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Learning by network cooperation: knowledge practices in local productive arrangements of software

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Abstract

This paper aims to contribute to the study of knowledge networks in regional clusters, by means of an analysis of the learning process in software small and medium enterprises (SME). The study consists of a multi-case exploratory and qualitative research in three Brazilian local productive arrangements (LPA) in Campinas, Belo Horizonte and Blumenau, involving 14 enterprises and 10 support institutions. The purpose of this analysis was to detach, among other aspects: a) the structure of clusters; b) the main learning sources and; c) the environment of trust necessary to this learning process. Data was collected through semi-structured interviews carried out with the main governance actors of the sector and with the SMEs. The results pointed out to the efficacy of inter-institutional organization through cooperation networks for the management of formal and informal learning processes in knowledge-intensive sectors.

Keywords

Learning. Knowledge. Small and Medium Enterprises (SME). Local Productive Arrangements (LPA). Productive cooperation networks.

1. Introduction

New domestic and international competitiveness standards have been producing a remarkable intensification of competition, challenging companies not only to think through their principles and arrangements in the organization of work, but also to seek new types of organizational structures, strategies and management models, in order to obtain competitive advantages in a less politically and economically protected scenario.

It stands out in this environment, the importance of a new paradigm, which holds in the intangible assets of the economy - such as knowledge, learning and capability - the alternative to achieve competitive advantages for companies. The capabilities of enterprises, regarding production and use of knowledge, have an increasing central role in their competitiveness. One important aspect of capability is the knowledge of tools and techniques for improvement, quality management, among others, that bring efficiency and efficacy to the activities of enterprises.

Several studies have shown that one of the most efficient ways for small and medium-sized enterprises (SME) to adapt and cope with these new demands and forms of competitiveness is through the organization of companies in the so-called local production arrangements (LPA) or local area networks (LAN), which characterize the geographic concentration of enterprises.

The importance and growing necessity of information exchange and learning is even greater when considering enterprises that make intensive use of technology and knowledge, like the software industry, due to the instability inherent to this type of business (STUART, 1998). The quality and improvement of the processes involved in the context of software

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development activity is critical, and nowadays, a fundamental requirement (NOGUEIRA, 2006). The process of software development is accomplished through a joint effort of creation. Its results depend directly on the people, organizations and procedures used in its construction (FUGETTA, 2000).

Software activity is presented as being of strategic importance for the competitiveness development of organizations and countries. In Brazil, there is a concern with the capability and certification of small and medium-sized companies, in view of the large amount of these enterprises in the software activity in the country and the difficulty they present in keeping active and competitive.

Thus, the main concern of the present article is to offer a contribution to the study of knowledge networks in productive agglomerations, through the analysis of the learning process of small and medium-sized software enterprises of interactive processes, so that it is possible to know the way these enterprises seek to increase their capabilities in the improvement of software processes.

The study was carried out in three Brazilian software production arrangements (Campinas – SP, Belo Horizonte – MG and Blumenau – SC), involving 14 enterprises and 10 support bodies and institutions. Such analysis aimed to remark, among other aspects: a) the structure of production arrangements; b) the main learning sources; c) and the necessary confidence environment for such learning.

The methodology used in this study consists of an explanatory and qualitative survey through the study of multicases. For the collection of data, it was used a semi-structured interview directed to the main governance agents of the sector as well as to the small and medium-sized software companies.

2. Local productive arrangements, inter-organizational networks, knowledge and learning

One setting trend in the industrial restructuration process regards the new intra and inter-enterprise relations. The formation and development of business networks and industrial agglomerations have been gaining relevance not only to the economies of several industrialized countries, but also to the so-called emerging economies.

In the literature on productive agglomerations, particularly, there is a consensus between several studies (ENRIGHT, 1998; PORTER, 1998; HUMPHREY; SCHMITZ, 1998; SCHMITZ, 1989, 1992; NADVI; SCHMITZ, 1999; IGLIORI, 2001; AMATO NETO, 2009) that the promotion of joint actions between enterprises and other organizations enhances the collective efficiency gain that the geographic concentration of businesses of the same sector may have. This efficiency gain is due to a combination of external economies (incidental, not planned), such as: existence of specialized labor and holders of specific skills within the local system, presence and attraction of a group of specialized suppliers for raw material, components and services, and dissemination of knowledge, skills and information related to the activities of the local producers (knowledge spillovers); with the economies of deliberate joint actions, such as: purchase of raw material, promotion of training courses for professional formation, creation of specialized consortia, technological centers for collective use, among others.

In fact, since the 1970's, a change in industrial organization has been noticed, with the creation of industrial districts of the so-called *Third Italy,* the local productive systems in France, Germany and the United Kingdom, the Silicon Valley in the USA, or the network of enterprises in Japan (*keiretsu*), Korea (*chaebol*) and Taiwan (*guanxi*). Also, in Latin America, several experiences have come up in the sense of forming productive agglomerations and cooperation networks of small and medium-sized enterprises (SME) (AMATO NETO, 2000).

There is, in the literature, a wide range of approaches regarding the theme. Suzigan et al. (2001) showed a summary of the main conceptual approaches and theoretical perspectives that address the importance of clusters or local production systems.

At first, there is the so-called *New Economic Geography*, whose most important figure is Krugman (1991, 1998). Krugman's approach is based on the pioneer contributions by Marshall, where it is supposed that agglomerations result from cumulative causation prompted by the presence of local external economies. For these authors, the external economies have just an incidental nature and the space structure of the economy is determined by "invisible hand" processes operating centrifugal and centripetal forces.

The second approach focuses on the importance of the *Business Strategies*, whose main author is Porter (1998). This approach emphasizes the importance of external economies geographically restricted, also of incidental nature. Among them, there are the concentrations of highly specialized skills and knowledge, institutions, competitors, linked activities and sophisticated customers. In this respect, the locational strategies are part of the more general strategies defined in the scope of business and they are the market forces that determine the performance of agglomerate producers. Concerning public policies, these authors point that the government shall provide

education, physical infrastructure and competition rules, without, however, acting as an active agent in the promotion of local development.

The third group of authors relate to the *Regional Economy*, among them it stands out the work of Scott (1998), who believes there is a strong connection between *economic geography* and *industrial development*, due to the existence of *incidental forces* and market forces in the formation of dense local systems. It should be noted that one element that distinguishes this approach from the previous ones is the recognition of the *extra-market coordination* importance, as well as of the public policies, which play an essential role in the construction of localized competitive advantages.

The forth current of thought analyzes the matter from the single standpoint of the economic theory (*Economy of Technology and Innovation*), where the most important works are from the authors of the so-called *neo-Schumpeterian* current, such as Audretsch (1998) and Belussi (1999). Under this approach, the geographic proximity of a group of enterprises with universities, R&D centers, research institutes and other specialized agents turns out to be a strategic factor in the process of generation and dissemination of knowledge and information flow relevant to the *cluster* business, also being able to cause the so-called "*knowledge spillover*".

Finally, it is worth citing the approach of *Collective Efficiency*, based, mainly, in the works by Schimitz (1989). This approach, which has the high scope as one of its great virtues, was widely used in several applied studies carried out in Brazil (in this sense, see TIRONI, 2001). Besides the local external economies - incidental or spontaneous, there are also deliberate forces that enhance the competitive capacity of enterprises. These deliberate forces come from cooperation, consciously sought among private agents and in the support of the public sector. The concept of collective efficiency, in this sense, matches the spontaneous effects (or non-planned) with those consciously sought (or planned), and it is defined as a competitive advantage derived from local external economies and joint action (AMATO NETO; GARCIA, 2003).

We shall also consider another essential element in the configuration of a given local production system (cluster), which is, the existence of a set of attributes that reveal the competitive potential of the group of economic agents: social rules, traditions and costumes, which are intrinsic to the community that holds such local production system (*the informal institutions*). The presence of these attributes competes with the existence of a network of relationships – inter-organizational and of institutions, which enables better conditions for the dissemination of knowledge and innovation, thus contributing to the greater collective efficiency of the economic agents and the agglomeration.

On the other hand, joint actions in agglomeration of enterprises depend on the existence of forms of governance or coordination of the site that motivate the maintenance of cooperative relations between agents, motivating the competitiveness of the group of producers (SUZIGAN et al., 2003). In the same vein, Scur and Garcia (2008) highlight that the deliberate actions of integration between the agents and the association of mechanisms of knowledge dissemination constitute key factors for innovation, reaffirming, yet, that clusters or local production systems may become *privileged mechanisms for the conveyance of these cognitive devices.* In other words, such authors emphasize that the local interaction among agents tend to reinforce the exchange of ideas, the generation of collective findings, the sharing of beliefs and values, collective sense-making, common practices, and the spreading of imitable routines (SCUR; GARCIA, 2008).

Confidence and cooperation are aspects that play a central role in the success accomplished by the SME networks. Confidence cannot be intentionally created, but it can be encouraged or generated by adequate structure and context. Confidence in the interrelations of agents is one of the factors that promotes reduction of transaction costs and makes the existence of networks economically viable (EBERS; JARILLO, 1998).

Enterprises' knowledge is shaped through internal learning or capabilities formed with the working environment (*learning by doing, learning by using, learning by searching*, among others), but also through external sources, such as suppliers/users, domestic innovation systems, environment and other enterprises (LUNDVALL, 1992; NELSON; WINTER, 1982; DOSI, 1988; FREEMAN, 1987). Although interactions with internal sources are important, external sources are primarily responsible for the generation of knowledge in member companies of productive agglomerations. External learning is socially determined by interactions, institutional formats and specific space contexts. In their studies on the Italian local systems or industrial districts, Belussi and Sedita (2005) remark the fundamental role of the limit learning process (*learning at the boundaries*), which enables the creation, by local agents, of external ties that greatly contribute to the promotion of endogenous processes of innovation and learning.

From another perspective, Souza and Arica (2006) observe that, besides these different ways of learning,

the set of interactions with multiple internal and external sources of information and knowledge would create a certain *systemic independence*, non-formal, in the productive systems of the respective agents, what could originate the so-called "Innovation Systems" (SOUZA; ARICA, 2006; LUNDVALL, 1992).

Analyzing the role of the National Systems of Innovation as a distinct tool for development promotion in emerging countries, Lundvall (2007) highlights the importance to clearly understand how the central core of the innovation system is embedded in the broader set of institutions that shape the behavior of agents and the relations between them. Such institutions cannot be created without the intense involvement of these agents in the construction of capabilities and the learning process. In this sense, the articulation of local institutions with other regional and national institutions also constitutes a fundamental aspect for the strengthening of local innovation and production systems. Some authors refer to local innovation systems or local production systems as the agglomeration of enterprises where learning and innovation are the main focus. Hence, local production and innovation systems are those arrangements where interdependency, articulation and consistent ties result in interaction, cooperation and learning, with potential to generate the increase of endogenous innovative capacity, competitiveness and local development (SUZIGAN, 1999; SUZIGAN et al., 2001; LASTRES; CASSIOLATO, 2003).

In short, the site is perceived as the designer of a cognitive system that is able to hold these learning processes, in that it mediates not only the geographic proximity, but also the cultural and institutional proximity between individuals, companies and organizations (CAMPOS, 2000).

For the software industry, specifically, learning processes and conversion of knowledge need to be quite effective, due to the prominent characteristic of how fast innovations are introduced and transformed in new products and processes, as well as of how quickly they become obsolete, due to the nature of intense technological and organizational dynamism, what makes it a highly innovative industry (BRESCHI; MALERBA, 1997).

The quality of the software product is strongly determined by the quality of the process used during its development and maintenance (PFLEEGER, 2001). In other words, besides the need to improve the quality of the final product, which results from the development process, organizations need to be increasingly concerned with process improvement, as a way to guarantee the quality of the product itself (SOMMERVILLE, 2003).

Among the models for improvement and capability of processes, the following are noteworthy: *Software Capability Maturity Model* (SW/CMM) by *Software Engineering Institute* (SEI) from *Camegie Mellon University* and *Capability Maturity Model Integration* (CMMI) by the same institution; ISO/IEC 12207 Norm and its amendments; and more recently, MPS. BR, reference model for Process Improvement of Brazilian Software.

Such models provide a measuring scale and a sequential guide for improvement, which are considered necessary to ensure the quality of processes. They define "what" and "how well", but not "how" it must be done, what greatly eases the way such standards can be implemented, what can even affect the results of this implementation (NOGUEIRA, 2006). This means companies have to develop or seek their own ways to accomplish the intended goals. This fact points to the importance of the inter-organizational exchange of knowledge and information.

Thus, the fieldwork analyzed how the learning dynamics occurs in software SMEs for the increase of their capabilities in improving software processes in local production arrangements (LPAs). This made it possible to identify how companies relate to the main external sources of local knowledge – LPAs, how knowledge dissemination occurs, within these networks, with the local governance, and the institutional aspects that influence the processes of learning, generation and dissemination of knowledge.

3. General configurations and dynamics of the software industry

The software industry lies at center of the current techno-economic transformation process of modern societies and it is the core of a new economy based and/or built on knowledge and information. The very process of development of countries has become especially linked to the contribution of new technologies and the way they interact with the changes in the fields of innovation, human resources and industrial redesign. The introduction of these changes is an imperative living condition for both countries, and for enterprises or organizations (TAKAHASHI, 2000).

At the same time, advances in information technology (IT) have enabled the dissemination and access to information at unprecedented speed and scale, making the linkage between industry and science vital for the local, regional and national dynamisms of production structure.

The activity of software development, or the "software industry"* is an integral part of the universe of information technology and it is characterized by very fast technical innovation, particularly by the continuous development of products through a quite peculiar raw material – knowledge, generated and supported in the capability of creative and intellectual labor.

Because of these characteristics, the term "software industry" should be understood as an expansion of the traditional concept of industry – transformer of raw material into production of goods. Although its product comprises a sequence of programming lines, which is named "computer program" or "software", it does not present anything tangible, though it may have some material support (FREIRE, 2002).

One of the main characteristics inherent to this industry refer to how fast innovations are introduced and transformed into new products, as well as to how quickly they become obsolete due to intense technological dynamism. Therefore, any analysis of the competitive dynamics of this industry needs to take into consideration the relevant role played by the introduction and dissemination of innovation.

The organizational dynamics is another characteristic present in this economic activity. Companies need to monitor technological development constantly, creating products and establishing new markets and, to this end, they must be agile and capable of identifying and adapting to these opportunities. These characteristics determine a strong dependence of the enterprises in relation to their human resources (creative and intellectual) – asset that accumulates organizational and technological capabilities (RIBEIRO, 1998).

The dynamism of the software sector is also characterized by a group of young and heterogeneous enterprises, which take part in distinct market structures that lead to diversified behavior and strategies of software development according to the market area. Thus, the competitive factors do not have the same weight in all segments of the software industry, resulting in the necessity to observe the segment where the software is applied for the analysis of such factors. For this reason, the sector lacks more appropriate analyses because of its particular dynamism and segmentation.

Regarding competitive advantage in the software market, it depends primarily on the creation and renovation of the competitive advantages, in a process where each producer strives to have peculiarities that would favorably distinguish them from the others – for instance, lower price and/or cost, better quality, shorter lead-time, greater ability in serving customers, etc. (COUTINHO; FERRAZ, 1993). Such advantages need to be developed and accumulated in companies in a process that requires time and it can be internally obtained or afforded by the institutional environment where the company is inserted.

The industry structure presents concentrated segments next to fragmented ones, with the presence of large corporations with standardized products and production scale established worldwide (Microsoft, Oracle, IBM, and others) that work by exploiting the advantages given by economies of scale, sales & support network, brand recognition, use of marketing, technological capability, financial power, tight relations with users, etc. While there is a growing niche space occupied by a large amount of micro, small and medium-sized companies that work through specialized service to customers, development of products that incorporate specific functions and other spaces left by the leading companies, whose lines of products do not meet all necessities (PONDÉ, 1993).

Particularly, the emergence of micro and small enterprises can be justified by the barriers to the establishment of large companies in these markets, determined by market size, geographic factors, borders, costumes, language and other local, regional and national specificities.

Although there is working space of interest to micro and small enterprises, the dynamics of the industry is given by the leading companies in concentrated market segments that determine the technical standards to be followed by the other enterprises.

Regarding the technological regime of this industry, there is a great variety of potential solutions and approaches, but there are reduced suitability conditions. This shortage is solved by the continuous introduction of innovations by companies through the use of elevated conditions of technological accumulation, which occurs both with the producing enterprises – with the constant improvement of their products, as well as with the users, who, due to the incurred learning costs, have difficulties to migrate to other products. (BRESNAHAN; GREENSTEIN apud NICOLAU; CAMPOS; CÁRIO, 2001).

Therefore, current developments depend on what has already been learned, that is: the essential fact about the software industry is that it produces new products and services that may always be updated,

*The literature discusses whether it is appropriate to classify software production as an industry. Besides the mensuration difficulties arising from the intangible and immaterial nature of software, the definition of the industry's contours itself is a particularly problematic task. The transversality of software along the various production chains causes these activities to be scattered throughout the most diverse economic sectors. The dimension of what can be called a set of software activities is far superior to what is termed software industry (ROSELINO, 2006).

increased or expanded on a certain knowledge basis that, in turn, expands in function of the accumulated knowledge. Thus, the creation of new software, given its technological complexity, demands the knowledge of technical and scientific grounds that rule this complexity. Once these fundamentals are understood, it is possible, from there, to create new products and/or services in a continuous process of knowledge accumulation, which always leads to the development of technologically better software. In this regard, the greater the knowledge accumulation of the software producing company the greater its capacity to innovate (RAUEN, 2006).

The characteristics of the technological regime and the competitive dynamics enable different sizes of enterprises to exploit opportunities in different markets, i.e., there is a situation of relative volatility of market structures in certain segments, as well as the existence of permanent space for new entrants (ROSELINO, 2006).

A quite present characteristic of IT, especially at the international level, is the tendency of this activity to geographically concentrate in complexes, for example, the Silicon Valley in the USA, Dublin in Ireland, Bangalore in India, and others. In these clusters, activities develop supported by the existence of powerful local institutions and the connection with other high-tech activities, markedly the software (DIEGUES JUNIOR, 2004).

Software is a determining link to the competitiveness, productivity and efficiency of most economic activities. This pervasive and/or transversal nature of software gives even more importance to it, to the extent that its omnipresence in the most diverse activities or production chains is the relevant or crucial factor to various sectors of the economy (ROSELINO, 2003).

Another element intrinsic to software, within the paradigm of IT, is that it possesses the necessary basic characteristics for the implementation of systems based on microelectronics, and on the other hand, it is intangible technology, but it has its value determined by how effective computer operations are realized, as well as by the reliable quality of its accomplished results. This way, one can say that software offers the personification of knowledge in products and/or systems in strategic assets (FREIRE, 2002).

Given the relevance of software in strategic assets, the sector has been the primary target of the Brazilian Policies for Industry, Technology and Foreign Trade with software products, processes and services, including through the encouragement of local productive arrangements. This topic will be discussed in more detail further on.

4. Research methodology

The methodology used in this study consists of an exploratory and qualitative research through the analysis of multicases. For data collection, it was used the semi-structured interview directed to the main agents of governance of the sector and to the software SMEs. The data collection techniques used were two semi-structured interview scripts: the first was intended to the governance agents of the clusters (LPAs) and the second to the enterprises belonging to the identical knowledge networks in the selected production arrangements. The script intended to the agents sought to identify, primarily, the efforts for dissemination of knowledge and capability of enterprises for the improvement of software processes. The second script aimed, basically, to discover how enterprises learn new knowledge in terms of the improvement of software quality and processes. Document analysis was another technique used, seeking to identify information concerning how companies learn and disseminate knowledge with the analyzed networks. In addition, documents generated by the specialized press, support bodies and work class associations were studied and websites of the sector were researched.

5. The learning process in the LPAs: a local design

The first arrangement of enterprises studied (Campinas – SP) had its formation and consolidation strictly related to the network of education and research & development institutions, to the R&D centers and to the laboratories locally established which have contributed for the creation and dissemination of scientific knowledge for several years. The mobility of local labor, the formation of qualified professionals, the interaction of research institutions with the productive sector, and the creation of new companies contributed to reach a cumulative process of collective learning that generated specific capabilities and streamlined the innovation capacity of the local enterprises (SUZIGAN et al., 2003). Nevertheless, in recent years, local interactions have decreased quantitatively and the nature of relations has also changed. Enterprises are more concerned with collective interactions that bring commercial gains than with those that bring gains in innovative learning.

The SMEs of this arrangement choose, among the existing information sources, the order "*learning by doing, learning by using"* as the main one for the development of incremental improvement and innovation in software development processes. They

indicate the use of their structural conditions of internal production in order to implement technical changes in process and product. Regarding the use of external sources to expand their capabilities, the enterprises do not exploit the possibilities within the arrangement to intensify the flow of information in the improvement of processes and quality. The arrangement has two important institutions of local coordination directed to the interests of the enterprises for the improvement of software processes and quality, the Regional Agent SOFTEX – an organizing institution of a group of enterprises for the implementation of methodologies in software process improvement. Through resource development agencies and cooperative operation, the implementation costs of methodologies are quite reduced compared to market costs. Also, CenPRA – a body from the Ministry of Science and Technology, which is one of the greatest centers of computer and telecommunication companies in the country and one of the main scientific and technological complexes in Latin America. It gathers capability in the qualification of processes and products in the areas of IT; prototype & product engineering; special R&D projects; computerizing of socioeconomic, environmental and infrastructure systems; and in internet applications. However, the interactions established with these institutions are of minor significance. No collective or cooperative actions of companies that resulted in enriching technical changes of process improvement were demonstrated in the survey. Nevertheless, these enterprises appeal to other sources of information, at costumers' level, from other companies in the arrangement for the exchange of informal information (leisure gatherings in bars, clubs and restaurants) and from the local educational institutions through the hiring of students.

This framework indicates that the companies in the arrangement, besides encountering few important support institutions that develop actions directed to the capacitation of enterprises for the improvement of processes and certifications, present limited demand to the services offered by these institutions. Thus, it was noticed a very low level of relationship between external information sources and the potentiating factor of the creation of local capabilities. This finding indicates the limited nature of the arrangement in creating endogenous conditions of production and interaction for knowledge transference and local learning that result in competitive advantages to the enterprises.

The second software production arrangement (Blumenau-SC) arose in the context of the decline in the activities of CETIL (Electronic Center of the Textile Industry), a great business venture in the area of computer science in 1969. Many professionals started their own companies or migrated to others. Thus, due to the vast accumulation of knowledge and capabilities generated by CETIL and to the low barriers to software activity at the time, new businesses in software were created, originating the cluster of software companies as from the 80's.

Joint actions of the new local entrepreneurs were responsible for the main institutional achievements supporting the sector and for important incentives granted to the industry through local public policies. As part of the response to this mobilization, BLUSOFT was founded – an association of technology enterprises, a result of the articulation of the city business community. This association was, and still is, the main reference of coordination of the local production agents. Since its foundation, it has significantly contributed to the achievements and growth of the cluster. Hence, local interactions were consolidated under the initiative of the local entrepreneurs or their representative organizations.

The joint actions in the cluster are slowly being consolidated. In 2001, the arrangement joined a large project for the mapping of software production bottlenecking with two other centers in the State of Santa Catarina. Geographically close, these three centers, through the collective action of companies' associations, universities, business incubators and funding institutions, developed the so-called PLATIC (Local Production Arrangement of Information Technology and Communication) project. The results of the bottlenecking were determinative in the creation of two centers responsible for improvement in software process (CMMI – for micro, small and medium-sized enterprises) in the region. Five companies in the region took part, cooperatively, in the implementation and evaluation of the program. Within the project, as from 2004, the Blumenau complex created a Center for Quality Assessment of Software Products, beginning to contribute to the improvement of product quality in the local enterprises. The results are still slow, with the predominance of initiatives concentrated in few companies. The concern of companies with the improvement of software processes is recent; part of this concern has been motivated due to a local institutional work with enterprises, but mainly of informal nature.

The MSMEs (micro, small and medium-sized enterprises) of the arrangement still choose, among the existing information, the "*learning by doing*" as the main way of process improvement. The "*learning by interacting*" order is derived from interactions

with costumers, who signal the need for changes or improvement of products or processes.

One of the main bottlenecks of enterprises in software development processes is related to the lack of qualified labor (which can demonstrate a probable diseconomy of the agglomeration). Thus, students from the local higher education institutions have acted as knowledge multipliers on process improvement methodologies. This proves the importance of creating a greater interface with companies and more effective communication channels and codes.

In the field of other information for software development improvement, conferences, seminars, fairs, informal leisure gatherings and meetings promoted by the business association, are mentioned by the enterprises as important learning mechanisms. Participation in fairs and events of the sector corroborates with a cooperative environment among companies.

The knowledge structure of the arrangement is partially built in development phase. Smaller companies still signal to be moving more by the logic of business profitability, with no concern to insert actions directed to make quality process a competitive instrument in the list of strategies.

The third and last arrangement studied, the LPA (Belo Horizonte – MG) also has in its course of development the knowledge spillovers from the great bureaus of data processing services for large companies, which settled in the city in the 50's and 60's. The consolidation of the complex was also closely related to the training of qualified labor, holding one of the first courses in the IT area in Brazil.

Nowadays, the software industry holds the second largest growth in job openings in the region in the past years. There is an estimate of more than 15,000 jobs in the sector (data from Belo Horizonte Prefecture and RAIS/MTE – List of Annual Social Information/ Ministry of Labor, 2004). There are approximately 2,800 enterprises linked to the software industry, with more than 1,300 software development companies, predominantly micro and small-sized businesses. The structure of higher and technical educational institutions in the surroundings is quite dense. There are 24 undergraduate courses offering nearly 3,000 vacancies (in the areas of Information Systems, Systems Analysis and Computer Science with majors in Information Systems and Computer Engineering), with over 2,700 vacancies distributed in Implementing Institutions' technological courses.

MSMEs represent 25% of all certified companies in Brazil. There is intense presence and interaction of enterprises with local support institutions and work class associations. There are several agents articulated and technically involved in a wide cooperation network to promote the local dissemination of knowledge and learning, where quality and improvement of software processes are the main priorities. Services rendered by institutions are based on the identification of necessities of the local companies. Learning through interaction is strongly stimulated by local governance agents. There are various sources of information available and used by enterprises that act as boosters of local capability creation (courses and training in process improvement, fairs, events, participation in meetings, and practicing communities [SPIN – *Software and Systems Process Improvement Network* - Belo Horizonte] for the dissemination of good practices in software process improvement), which enhance the possibilities of learning by imitation (*learning by imitating*), corroborating, this way, with a cooperative environment amongst enterprises.

From 2006 till the end of 2007, 31 enterprises took part in the program MPS.BR (Process Improvement of Brazilian Software), with the participation of 27 cooperative model learning enterprises. The arrangement holds a Capability Center in Quality and Productivity (CCOMP.MG) with the mission to promote the qualification and certification of small and medium-sized IT companies in the State of Minas Gerais (CMM, CMMI and MPS.BR). It has the competence of Implementing Institution (II), Assessment Institution (AI), and Organizing Institution of a Group of Enterprises (OIGE) of the MPS.BR program, what grants it with the status of the only complete agent in processes regarding improvement and quality (involving certification) of software processes in Brazil. Such local initiatives are fundamental to the construction of a pathway of local dynamic capabilities.

In this arrangement, the presence of a greater intensiveness in the capacity building and learning processes is latent. The frequent exchange of information between agents, enterprises and training centers (*learning by interacting*) has been essential to place this arrangement in a development level higher than the other arrangements. One can see the genesis of a more intense process in the capacity building of companies in process quality and improvement that presents greater possibilities of success in a shorter amount of time, unmistakably aided by public policies from the city, state and federal governments.

Chart 1 shows a summary of the main research dimensions analyzed in this work.

Chart 1. Research dimensions and characteristics of the LPAs.

Matters relevant to the research	LPA – Campinas	LPA – Belo Horizonte	LPA - Blumenal
1) Learning mechanisms and processes	Informal *Learning by doing/using, Learning by interaction*	Informal Formal *Learning by doing/using, Learning by interaction*	Informal *Learning by doing/using, Learning by interaction*
2) External sources of knowledge	Costumers Local educational institutions Interaction	Costumers Courses and training in process improvement Fairs, events Participation in practicing communities Cooperative model of business (MPS.BR) Interaction Cooperation	Costumers Conferences Fairs Informal gatherings Meeting promoted by business associations Local educational institutions Interaction Cooperation
3) Knowledge transference/ dissemination processes	Implicit Infrastructure restricted to information exchange Informal horizontal networks	Implicit Explicit Infrastructure open to information exchange Informal horizontal networks	Implicit Infrastructure restricted to information exchange Informal horizontal networks
4) Main governance structure (agents)	Agent SOFTEX Cenpra	Working class associations (producers) Support institutions	Local support institutions(producers)
5) Institutional Framework (*Social Capital*)	Confidence in interpersonal relations	Confidence in interpersonal relations and intergroup cooperation	Confidence in interpersonal relations and intergroup cooperation

6. Final considerations

As in many modern and dynamic sectors of the economy, the software industry presents a clear international separation of the productive activity. Large corporations direct the lower ranked functions of the production process to peripheral countries - Brazil is among them; and focus their efforts and investments in activities of the upper rank with greater value added from the technological and innovative viewpoint, and also privilege the more strategic market segments.

The results of the study confirmed the proposition that the processes of learning through interaction are determining for software SMEs for the building of knowledge and in the creation of innovative capabilities.

Among the various aspects observed throughout this study, we would like to highlight the following:

- Companies' learning may be based on a model of production organization where the location is the aspect of utmost importance for their integration;
- The deliberate joint actions present in agglomerations depend on the existence of certain forms of governance or on the coordination of efforts that motivate the maintenance of cooperative relations between the diverse public and private agents directed to the increase of competitiveness power of the local producers of the arrangement;
- The several forms of relationship inter-companies and/or inter-organizations enhance the learning process through interaction. The real understanding of the dynamics of this phenomenon is directly related to the possibility of knowledge and information transference inside a certain productive agglomeration, decisively contributing with the possibilities of innovation generation;
- The cooperative model of business for enterprises' learning in the specific matters of process quality and improvement, despite having some limitations regarding its broad generalization, it has proven to be efficient concerning the creation of knowledge specificities and the dissemination of local cooperation; and
- In particular, even though there is no intention to defend any of the improvement methodologies of software process, it could be mentioned that the MPS.BR methodology is a relatively successful initiative. Such program has trained and enabled about 3,000 people in this area since July 2004. Moreover, nearly 900 professionals have already been certified to perform the implementation of the model in more than 120 enterprises – 93 in the Cooperate Business Mode.

The present study revealed, among other aspects, that the software industry is a field of study within itself, because of its singularity and its complex configuration. The production structure of this sector is highly heterogeneous and segmented, presenting several functions and varied technological intensities. On the one hand, activities of lower technological intensity can be noticed, such as tests, database maintenance or programming, which involve simpler

and already codified (explicit) knowledge. On the other hand, there are the more complex activities, of higher technological intensity, that generate products of greater value added (intangible), which will demand, in general, more sophisticated knowledge (implicit) and that will also demand closer costumer-user contact.

The present study evinces, furthermore, the importance of an articulated governance structure that can promote and encourage a local knowledge system. An institutional framework is essential for the capacity building of companies and the competitive development of LPAs; this framework shall promote interaction and cooperation, aiming ultimately to create dynamic local competences. Among them, the cooperative learning programs of enterprises in software process improvement and the knowledge networks through practicing communities, and the generation of a motivation for the development of cooperative actions.

In conclusion, we would like to highlight the intrinsic difficulties in synthesizing empirical results, which place limitations to scientific research, especially when facing a large diversity of situations and reduced sampling. This research was more focused on the structural analysis of the production arrangements of software enterprises. New deployments of this work could investigate other aspects related to the theme, such as: a) Analysis of the different forms of interactions between the client companies, b) Comparison and enlargement of the study about the dynamics of knowledge learning and transference inside of a production agglomeration in other localities.

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