended by Chesbrough (2003; 2012), Herzog and Leker (2010) and Koulopoulos (2009), among others. On the other hand, stood out only the information networks and the consumers and suppliers, which points to a model of collaborative innovation activities in relation to those agents, but still fragile in the valuation of research activities, including in relation to R&D itself.

Thus, one has to expect a low innovative potential of these companies, especially with regard to radical or new innovations to the market, which development demands a high level of research activities and scientific knowledge accumulation. Thus, even if the use of external cooperation of agents are to be presented as a conditioning element for this process, since the accumulation of innovative capabilities can occur from the activities and routines of the company itself, it is asserted the need of development strategies creation and strengthening of relationships between companies and universities and research centers, in order to generate a stock of technological capabilities in which national companies could move toward the technological frontier. Therefore, the use of information and tools for creating and maintaining these links between companies and universities appears as a favorable path network, in view of the high level of importance assigned to these networks by enterprises.

Moreover, the characterization of the different types of manufacturing industries in groups from the cooperation patterns indicated by these companies can help to formulate strategies that are specific demands and needs of each industry analyzed in order to avoid simply adding generic strategies that do not correspond to the distinctive characteristics that are unique to each type of industry. In fact, given the heterogeneous characteristics of the innovative process, which stand out when the groups formed in the analysis of data from this survey are compared in terms of innovation agents, is not recommended managers to simple incorporate of general revenues for the management of innovation in business. Instead, recognizing the particularities of each industry's innovation process, starting with the identification of its main innovation actors, is expected to enable the building of a model that meets innovation demands of different sectors, also enabling an expansion in the current innovation network of a given company with the inclusion of agents that have not been previously considered in their strategies.

It is noteworthy in this context the need for qualitative studies, which carry greater potential for assessment of individual aspects in each of the analyzed industries, especially those who had lower cooperative activity, in order to investigate the causes of this low level of cooperation , enabling the creation of strategies aimed at developing relationships with the agents that are most important. In addition, the absence of similar studies within the extractive industries and services indicates the need for the replication of the same procedures used in this study for the development of researches in these sectors.

Also, respecting the historical characteristic carried by the innovation development process, this research can even be extended to other time periods, using the same PINTEC database, in order to observe changes in the identified patterns of cooperation and, if possible, therefore, point out developments and setbacks in this cooperative context that shows increasingly central to the development of innovations.

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