Abstract Number: 008 0706

Learning through cooperation and diffusion of the knowledge: a study of SME's networks of software companies in their qualification practices towards quality and the improvement of processes.

Ana Paula dos Reis

Universidade de São Paulo- Departamento de Engenharia de Produção

Av. Prof. Almeida Prado, N. 128, Travessa 2, Sala 229 –CEP05508-900

e-mail: ana.reis@poli.usp.br

Prof. Dr. João Amato Neto

Universidade de São Paulo – Departamento de Engenharia de Produção

Av. Prof. Almeida Prado, N. 128, Travessa 2, Sala 229 –CEP05508-900

e-mail: amato@usp.br

POMS 19th Annual Conference

La Jolla, California, U.S.A.

May 9 to May 12, 2008

SUMMARY

The ability to create and use knowledge to generate innovation in products and processes is a great challenge to all companies, no matter their size. In this context, the development of abilities and qualifications is a crucial factor to attain and sustain competitive advantages. The cooperation through structuralized interactions is an important way to enlarge and to enhance the conditions of insertion in the activity of production. The inter-organizational networks of cooperation have been seen as the new locus of innovation. By using the learning process, they can generate knowledge faster and in a more efficient way. This work analyzes the processes of learning in environments of SME's networks intensive in knowledge. Networks in three productive arrangements of software were studied. The results contribute to the understanding of the dynamics of the processes of formal and informal learning, as well as to the comprehension of the qualifications that support competitive advantages of the SME's intensive in knowledge.

Keywords: knowledge diffusion, processes of learning, social networks, small and medium enterprises, process improvement.

1. Introduction

Fierce competition among companies has grown noticeably as a consequence of new standards of competitiveness locally, regionally and abroad. This has challenged organizations not only to rethink their principles and arrangements on work organization, but also to pursue new types of organizational structures, strategies as well as management models. Such behavior and improvements are necessary in order to survive and obtain competitive

advantages in a present worldwide scenario, which is every time less economic and political protected.

As part of this reality, companies start searching for a more lean and flexible model. It increases even more the necessity of organizations to focus on their core abilities and, in parallel, establish partnerships in order to develop products, services and processes suitable to cope with the continuous changes of the environment and the necessity to generate innovations.

In such environment, it turns to be of a great importance the establishment of new paradigms which has on intangible assets of economy, such as knowledge, learning and qualification, the alternative to promote competitive advantages to the organizations. The qualification processes of the companies, in terms of production and use of knowledge, play more and more a central role on their competitiveness. A key aspect of qualification is the know-how of improvement tools and techniques, and quality management, among others, that can drive companies towards efficiency and effectiveness in their activities.

Several studies have demonstrated that one of the most efficient ways of small and medium enterprises (SME's) adjust and deal with these new demands and competitive forms is through the construction of the so called local productive arrangements (LPA’s) or local networks, which is characterized by the geographic concentration of the companies.

The importance and need of information and knowledge exchange is even greater when it is taken into account companies that make intensive use of technology and knowledge, as the software industry, due to the inherent instability of such businesses (STUART, 1998). The quality and the improvement of the processes involved in the context of the software development activities are critical points and, nowadays, fundamental requirements (NOGUEIRA, 2006). The software development processes are carried out through collective

efforts of creation. Their results highly depend on people, organizations and proceedings that were used on their constructions (FUGETTA, 2000).

Software activities are of a strategic importance for the development of organizations and the competitiveness of countries. In Brazil, actually one of the main concerns is the qualification and certification of SME's, considering the large number of such companies in the Brazilian software industry and the difficulties they face to stay alive and competitive in the market.

Therefore, the main purpose of the present article is to contribute to the studies of knowledge networks in productive agglomerations by analyzing the dynamics of learning in the SME's of software with interactive processes. Through this analysis, this paper also intends to comprehend the way how these companies acquire and enhance qualification concerning the improvement of the software processes.

The study was conducted in three LPA's of the Brazilian software industry with a universe of 14 companies and 10 entities and support institutions. The methodology used in this study consisted in an explored and qualitative research through the study of multi-cases. To collect the data, it was used a semi-structured interview applied to the main governance agents of the sector and to some SME's of software.

2. Local Productive Arrangement, Inter-Organizational Networks, Knowledge and Learning

In literature about productive agglomerations, it is a consensus among several studies (PORTER, 1998; HUMPHREY e SCHMITZ, 1998; NADVI e SCHMITZ, 1999; and others) that the promotion of joint actions among companies increases the potential gain of efficiency that a geographic concentration of companies, from a same sector, can bring. This gain is a

result of a combination of external economies (incidental, not planned, such as the existence of specialized labour bearing specific abilities concerned to the local system; the presence and attraction of specialized suppliers of material, components or services; the dissemination of knowledge, abilities and information related to the activity of the local producers – "spillovers" of know-how), with the economies of deliberated joint actions, such as raw material purchase, promotion of qualification training for professional development, creation of specialized consortiums, technological centers of collective use, among others.

The joint actions in the concentration of companies depend on the existence of types of governances or local coordination that promotes the maintenance of cooperative relations among the agents, thus stimulating the competitiveness of the group of the producers (SUZIGAN et. al, 2003). The combination of adequate structures and a creative and cooperative environment is a fundamental line of direction in the politics of local development. Humphrey and Schmitz (2000) observe that there are forms of local, public and private governances that can have an important role to promote the competitiveness of the agglomerated producers. In the case of public governance, the actions may be coordinated by the public sector, with a special remark to the actions coordinated by the local governments for the assistance and promotion of the agglomerated producers (among those, actions of creation and maintenance of organisms related to the promotion of the development of local human resources such as labor training centers, centers for delivering technological services and governmental agencies of development). In the case of private local governance, it is worthy to mention the role of associations of classes and as well as of the local private agencies for development.

Trust and cooperation are core aspects with central role played in the success achieved by networks of SME's. Trust cannot be intentionally created, but it can be encouraged or

generated from an adequate structure and context. Trust in the inter-relations of the actors is one of the factors that promotes the reduction of transaction costs and makes economically possible the existence of the networks (EBERS e JARILLO, 1998).

The process of gaining knowledge in the companies may occur by the learning or qualification obtained internally, in the workplace environment ("learning by doing" and "learning by using"), or through interactions with external sources ("learning by interaction") – for example suppliers/users, national systems of innovation and other companies (LUNDVALL, 1992; NELSON e WINTER, 1982; DOSI, 1984 and FREEMAN, 1987). Although interactions with internal sources are important, the external sources are the main responsible ones for the generation of knowledge in the companies of a productive agglomeration. The external learning is socially determined by interactions, institutional formats and specific space contexts. In this direction, the physical place becomes to be understood as a builder, promoter of a cognitive system, capable to sustain these processes of learning, once it measures not only the geographic proximity, but also cultural and institutional environment among individuals, firms and organizations (CAMPOS, 2000).

In regard of the software industry, specifically, the learning processes and the conversion of the knowledge have to be highly effective, given the prominent characteristic of the velocity that innovations are introduced and transformed into new products and processes. Similarly, products and processes also become quickly obsolete, given the intense technological and organization dynamisms of this activity. These facts make software industry a highly innovative branch (BRESCHI and MALERBA, 1997).

The main goal of a software company is to produce software with well defined quality standards in the established delivery dates. In the case of the software industry, the quality of

the product is strongly linked with the quality of the processes used during its development and maintenance (PFLEEGER, 2001). In other words, besides the need of quality improvement of the final product, which is resultant of the development processes, the organizations need to care, more and more each time, about the improvement of the processes in order to guarantee the quality of final product (SOMMERVILLE, 2003).

Among other models for quality improvement and assurance of processes, some can be highlighted: the Software Capability Maturity Model (SW/CMM) from the Software Engineering Institute (SEI) of the Carnegie Mellon University, and the Capability Maturity Model Integration (CMMI), from the same institution. In addition, there is the norm ISO/IEC 12207 and its emendations; and more recently the MPS.BR, the reference model for the Improvement of Process of the Brazilian Software.

The models provide a measurement scale and sequential script for improvement. Generally, they recommended practices and proceedings that are seen as necessary to ensure the quality of the processes. They define “what” and “how good” it has to be done, but not “how to do” – which allows a broad, large field for different understandings about the way proceedings have to be implemented, what might even endanger the results of the implementation (NOGUEIRA, 2006). This obligates the companies to develop and/or search proper ways in order to reach the planned objectives. Such a fact reinforces the importance of inter-organizational exchange of information and knowledge.

Thus, a field work was conducted within the scope of a research and analyzed how the dynamics of learning occur in SME’s of software in order to increase their capabilities of improvement of processes in a local productive agglomeration. By this way, it was possible to identify how companies relate with the main external sources of local knowledge (the local productive agglomeration), how is the diffusion of the knowledge inside of these networks,

and how local governance and the institutional aspects influence the processes of learning, generation and diffusion of the knowledge.

3. The Dynamics of Learning in the LPA's

The first local productive arrangement studied (APL Campinas – SP) had its foundation and consolidation narrowly related to the surrounding education and research institutions, to the centers of research and development and to the locally established laboratories that contributed for the creation and diffusion of scientific and technological knowledge during several years. The local mobility of personnel, the qualification of skilled professionals, the interactions of the research institutions with the productive sector as well as the constitution of new companies contributed to culminate in a cumulative process of collective learning that generated specific qualifications and lifted the capacity of innovation of the local companies (SUZIGAN et. al, 2005). However, in the last years the local interactions diminished quantitatively, and the nature of the relations changed. The companies are more concern in common actions that can bring commercial gain than instead of innovative learning.

The SME's of this arrangement have elected, within the existent sources of information, the form "learning by doing" as the main stream for the development of improvements and incremental innovations in the processes of software development. They use their structural conditions of internal productions to implement technical changes in processes and products. Regarding the use of external resources to extend their qualifications, the companies do not explore the existing possibilities in the arrangement to intensify the exchange of information concerning quality and processes improvements. The arrangement includes two important institutions of local coordination that aim to fulfill the interests of the

companies in improvement of software and quality processes: the “Agente Regional SOFTEX” – which is an institution prepared to organize groups of companies to implement methodologies towards the improvement of software processes. (due to resources from agencies of promotion and also the joined operation, the costs of implementation of the methodologies are largely reduced in comparison to the market values); and also the “CenPRA”, an agency of the Ministry of Science and Technology that is one of the biggest centers of telecommunication and computer science companies of the country and one of the main scientific and technological center of Latin America. The CenPRA congregates abilities in the qualification of products and processes concerning information technology, engineering of products and prototypes, special projects of research and development, information systems and database regarding economics, environment, infrastructure and internet applications. However, the interactions established between these two institutions are little significant. It was not evidenced in the research any common action or cooperation between the companies that resulted in technical construction changes or improvements in processes.

Nevertheless, these companies call for other sources of information: customers and the other companies of the arrangement in order to exchange non-formal information (casual meetings in bars, pubs or restaurants). Information may also come by hiring students or trainees from the nearby education institutions.

This picture portraits that the companies of the arrangement demand services from those two important institutions in a very limited volume – despite knowing that there are just a few number of institutions countrywide that support and develop actions directed to the qualification of the companies towards improvements of processes and the attainment of certifications. This study found a low degree of usage of the available external sources of information as potentials to create local qualifications. This observation demonstrate the

limited ability of the arrangement in creating endogenous conditions of production and interaction for the knowledge transference and local learning that could result in competitive advantages for the companies.

The second software productive arrangement that was investigated (Blumenau - SC), arose from the deterioration of the activities of the "CETIL – Centro Eletrônico da Indústria Têxtil", a large business enterprise in the area of computer science, in 1969. Many specialists started their own companies or began working for other ones. Thus, due to the vast accumulation of knowledge and qualifications generated by CETIL and the low barriers of entrance that characterized the activities of software at that time, new software enterprises were created and gave birth to various software companies since the 80's.

The joint activities of the new local entrepreneurs were responsible for the main institutional achievements of the sector, as well as relevant incentives granted to the companies by local governmental politics. As one of the consequences of such mobilization, it was established the "BLUSOFT" – an association of technology companies, a result of the association of the various software entrepreneurs of the city. This association used to be, and still it is, the main reference of coordination of the local productive agents. Since its foundation it has significantly contributed in the attainment of conquests and growth of the agglomeration. In such a way, the local interactions were consolidated and ran under the entrepreneurs' initiatives or their representative agencies.

The joint actions in the arrangement have little by little being consolidated. In 2001, the agglomeration jointed works into a wide project made to identify restrictions (bottle necks) of software projects in the state of Santa Catarina (where the city of Blumenau is located), together with other two software arrangements from other locations. Geographically closed, these three LPA's developed a project named "PLATIC" – Local Productive Arrangement of

Information and Communication Technology; which was constructed from the collective action of the associations of the companies from the arrangements, the universities, the incubators as well as the promotion institutions. The findings of the mapping processes were determinant to create two centers responsible for promoting improvements of software processes in the companies of the region ("CMMI" centers – designed to micro, small and medium enterprises). Five companies of the region acted cooperatively in the implementation and evaluation of proposed programs. Starting in year 2004, being inside of the project scope, Blumenau's arrangement created the so called "Evaluation Nucleus of the Software Products Quality", which started contributing to the improvement of the qualifications of the local companies. The results still are modest, with the predominance of initiatives concentrated in just a few companies, yet promising. The concern of the companies with the issue of software processes improvement is recent, and part of this concern has been motivated due to a local institutional work with the companies, more strongly of informal character than formal.

The micro, small and medium enterprises (MSME's) of the arrangement still choose, among the sources of existing information, the "learning by doing", as the main way of improvement of their processes. Yet, the "learning by interacting" is present as it is derived from interactions with customers who present the need of changes or demand for improvements in products and processes.

One of the main bottle necks of the companies in business of software, found by the research, is the lack of qualified personnel (which can demonstrate a notable non-economy of agglomeration). In order to minimize this effect, the arrangement has asked students from nearby local colleges to learn and divulgate techniques of processes improvements within the companies, performing like multipliers of the concepts. This demonstrates the importance of

creating a wider interface among the companies and developing more effective communication channels.

Concerning other information towards improvements in software processes, conferences, seminaries, exhibitions and fairs, casual and non-formal meetings, and meetings promoted for the enterprise association are highly considered by the companies as important mechanisms of learning. It was seen that participation of personnel in fairs or events of the industry corroborates for a cooperative environment between the firms.

The knowledge structure of the arrangement is partially under a development stage. Smaller companies still seem to be driven more for the logic of the shot-term profitability of the business, without showing great concerns for actions towards the qualification of the processes as a competitive instrument of their policies.

The third arrangement that was studied, the LPA of Belo Horizonte - MG, also has in its development trajectory the spill over of large bureaux of services of data processing for big companies that had been installed in the in the city within the decades of 50 and 60. The consolidation of the agglomeration also is narrowly related to the formation of qualified labor, sheltering one of the first courses in the area of Information Technology in Brazil.

Nowadays, in the region of Belo Horizonte, the software industry is the second largest growth segment in terms of number of employees. It has been estimated more than 15,000 workers (according to the City Hall of Belo Horizonte, based on the RAIS/MTE – Annual Relation of Social Information of the Ministry of the Work and Job of year 2004). They are approximately 2,800 on companies of the sector of software, being more than 1,300 software development companies, predominantly micro and small sizes (SEBRAE, 2006). The structure of higher education and schools for technicians are sufficiently dense. They are 24 courses of higher education with approximately 3,000 vacant (distributed into Information System,

Computation Science, System Analysis, Computation Science with emphasis in Information Systems, and Computation Engineering), being more than 2,700 vacant distributed in 11 technological courses.

The MSME's represent 25% of the total certified software companies in Brazil. There is a great presence and wide interactions of the companies with representative class institutions and local support entities. There is a large presence of articulated agents involved technically in a broad network of cooperation to promote the diffusion of knowledge as well as local learning – where the improvement and the qualification of software processes are part of the main priorities. The services given for the institutions are based on diagnosis of the necessities of the local companies. The learning for interaction is strongly stimulated by the agents of local governance. The sources of available and useful information by the companies are numerous and act as key sources to create and enable local abilities (courses and training concerning improvements of processes, fairs, events, participation in meetings and practical communities [SPIN -Software and Systems Process Improvement Network of Belo Horizonte] for dissemination of best practices in improvement of software processes), that extend the "learning by imitating" corroborating for a cooperative environment among the firms.

From 2006 until the end of 2007, 31 companies took part in the program MPS.BR (Improvement Process of the Brazilian Software), being 27 participant companies of the cooperated model of learning. The arrangement has a Competence Center in Quality and Productivity (CCOMP.MG), with the mission to promote the qualification and certification of the small and medium enterprises of information technology in Minas Gerais (CMM, CMMI and MPS.BR). It has the competence of an Implement Institution (II), Appraiser Institution (AI) and Organizer Institution of Companies' Groups (IOGE) of the Program MPS.BR, which enable it to hold the status of a complete agent, the only one, in the relative processes to the

improvement and quality (involving certification) of software processes in Brazil. Such local initiatives have been fundamental for the construction of a trajectory of local dynamic qualifications.

In the Belo Horizonte arrangement, the presence of an intense increase of learning and qualification processes is latent. The exchange of information among the agents, companies, centers of qualification ("learning by interacting"), combined with "learning by doing" have been an important fact to carry this arrangement to a stage of development superior to the others. It was perceived the genesis of a more intense process of qualification of the companies in qualification and improvement of processes that demonstrate greater possibilities of success in lesser periods of time, assisted by local, state and federal, actions of public policies.

4. Conclusions

The findings of this research corroborate with the thesis that learning processes for interaction are determinant for SME's of software in the construction of knowledge and generation of innovative qualifications.

The learning of the companies can be based in an organization model of the production where the territory arrangement is an aspect of great importance for the integration of the companies.

The present study evidences the importance of a structure of articulated governance that can promote and foment a system of local knowledge. It becomes essential for the qualification of the companies and for the competitive development of an LPA, an institutional structure that drives into the direction of promoting interactions and cooperation, thus creating dynamic local abilities. Among them, it is relevant to mention: the programs of cooperated

learning of companies in improvement of software processes, the networks of knowledge through the communities of practical experiences as well as the stimulation generation of cooperative actions.

REFERENCES

STUART, T. E. (1998). Network positions and propensities to collaborate: an investigation of strategic alliance formation in a high-technology industry. Administrative Science Quaterly, v. 43, n.3, p.668-698, 1998.

FUGETTA, A. (2000). Software Process: A Roadmap. IN: The Future of Software Engineering 2000, Procedings of the 22 International Conference on Software Engineering. p 27-34. Ed. Anthony Fiukelstein – The Association for Computing Machinery (ACM) New York.

PORTER, M. E. (1998). Clusters and the new economics of competition. Harvard Business Review. Boston, EUA, v. 76, n. 6, p. 77-90, november – December.

HUMPHREY, J. & SCHMITZ, H.(1998). Trust and Interfirm Relations in Developing and Transition Economies. Journal of development Studies, vol.34, n.4, pp. 32-61.

NADVI, K. & SCHMITZ, H. (1999). Clustering and Industrialization: Introduction. World Development, vol.27, n.9, p. 1503-1514.

SUZIGAN, W et al. (2003). Sistemas locais de produção: mapeamento, tipologia e sugestões de políticas. Anais do XXXI Encontro Nacional de Economia. Porto Seguro, Ba, 9-12 de dezembro de 2003.

EBERS, M.; JARILLO, J. C. (1998). The construction, forms, and consequences of industry networks. International Studies of Management and Organization, v.27, p.3-21, Winter, 1998.

LUNDVALL, B. A. (1992). Introduction. In: LUNDVALL, B. A. (ed.). National Systems of innovation: towards a theory of innovation and interactive learning. London: Pinter.

NELSON, R.;WINTER, S. (1982). An Evolutionary Theory of Economic Change. Cambridge: The Belknap Press of Harvard University Press.

DOSI, G. (1988). Sources, procedures and microeconomic effects of innovation. Journal of Economic Literature, vol. 26, n.3.

FREEMAN, C. (1987). Technology and Economic Performance: Lessons from Japan. Londres: Pinter Publishers.

CAMPOS, R.R. et. al.(2002). Aprendizagem por interação: pequenas empresas em sistemas produtivos e inovativos locais. UFRJ: RedeSist. (Texto do Projeto Proposição de Políticas para a Promoção de Sistemas Produtivos Locais de Micro, Pequenas e Médias Empresas Brasileiras). Disponível em: http://www.sinal.redesist.ie.ufrj.br/nts.nt33F22_Renato.pdf

BRESCHI, S.; MALERBA, F. (1997). Sectorial innovation systems: technological regimes, schumpeterian dynamics, and spatial boundaries. In : EDQUIST, C. (ed.) Systems of innovation technologies, institutions and organizations. London: Pinter, UK, p.130-156.

PFLEEGER, S. L. (2001). Software Engineering – Theory and Practice. Shari Lawrence Pfleeger. (2nd ed.) Prentice Hall.

SOMMERVILLE, I. (2003). Engenharia de Software. Addison Wesley, 6 edição.

NOGUEIRA, M.O. (2006). Qualidade no setor de software brasileiro: uma avaliação das práticas das organizações. Tese de Doutorado. Universidade Federal do Rio de Janeiro, COOPE.

SUZIGAN, W. et al. (2003). Sistemas locais de produção: mapeamento, tipologia e sugestões de políticas. Anais do XXXI Encontro Nacional de Economia. Porto Seguro, Ba, 9-12 de dezembro de 2003.