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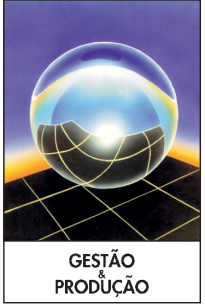


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# Vertical and horizontal relationships in the process of innovation and learning by interacting: study in an industry cluster

## *Relações verticais e horizontais no processo de inovação e aprendizagem interativa: estudo em um aglomerado produtivo*

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**Abstract:** This study sought to examine the vertical and horizontal relationships and the impact of these relationships on the process of innovation and learning by interacting, using a case study in an active industry cluster in Brazil. The methodology procedure was field research with a universe of 36 companies of the lumber industry. The research results helped identify the factors that prevent companies of a cluster from establishing more solid collaboration relationships capable of enhancing competitiveness. It was found that the prevailing mechanism in the business environment of the cluster was learning by doing, obtained from accumulated experiences and skills acquired locally, which allow the definition of adaptations and technological improvements. These findings reveal the need to create spaces inside the companies for learning by interacting and the development of new skills and competencies required for innovation.

**Keywords:** Vertical and horizontal relationships; Interactive learning; Innovation in industry clusters.

**Resumo:** *Este estudo buscou analisar as relações verticais e horizontais e o impacto delas no processo de inovação e aprendizagem interativa, mediante um estudo de caso realizado em um aglomerado produtivo atuante no Brasil. Em termos de procedimento metodológico, foi realizada uma pesquisa de campo, contemplando um universo de 36 empresas que atuam no setor madeireiro. Os resultados da pesquisa ajudaram a identificar os fatores que limitam as empresas de um aglomerado a aderirem a relacionamentos de cooperação mais sólidos, capazes de incrementarem a competitividade. Constatou-se que no ambiente das empresas do aglomerado produtivo prevalecem os mecanismos do tipo learning by doing, obtidos pelas experiências acumuladas e habilidades adquiridas localmente, possibilitando a definição de adaptações e melhorias tecnológicas. Foi possível constatar a necessidade da construção de espaços que permitam a aprendizagem interativa no ambiente interno das empresas, com o desenvolvimento de novas habilidades e competências necessárias à inovação.*

**Palavras-chave:** *Relações verticais e horizontais; Aprendizado interativo; Inovação em aglomerados produtivos.*

## 1 Introduction

Globalization is changing the modes of production, the productive structures, and the standards of localization, and establishing a new profile of competitiveness. In this economic environment, companies are especially concerned with obtaining financial resources, gaining flexibility, boosting their technological capacity, finding new ways of organizing and managing production, maintaining market access, and accompanying international shifts and trends.

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Industry clusters are among the most notable characteristics of these shifts. They gather producers of the same sector or industrial segment and related industries in the same geographical location (Porter, 1998; Garcia et al., 2004; Takeda et al., 2008; Garcia & Madeira, 2013). The geographical and cultural proximity of the agents in these spaces encourages and facilitates learning by interacting and innovation, as well as the exchanging of information and knowledge, all of which have positive effects on the individual innovation activities of the companies (Capó-Vicedo et al., 2007; Heikkilä et al., 2010; Karaev et al., 2007; Capó-Vicedo, 2011; Zhi-Xin & Cui, 2011).

Industry clusters reflect the benefits of company engagement in learning by interacting and innovation processes and the knowledge exchanged in these environments is incorporated into the individual qualifications and organizational procedures and routines, as well as collectively by establishing local learning practices that generate specific externalities (Moeller, 2010; Kajikawa et al., 2010; Brown et al., 2010; Tatsch, 2013; Bengtsson & Kock, 2014).

The formation and development of industry clusters are enhanced by the positive externalities that benefit producers. Local businesses can seize a series of benefits generated outside their domains but within the limits of the local system (Davenport, 2005; Tálamo & Carvalho, 2010). One of these benefits is the local process of learning and circulation of knowledge, heavily mediated by the geographical and cultural proximity between agents (Audretsch & Feldman, 2004; Vale & Castro, 2010).

Lundvall et al. (2002) advocate that, depending on the studied location, certain types of information are more difficult to encode and, subsequently, harder to transmit than others. Thus, learning by interacting becomes a critical tool for generating and transferring knowledge, promoting development and innovation, and creating fundamental bases for companies to remain more competitive (Lundvall & Johnson, 2000). Based on this premise, the aim of this study was to answer the following question: How do the vertical and horizontal relationships in an industry cluster affect the process of innovation and learning by interacting of the involved companies?

To answer this question and confront the theoretical approaches, an empirical study was conducted in the Industrial Lumber Cluster of Telêmaco Borba, in southern Brazil. This cluster is classified as a Local Development Vector ("VDL") and it has significant local or regional economic significance (IPARDES, 2005).

## 2 Learning by interacting

In the late 1970s, discussions on technology transfer mechanisms, choice of techniques, restrictive business practices, and comparing science and technology budgets in different countries give rise to discussions on the nature and direction of "technological learning" in the so-called newly industrialized countries, leading to efforts to develop an empirical and theoretical explanation of the dynamic aspects of technical change (Dahlman & Fonseca, 1978; Katz, 1980; Frasman, 1982; Dahlman et al., 1987; Lall, 1992; Bell & Pavitt, 1993). Certain characteristics of the externally acquired technologies of the technology marketplace, such as non-replicability and imperfect information, drove companies of developing countries through a process of technological learning with a strong idiosyncratic and adaptive bias (Katz, 1980). Based on this technological learning, companies in developing countries acquired the skills they needed to select, assimilate, adapt, and improve imported technologies.

In the 1990s, with the opening up of markets and the intensification of globalization and global competition, studies were conducted on learning mechanisms and their different characteristic sources and interactions (Lall, 1992; Bell & Pavitt, 1993; Figueiredo, 2004). Technological learning processes quickly became critical for developing countries seeking competitive leverage.

With regard to conceptual approaches to the term technology learning found in literature (Katz, 1976; Lall, 1987; Dahlman & Westphal, 1982; Bell, 1982; Westphal et al., 1984; Scott-Kemmis, 1988) the earliest approaches consist of inventive or systematic creative efforts to obtain new knowledge in production. Technology learning includes learning skills and knowledge incorporated by workers, facilities, and organizational systems to enable change in production and the adopted techniques. Thus, technology learning is related to an "internal technological effort" to master new technologies, adapt them to local conditions, and perfect and even export them (Bell, 1982; Lall, 1987).

Moreover, technology learning can occur through informal or unstructured mechanisms that also create internal innovative skills in the companies (Campos et al., 2002; Silva & Stal, 2013).

These learning processes generated from internal sources of knowledge include production experience or training acquired in the actual work environment (learning by doing and learning by using) to increase productive efficiency and the continuous flow of modifications and incremental innovations in processes and products, as well as

external learning through interaction with external sources (learning by interaction with suppliers, users, national innovation systems, environment, and other companies) (Nelson & Winter, 1977; Dosi, 1988; Freeman, 2000; Lundvall et al., 2002).

Based on this context, learning becomes a continuous and dynamic process with permanent changes in the state of knowledge, frequently manifested by changes in understanding, decision, and action (Humphrey & Schmitz, 1998; Lazerson & Lorenzoni, 1999; Johnson & Lundvall, 2000; Davenport, 2005; Balbinot et al., 2012).

The generation of knowledge through external sources in the learning by the interacting process, especially between the agents of an industry cluster has been the object of several studies (Freeman, 2000; Casas et al., 2000; Maskell, 2001). This literature has shown that the presence of additional knowledge and cooperative behavior leads to cognitive interaction between agents that, in turn, promotes the generation of new knowledge.

Learning by interacting includes customer-producer relationships, formal and informal collaboration, the intercompany mobility of skilled workers and new business spin-offs from existing companies, universities, and research centers (Breschi & Malerba, 2001).

Knowledge transfer in the industry cluster environment occurs when the learning processes allow a combination of knowledge originally coming from different firms or when local knowledge is combined with knowledge from outside the cluster (Lam, 2000; Giaretta, 2014).

Learning through interacting is learning from relationships between the company and its customers, between the company and its suppliers, between the company and its competitors, and between the company and research centers, universities, and other organizations, such as public institutions (Lundvall et al., 2002). The intrinsic collective and social nature of interactive learning process occurring outside company walls require the joint contribution of the agents involved to solve complex problems, especially through common codes of communication and coordination (Lundvall & Johnson, 2000). Interactive processes between agents allow the exchange of information, joint actions, the sharing of responsibilities, and the establishment of codes and procedures to improve production methods and product quality, and increase technological training (Belussi & Gotardi, 2000; Fu et al., 2013).

Learning from within industry clusters is related to highly facilitated interactions based on standards that reinforce confidence between the agents. In this environment, individual companies engage in multilateral cooperation through equipment sharing, joint purchases of inputs to cut costs, and new product development, while suppliers and producers work together to improve components used in production (Hamel, 2001; Martin & Sunley, 2003). However, the externalities generated by industry clusters are insufficient, which calls for joint actions and interactions between the companies of the cluster to ensure collective gains (Schmitz, 1995).

As stated by McCormick (1999), learning by interacting is a key aspect of the new context of economic and technological development, and geographic proximity becomes an important feature to promote the exchange of tacit knowledge. Local clusters are therefore essential in the pursuit of competitiveness and innovative technological dynamism.

Emphasis on interaction is related to the conditions and context in which these companies are inserted, facilitated by the proximity of the agents (Cassiolato et al., 2007). For Malmberg & Maskell (2006), proximity in "localized learning" involves the vertical dimension (resulting from learning by interacting, the relationship between companies of different links in the chain), the horizontal dimension (which allows learning by monitoring through observation and comparison) and the social dimension, of an informal nature through habits and common values.

## 3 Innovation

The systemic vision of innovation is based on the importance of transferring and spreading ideas, skills, knowledge, information and different signals. The channels that allow the circulation of this information are inserted in a social, political, and cultural context heavily oriented toward or limited by the institutional structure (FINEP, 2004; Casagrande, 2004; IPEA, 2006). This approach to innovation causes policies to emphasize interaction between institutions to ensure interactive processes are conducted in the creation, diffusion, and application of knowledge (FINEP, 2004).

The Industrial Survey of Technological Innovation (PINTEC, 2011) defines technological innovation as introducing a technologically new or substantially new product (good or service) into the market or introducing a technologically new or substantially enhanced production process into a company, developed by the company or acquired from another company/institution that developed this process.

According to Cassiolato et al. (2007), studies on innovation as an interactive and endogenous phenomenon of competitive processes inherent

to specific technological regimes also found that innovation does not merely refer to radical changes in products and processes, and acknowledge the importance of incremental and organizational innovations. Learning processes are not restricted to formal research and development activities (R&D); they include processes that acquire many forms and mechanisms increasingly tied to possibilities of interaction between companies and other agents.

Approaches to innovation in Brazilian companies (PINTEC, 2011) also show that R&D is not the only way of creating knowledge nor is it detached from other essential routine or non-routine activities of companies and their strategic and marketing decisions.

Lundvall & Johnson (2000) state that the process of generating innovation and knowledge involves the following: scientific, technological, and organizational training and substantial learning efforts based on individual experience in production process (learning by doing), commercialization and use (learning by using), in the incessant search for new technical solutions in research and development units or in less formal situations (learning by searching); interaction with external sources, such as suppliers of raw materials, components and equipment, customers, users, consultants, partners, universities, research institutes, government laboratories and agencies (learning by interacting); specific interactions for outsourcing inputs, components or products (learning by subcontracting); or even competitor imitation processes (learning by imitation).

Moreover, according to Cassiolato & Lastres (2005), the innovative performance of companies depends on their internal struggle and how they interact and learn with other companies and institutions. This is the basic idea behind industrial clusters since they can promote and facilitate innovation through close relationships between partners and suppliers, facilitate monitoring of competitors in a cluster, enable the high availability and exchange of information, and allow the easy observation of technological trends and shifts in habits and customer needs (Becattini, 1990; Porter, 1999; Mytelka & Farinelli, 2000; Casarotto Filho & Pires, 2001; Suzigan et al., 2001; Carpinetti et al., 2008; Amato, 2009). In particular, this is the crucial role of clusters in the processes of innovation, considered learning by the interacting process (Salom & Albertos, 2006; Maehler et al., 2011; Kim et al., 2014).

Social relationships are the most important channel for the flow of information, facilitated by geographical proximity and the establishment of networks based on trust. In some studies, the most important effect is divulging knowledge acquired in the cluster between the member companies, the so-called "spillover", both horizontally and vertically, as these geographically close members can help the cluster grow through innovation and improvements within the companies (Silva & Hewings, 2010; Thompson, 2002).

The ability to generate innovations is facilitated through the specialization of socioeconomic environments and intensified as they generate interdependence between the various actors, producers, and users of goods, services, and technologies (Cassiolato & Szapiro, 2002; Carpinetti et al., 2007). Consequently, companies in a cluster are able to acquire components and services faster, which facilitate innovation due to the lower cost of experimentation and the reduced financial cost of innovation. However, as pointed out by Porter (2000), innovation can also lead to problems in a cluster in situations where competition between the companies is reduced and when innovations are so radical, they invalidate a part of the cluster or even the entire cluster. In this case, we can cite the case of new products that result in the discontinuation of old products.

## 4 Industry clusters in Brazil

In Brazil, the study of clusters gained momentum in the last few decades due to some successful experiences of productive and business training in this kind of territorial production organization (IPEA, 2006). Furthermore, these localized production structures attracted the increasing attention of public organs and institutions by actions and measures to support the competitiveness of the companies.

In this study, IPEA (2006) used a work comprising the statistical mapping and structural characterization of the clusters to establish four basic types of clusters in 26 Brazilian states. According to this classification, the clusters are categorized according to two variables: the importance of the companies in a cluster for the region (high or low) and the importance of the plants in a cluster for a sector as a whole (high or low). The intersection of the two levels of these two variables generated the four presented classifications. Evidently, there are coincidences with the overall hierarchy of problems and deficiencies in the training of skilled labor and business management; however, there are also indications of different priorities for each type of cluster.

The first type of cluster is important for the local economy and economic sector where its activities are centered. This dual importance of the cluster for its region and business sector makes it a Sector - Regional Development Hub ("NDSR").

The second type of cluster is the opposite to that of the advanced vectors; it is important for the local economy but does not have significant participation in

the main activity to which it is connected. This cluster is essentially classified as a Local Development Vector ("VDL").

The third type of cluster is important for the sector (with total employment participation) and it is diluted in a much larger and more diversified economic fabric, that is, this cluster is important for the sector, but the local or regional economy is not so dependent on it. This type of cluster is considered highly developed because of its significant local resources and can be attributed the term Advanced Vector ("VA").

The fourth type of cluster has little significance for its sector and coexists in the local economy with other economic activities. Based on its structural characteristics and potential, this type of cluster is termed an Embryo (E), and it is the most lacking in actions from public policies.

The results of the analysis conducted by IPEA (2006) are shown in Table 1.

The lumber cluster and object of this study were classified as a Local Development Vector ("VDL"), the term used for clusters considered highly important for their region, that is, for the local economy, but with little importance for their sector (IPEA, 2006; IPARDES, 2005). The VDL cluster must acquire knowledge of its market and commercialization systems, train its workforce, learn about business management and strategic assets, get access to financing, and improve its infrastructure and the supply of technological services (IPEA, 2006).

## 5 Methodological procedures

The research was initially conducted using literature on the study object as the primary and secondary source to direct and guide the investigation, which demanded a theoretical contextualization of the problem based on a literature review of the proposed question.

An exploratory study was conducted to achieve the research objective and the results were used to analyze the relevance of vertical and horizontal relationships and the impact of these relationships on the process of innovation and learning by interacting based on a case study in a lumber industry cluster.

The Industry Cluster Telêmaco Borba is located in the state of Paraná, Brazil. It is specialized and structured for the transformation of wood. The cluster occupies an area of over 200 hectares and consists of approximately 60 companies of the sector that employ around 2000 workers (Silva et al., 2013).

The lumber industry cluster was established from the partnership of a large local pulp and paper company, government organs, and the state industrial association. The lumber industry cluster also triggers the creation of companies, which absorb the local workforce (Silva et al., 2011).

Of the universe of 60 companies, field research included a sample of 36 micro, small, and medium-sized enterprises that transform timber into products with greater or lesser added value. The studied companies were grouped according to their economic business sector, as shown in Table 2.

The sampling technique was non-probability based on availability. When the company operated in more than one sector, in view of the processes that complement each other in some plants and the manufacturing of products included in other sectors, the criterion for classification was the sector with the greatest added value and the highest production percentage for the company.

A methodology was necessary to support the analysis of learning by interacting and innovation processes. The data collection instrument was a questionnaire completed by the researchers. The research model and scale of the questions were created using the theoretical approaches specified in this work.

To display the results and based on the methodology, most questions were arranged in tables to prioritize analysis of the highest and lowest percentages in

**Table 1.** Number of potential industry clusters identified in Brazil.

| Brazilian state | Total clusters | Sector - Regional Development Hub ("NDSR") | Local Development Vector ("VDL") | Advanced Vector ("VA") | Embryo ("E") |
|---|---|---|---|---|---|
| 26 | 762 | 117 | 85 | 376 | 182 |

Source: Consolidated Report (IPEA, 2006).

**Table 2.** Number of enterprises surveyed by economic lumber sector in the industry cluster.

| Economic Lumber Sector | Number of surveyed companies |
|---|---|
| Lumber Sawing and/or Drying | 20 |
| Manufacturing of Laminated Wood and Plywood Sheets | 4 |
| Manufacturing of Various Wood Artifacts | 12 |
| **Total** | **36** |

Source: Based on data from field research.

each question. The adopted criterion was the ordering and discussion of items with the highest and lowest citations frequencies.

## 6 Analysis and discussion of the results

This section provides a description and analysis of the answers of the questionnaires applied to the companies in the lumber industry cluster on vertical relationships with raw material suppliers and providers of goods and services and horizontal relationships between the lumber companies. It also contains an analysis of the impacts of these relationships on the process of innovation and learning by interacting.

### 6.1 Raw material supplier

The production volume of the companies is linked directly with the supply of raw material. It was found that 87.9% of the suppliers are located in the region, and Klabin Florestal is mentioned by the companies as the main supplier of sustainably managed wood certified by the Forest Stewardship Council - FSC. The geographical proximity of the companies in relation to the raw material supplier is considered one of the more favorable aspects for the economy of agglomeration, because it reduces the cost of freight (Amato, 2009).

Some of the lumber companies that depend completely on the supply of Klabin Florestal S.A. are covered by 10-year agreements since they did not have their own planted forest areas at startup. This fact is explained by the lack of capital available for investing in planting; a long-term return investment (15 to 20 years). An interview with the supplier revealed the need for lumber companies to consider forest sustainability to maintain the competitiveness of the industry cluster. This finding denotes the interest of suppliers in participating in forestry incentive programs through the donation of seedlings, forestry management, and technical assistance.

The partnership that exists between the lumber companies is based on a policy of reciprocity, that is, the companies buy wood from Klabin Florestal S.A. and agree to sell the chips and/or waste back to the company to manufacture pulp or generate energy for the boilers.

### 6.2 Suppliers of goods and services

The lumber industry cluster depends on suppliers of inputs, components, machinery, equipment, and implements, as well as providers of transport services, consultancy, training for labor, and research in wood, among others. In addition to providing goods and services, the suppliers interact with the companies. These forms of interactions and/or multilateral cooperation help the companies solve common problems, enhance products and processes, and develop new products. Table 3 shows these forms of interaction.

The forms of interaction and cooperation mentioned by the companies include suggestions of the company owner to the supplier for the improvement and disposition of products, considering environmental aspects and participation in company's internal events, such as the In-House Work Accident Prevention Week ("SIPAT").

These results indicate the importance of this interaction between the cluster companies and suppliers to encourage learning processes and generate innovations in products and production processes, resulting in financial gains for the companies (Johnson & Lundvall, 2000; Maskell, 2001.

### 6.3 Relationships between companies

Table 4 shows that 90% of the respondents have an extraprofessional relationship (friendship and social interaction with informal meetings) with other entrepreneurs, besides a business relationship and informal exchanging of information, often involving new market technologies, credit availability,

**Table 3.** Forms of interaction and/or cooperation of suppliers with companies of the cluster.

| Form of interaction and/or cooperation | Number of mentions | Freq. (%) |
|---|---|---|
| | Yes | Yes |
| Supports/Collaborates with/Provides information to improve and differentiate end products | 26 | 72.2 |
| Offers support/collaboration to solve problems arising from the supplied products/inputs | 27 | 75.0 |
| Requests suggestions on how to improve the final supplied products/inputs | 19 | 52.8 |
| Explains the features of the supplied products/inputs | 31 | 86.1 |
| Invites companies to participate in events such as trade fairs and equipment exhibitions | 29 | 80.6 |
| Organizes trade fairs and events | 12 | 33.3 |
| Others (specify) | 3 | 8.3 |

Source: Based on data from field research.

competitors, quality, and specifications of products, machinery, and equipment.

The formal exchange of information is less significant, while 49% of the respondents replied they address issues such as the technological innovation of machines and equipment, quality and product specification, new products, optimization and price of raw materials, labor, environmental laws, marketing and financial and other issues related to the lumber industry.

On the one hand, if the results reveal easy access to informal information exchange, on the other hand, there are difficulties in transmitting this knowledge. These observations corroborate the suggestions of Lundvall & Johnson (2000), who state that elements rooted in practice and production are easily transferred since they are the property of those who execute them and any barriers can be overcome with the simple interaction between individuals and the organizations.

Trade relationships and the formal exchange of information are still minimal and tend to occur in isolation between companies of the production cluster. In some cases, the relationship arises from social interactions. Of the respondents, 47.2% socially interacted in weekly meetings with entrepreneurs, 30.6% in recreational and sport clubs, 11.1% in cultural activities, and 8.33% in informal meetings in the vicinity, 5.6% in churches, and 5.6% at family gatherings. Along these lines, Breschi & Malerba (2001) state that the social context is important for learning because it allows the sharing of conventions, standards, and codes; however, the use of the resources and capabilities for learning will partly depend on the mode of governance coordinating these interactions.

Considering the results, it appears that there is an exchange of information in the cluster, although it is insufficient to increment more advanced aspects of integration that lead to innovation and competitive advantages for the companies in the cluster. Up to twelve companies of this cluster interact, while the others are more reserved and focus more on competitiveness than cooperation. Porter (1999) states that industry clusters are a clear combination of competition and cooperation, where part of this cooperation is vertical and involves correlated sectors. The author recommends that, in addition to exchanging information, there must be a partnership involving various aspects and stages of business relationships.

Despite the incipient cooperative relationships, the respondents mentioned the possibility of developing collective actions to consolidate the studied cluster. These results reveal points of convergence and divergence in relation to certain types of collective administrative, commercial, and organizational actions, as detailed in Table 5.

**Table 4.** Relationship and exchanging of information between companies of the industry cluster.

| Relationship/Exchange of Information | Frequency (%) |
|---|---|
| | YES |
| Extraprofessional relationship | 95 |
| Business relationship | 98 |
| Informal exchange of information | 98 |
| Formal exchange of information | 49 |

Source: Based on data from field research.

**Table 5.** Forms of cooperation and collective action for the consolidation of the industry cluster.

| Form of cooperation /Collective action | Totally Agree | Partially Agree | Prefer Not to Say | Disagree | Totally disagree |
|---|---|---|---|---|---|
| Recruitment and staff training | 19 (52.8%) | 11 (30.6%) | 0 (0.0%) | 1 (2.8%) | 5 (13.9%) |
| Joint development of new technologies | 14 (38.9%) | 13 (36.1%) | 1 (2.8%) | 5 (13.9%) | 3 (8.3%) |
| Facility sharing | 4 (11.1%) | 8 (22.2%) | 1 (2.8%) | 2 (5.6%) | 21 (58.3%) |
| Shared of product advertising | 17 (47.2%) | 9 (25.0%) | 2 (5.6%) | 0 (0.0%) | 8 (22.2%) |
| Shared new process and product promotion – R&D | 12 (33.3%) | 9 (25.0%) | 3 (8.3%) | 5 (13.9%) | 7 (19.4%) |
| Maintaining a sales office for the foreign market | 15 (41.7%) | 7 (19.4%) | 3 (8.3%) | 1 (2.8%) | 10 (27.8%) |
| Shared purchasing of supplies and raw materials | 12 (33.3%) | 8 (22.2%) | 1 (2.8%) | 5 (13.9%) | 10 (27.8%) |
| **Total** | **93** | **65** | **11** | **19** | **64** |
| **Frequency** | **36.9%** | **25.8%** | **4.4%** | **7.5%** | **25.4%** |

Source: Based on data from field research.

Most respondents addressed the difficulty in obtaining skilled labor in the region for specific functions in the production process.

Moreover, 83.3% (of those who fully agreed or partially agreed) of the respondents believe that recruiting and staff training can be cooperative since it can support the demand of common functions for the economic sectors.

As for the joint development of new technologies, the concordance index was 75% (of those who fully agreed or partially agreed). This form of activity is presumed possible insofar as the technology is designed according to the specific needs of each sector.

The concordance index for collective actions was 62.7%, of which 36.9% fully agreed and 25.8% partially agreed. For this item, the respondents addressed the possibility of improving coordination between the companies to identify problems and create solutions to better consolidate the cluster. This result can be correlated with the conclusions of Schmitz & Nadvi (1999), who stress that competitiveness between companies of a given industry cluster is especially intense, but it does not prevent these competitors from working together to overcome common difficulties.

## 6.4 Innovation process

For most of the companies, innovation is considered important for competitiveness, and 86.1% of the respondents are concerned with product innovation, 100% with process innovation, and 100% in equipment innovation. These results highlight the importance of concentrating companies in an industry cluster, which provides them with a clearer vision of the business factors they need to adapt to the market at a quicker rate than companies working in isolation (Lombardi, 2003). Another issue raised by the author is that a cluster of companies from the same sector in a specific location can cooperate and learn by interacting and consequently increase their capacity to innovate.

The vertical sources of information clusters use to promote innovations, whether in equipment, production processes, or manufactured product, are shown in Table 6.

Visits to other companies in the sector and the exchange of information with customers are the most commonly used sources of information to increase innovations. This interdependence of the companies is identified by Cassiolato & Szapiro (2002) as the ability to generate innovations and as a key factor for the success of companies.

Other sources of information include vertical relationships with suppliers of machinery and equipment and participation in congresses and trade fairs of the sector. The most commonly cited event was the International Fair for Machinery, Equipment, and Products for Extraction and Industrialization of Wood and Furniture (FEMADE) as a major point of convergence for the various segments of the wood industrialization sector. In this line of thought, Breschi & Malerba (2001) claim that these interactions are widely facilitated and enable learning processes through the sharing of common conventions, standards, and codes.

Although innovation is a significant factor for most companies, relationships with universities and technological research centers for the development of new "learning by searching" and "learning by interacting" processes are virtually non-existent in the cluster, which restricts these relationships to a small portion of companies, as shown in Table 7.

**Table 6.** Sources of information for innovation in companies of the industry cluster.

| Source of information | Number of mentions | Frequency (%) |
|---|---|---|
| | Yes | Yes |
| Within the company | 19 | 52.8 |
| Specialized consultancy | 6 | 16.7 |
| Universities and technological research centers | 4 | 11.1 |
| Acquisition of new equipment | 23 | 63.9 |
| Specialized publications | 13 | 36.1 |
| Information exchange with customers | 30 | 83.3 |
| Suppliers of raw material | 15 | 41.7 |
| Suppliers of machinery/equipment | 26 | 72.2 |
| Visits to other companies in the sector | 31 | 86.1 |
| Unions | 2 | 5.6 |
| Conferences and trade fairs of the sector | 24 | 66.7 |
| Others (specify) | 1 | 2.8 |

Source: Based on data from field research.

**Table 7.** Exchange relations of companies of the cluster with universities, research centers, and related institutions.

| Form of interaction | Frequency (%) | | | |
|---|---|---|---|---|
| | Non-existent | Rare | Annual | Monthly |
| Forestry chain-of-custody certification | 63.9 | 0.0 | 36.1 | 0.0 |
| Characterization and selection of raw material | 94.4 | 2.8 | 2.8 | 0.0 |
| New product development | 97.2 | 2.8 | 0.0 | 0.0 |
| New process development | 97.2 | 2.8 | 0.0 | 0.0 |
| Reuse of industrial waste | 97.2 | 2.8 | 0.0 | 0.0 |
| Others (specify) | 92.7 | 7.3 | 0.0 | 0.0 |

Source: Based on data from field research.

Factors that hinder any advancement in this direction include individualistic and reluctance behavior of the entrepreneurs, short-term outlooks, the pursuit of immediate profits, and distrust towards partnerships with institutional actors. Furthermore, the companies in the lumber industry cluster do not invest much in a formal research conducted in the engineering or R&D departments, but they do deal with high levels and reuse of knowledge and routines and replicate routines with substantial collective learning processes. The low innovativeness observed in this study can be complemented with the methodology of the FINEP (2004) since the lumber industry is inserted in the group of companies with low technological intensity and low investments and tendency to innovate, especially in terms of radical disruptive innovations linked to R&D.

Based on the results, the systematic exchange can be considered beneficial for the exchanging of production, technological, and market information, and provides the dynamics for the potential creation of innovative processes for the company. This perception is aligned with the thought of Belussi (2005), who states that the growth of the potential of clusters is related to local know-how accumulation and tacit knowledge not being simply transferable or easy to imitate, that is, it is necessary to intensify learning processes for innovation. The proximity, values, common codes, and cooperation with research centers and universities must be intensified to access the technical and technological knowledge that leads to innovation and stimulates the learning processes.

## 7 Final considerations

The aim of this study was to examine vertical and horizontal relationships and the impact of these relationships on the process of innovation and learning by interacting using a case study in an active industry cluster in Brazil.

To achieve this goal, it was initially necessary to retrieve the main theoretical approaches and confront the data found in the literature. Many data corroborate the theoretical grounding, while others differ from these approaches. This bias was used to summarize the main findings.

The analysis for the raw material suppliers revealed a partnership (vertical interaction) between Klabin Florestal S. A. as the main local supplier of raw material and the buyer of all the waste generated during production in most companies. This partnership refers to a policy of reciprocity and bonds, ensuring profitability for both parties involved.

With regard to suppliers of other goods and services, interaction and/or bilateral cooperation mainly occur through the exchange of information to solve common problems, improve products and/or processes, and develop new products.

It was observed that the relationships between the companies, for the most part, are not systematic and are restricted to isolated actions between companies in the same economic sector. This reality can be correlated with certain contributing factors such as the very nature of sector activities, considered mostly as routine and revisable, easily learned with direct guidance, requiring rudimentary knowledge; and the existence of a large contingent of semi-skilled employees, with which the knowledge transfer between companies becomes minimally effective.

The studied industry cluster provides good job opportunities and generates local income; however, it has not been facilitated the process of cooperation, exchange, and transfer of knowledge between the companies to increment advanced learning by interacting processes. On the contrary, some of the companies were isolated and most interaction was driven by interests in solving common and concrete problems, such as the supply of raw material.

The study of this industry cluster revealed an environment of knowledge with restricted and

passive learning mechanisms. This scenario allows the specialization of labor with a greater orientation toward learning by doing, with substantial learning efforts through experience rather than learning by interacting.

It was observed that the intention to cooperate must be based on an internal need; entrepreneurs must believe joint actions will be more effective than isolated actions and understand that the company decision to act in cooperation entails the willingness to share information and strategic knowledge.

The geographic location of the lumber companies is almost the only favorable point of the economy of agglomeration, especially because of the physical proximity with the supplier of the basic raw material, skilled labor, and systemic and infrastructural factors. These factors can be considered as external economies since they help maintain the competitiveness of the cluster. However, it was also observed that the interaction between the companies is weak and cooperative relationships are isolated and moved by individual interest without the establishment of formal and systematized collective work processes.

The companies in the cluster are concerned with the requirements of innovation for products, processes or equipment, and can, therefore, be considered a cluster with the potential for growth.

The absence of integrated R&D activities in favor of technology was also observed. One of the biggest challenges for companies in the cluster is their capacity to seek new technologies and develop new skills and competencies required for innovation through relationships with universities and technological research centers in order to develop new processes and products of learning by searching and learning by interacting.

The findings presented in this paper reveal the importance of establishing a policy to create spaces inside companies that enable learning by interacting and the development of new skills and competencies for innovation. The actors of the institutional fabric, especially the state and its institutions, must promote actions to consolidate lumber industry clusters and stimulate innovation and learning by interacting. Among the public agents, it was possible to identify those who focus on coordinating policies in the same location and state as the clusters. The public institutions are responsible for implementing and coordinating programs and projects for the industrial activities of the cluster, designing funding and investment programs, and encouraging innovative initiatives. In the second category, universities are responsible for the scientific and technological development, while the role of institutions is to promote local governance, divulge cooperative values among companies and actions to solve specific problems and qualify companies to be competitive.

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