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A MODEL TO FOSTER TECHNOLOGICAL DEVELOPMENT, BASED IN THE CASE OF PATO BRANCO CITY

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Abstract: The present paper aims to discuss a framework suggested for technological development and proposes a model that shows the interaction among the various actors involved in the process, emphasizing interorganizational communication aspects. The methodology used has two main scopes: review of related references and conduction of a case study. The perceived result shows the existence of guidelines that integrate the various parts involved in a generation and attraction of knowledge-based enterprise process. This is a closed loop process that involves environment creation, preparation, maturation and consolidation, where the actions performed by the agents contribute to its sustainability and consolidation.

Keywords: Innovation habitat, sustainable development, technopolis, regional development, interorganizational communication

Introduction

The development and production of knowledge intensive products require not only knowledge and technology but also intelligence and creativity. Hence, the necessities of knowledge-based enterprises are different from the ones required by organizations that follow the industrial paradigm.

The industrial production – in this paper the production of Information Technology (IT) systems is also called industrial production – must be optimized, dynamic and must be based on technical and human excellence, ecological principles, and social justice in order to face market oscillations as well as to foster social development and environment protection. Moreover, the production needs to be adapted to the new technological paradigm aiming at the optimization of primary goods utilization, cost reduction and continuous innovation.

In order to face these challenges, quality and productivity are not competitive advantages anymore, innovation is. The enterprise survival and development relies on its ability to create, develop and adapt products, processes and services.

This context implies greater efforts in research and development, what make enterprises – universities – research institutes alliances a good alternative to overcome the obstacles. These alliances accelerate research and development, reducing costs and time to market.

During the 50's a special type of university – enterprise alliance appeared in the USA, and later became to be called technological park (Paladino et al. 1997). This model was adapted to local characteristics and largely used around the world. In these innovation habitats, the integration between universities, research institutes and enterprises is very strong. In this same environment the creation and consolidation of enterprises is highly motivated.

In this way, aiming to identify actions that enhance university – research institute – enterprise alliances the present case study on the technological transformation of Pato Branco region was conducted. Observing these transformations, that were originated by the local government, the present paper aims to discuss a framework suggested for technological development in order to find out theoretical explanation and propose a model that shows the interaction among the various actors involved in the process. The objectives of this research are: give theoretical explanation for the action of each organization that constitutes the innovation habitat; identify and analyze its specific role in the process; characterize the main parts of the whole innovation process, showing how they are related; and, indicate concepts that will support interorganizational communication.

Sustainable Development

Knowledge is and always was essential to foster production, as it is fundamental to all human activities. However, during the two last decades some particular aspects that distinguish the relationship between knowledge, technology, production, and economic development, have been noticed in micro and macro terms.

Some of these aspects (Ferreira et al. 2002) are: time to market of technological innovations; the

new dynamic of economic transactions, access to information and decision process; the fast increase in enterprise investment on research and development; the importance of the intellectual property issues; the importance of public policies that motivate creation and dissemination of knowledge among enterprises.

What the enterprise learns through interaction with other organizations is a key element to make innovation possible. According to Cooke et al. (1997) innovation is considered to be a systemic process with different information flows and directions among multiple actors that understand innovation as an interorganizational process. This shows the close correlation between knowledge and innovation.

The innovation systems are environments full of information and knowledge being transferred among organizations. The intensity and efficiency of these transactions indicate the development degree of the system. Services, networks and interface structures are developed to improve the information and knowledge transference process.

The innovation policy and national innovation system concepts (Lundvall 1992) became the pillars of a large number of governmental initiatives in the developed countries that foster the creation and development of technology based enterprises, knowledge transference between universities, research institutes and enterprises, and the creation of specific programs and stable networks.

According to the analysis of the Brazilian context of investments and development (Theis 2002), it is possible to affirm that worse than low investment rates on R&D is the geographic concentration of these investments, and the fact that they do not follow appropriate development policies. This concentration of C&T resources generates great development differences among regions.

In such cases, in general, “regional advantage will go to those places which can attract and quickly mobilize the best people ("knowledge workers"), resources and capabilities required to turn knowledge into new business ideas and commercial products and processes through innovation" (European Commission 2002).

Information and Technology as Development Inputs

The “New Economy” is based on the possibility of continuous information retrieval and knowledge creation supported by network technology. And the main objective in this scenario is investing in globalized production and distribution, focusing on innovation and technology convergence.

According to Imparato, apud Schenatto et al. (2002) “nowadays the factors that provoke change, technology and globalization, are responsible for innovation becoming a must”. Moreover, the ability of innovating is a competitive advantage based on significant information retrieval, through high technology network systems, and on knowledge creation, that makes entrepreneurial activities profitable. That is to say that competitive intelligence, strategic knowledge and organizational competence are the passwords to access the new economy.

Then, the organizations must reorganize their managing structure. According to Ferreira et al. (2002) the organizational knowledge must be managed in three different levels: operational in each

organization, strategic in each organization and the interaction among organizations.

Considering the interaction among organizations, special attention is given to programs, services and structures that foster economic intelligence, monitoring and prospecting of business environments, knowledge sharing, and creation of technology based enterprises, that are knowledge diffusion elements. Then it is noticed the need for development of specific services and information systems that add value to the information flow among organizations members of the same network.

So that an organization can achieve the above competitive advantage it has to master management of technology innovation techniques. In this paper, management of technology innovation is defined as "the organization and direction of human and economic resources in order to increase knowledge creation; the generation of ideas and techniques that allow radical and incremental innovation" (Roberts 1984).

Schenatto et al. (2002) argue that the development and implementation of new products are consequence of an optimized administration of information in the value chain. Moreover, the organizational performance depends on the relations among the different actors in the value chain, what may constitute a strategic alliance.

Innovation Habitats

The transition from the industrial paradigm to the knowledge paradigm represents a major challenge to the regions and countries. In order to succeed it is necessary to overcome some obstacles, such as: high rates of unemployment; degradation of the environment; disorganized territory occupation; need for preservation of local culture; need for enhancement of the organization, regulation and planning power of the government; improve quality of life of the people (Spolidoro 1997).

Important actions are being undertaken to overcome these obstacles, especially the ones related to the creation of innovation habitats, such as enterprise pre-incubators and incubators, technological parks and technopolis.

Due to the diversity of models that describe innovation habitats it is difficult to have only one definition for each mechanism involved in regional development planning. Moreover, the mechanisms must consider the specificity of the region, such as degree of technological development, ability of the region in mastering its own development, capacity of R&D and innovating. In this paper will be described as agent every organization that provides an innovation habitat or that performs an action that promotes regional development.

Pre-incubator is a structure where the entrepreneur can work out a business idea until it becomes a prototype; the pre-incubator offers services that help the entrepreneur to clearly define the business and make a primary business plan (Pereira et al. 2002).

Incubator "is an organization – private or public – which provides resources that enhance the creation of new small business, and are assumed – directly or indirectly – to support corporate spin-offs, such as new technology-based firms" (Lofsten 2002). Incubator is "a flexible and helpful environment that facilitates the creation and growth of new enterprises" (ANPROTEC 2002).

Technology Parks, according to the UKSPA (United Kingdom Science Parks Association), are organizations that: a) have formal links with universities; b) support the creation and development of technology based enterprises; c) support enterprises located inside its area in terms of management of technology and business (Massey et al. 1992). Nowadays, however, due to information and communication technologies there are also enterprises that are not located inside the technology park but are able to share the services provided. In this paper the concept of a Technology Park is also extended to similar organizations such as: innovation center, research park, science park, industrial park, business park. Technology parks and enterprise incubators have been studied as regional development and industrial competitiveness instruments (Vedovello 2000).

Technology Pole "is an arrangement of organizations with similar objectives that act together in a certain territory" (Spolidoro 1997). The Poles may have distinct characteristics: they can be science-technology poles, or modernization poles – that promote knowledge creation inside universities and research institutes and subsequent technology transfer to enterprises (Medeiros et al. 1992).

Clusters, according to Porter (1998), "are geographic concentrations of interconnected companies and institutions in a particular field". Clusters are critical to competition because they facilitate the organizations access to suppliers, information, technology and complimentary institutions as well as promote interorganizational cooperation and performance measuring. However, clusters also fail and their decadence are due to two main reasons, according to the same author: organizational inflexibility that inhibit productivity and innovation; external events that may neutralize the cluster advantages, such as technology discontinuities.

Technopolis are spaces where research, education and enterprise agents interact under the guidance of education and research organizations. Spolidoro (1997) says "a technopolis is a region which promotes its development and its competitive insertion in the global economy of the Knowledge-based Society through intensive use of science and technology capabilities and innovative approaches in all domains".

The necessary conditions to establish a Technopolis, according to Spolidoro (1997) are: highly educated people; high quality universities and research institutes; territory occupation planning; adequate public policies; market; favorable entrepreneurial conditions; high quality of life; favorable environment for innovating; local initiatives; and new scientific and technological paradigms.

Interorganizational Communication

Considering that innovation habitats exist only through cooperation of various and different organizations it is necessary to develop an efficient interorganizational communication system.

When operating within alliances, the enterprises can relate to each other in various configurations, according to the requirements of the tasks they have to perform. These forms of inter-operability can vary from a centralized characteristic to a loose one (Van der Aalst 2000).

For the present research, the loosely coupled form of inter-operability (Van der Aalst 2000) was chosen to be the most suitable one. In this configuration, the independence of each organization is

preserved, even though they are operating in an alliance, and as a consequence, it may increase the degree of parallelism and the speed of the processes. On the other hand, a good coordination structure has to be provided in order to solve concurrency and other inter-organizational conflicts.

The loosely coupled concept considers that each organization has its own internal management system. Then, the only change that the organization will have to make in order to inter-operate in the alliance is in the interface system.

Thus, although each organization in the alliance may have its own management system, all of them have to agree on communication protocols that allow information transfers. On the other hand, these protocols have to be widely shared, so that switching flexibility is guaranteed (Takeda and Kokuryo 1996).

Specifying a communication protocol involves defining elements, formats, and procedures: elements are words and codes that express specific meanings; formats define the relationships among the elements to form a meaningful message; and procedures are forms of exchanging messages.

One criterion that influences the definition of the protocol is the information richness theory (Daft et al. 1986). A correct media choice must be made by taking into consideration uncertainty and equivocality of information. Uncertainty refers to lack of information, that is to say, as amount of information increases, uncertainty decreases. And equivocality means ambiguity, the existence of multiple and conflicting interpretations about an organizational situation.

Based on these two concepts, a suitable media can be suggested for each organizational situation, which is derived from three main aspects: technology, inter-departmental relations, and the environment.

Concerning technology, two main concepts are defined: task variety, and task analyzability. Task variety, which is related to uncertainty, means the frequency of unexpected and novel events, and task analyzability, related to equivocality, refers to the way that individuals respond to problems.

When interdepartmental relations are taken into account, the departments differentiated characteristics and interdependence must be considered. Equivocality increases with differentiation and uncertainty increases with interdependence.

Considering the influence of the environment leads to two perspectives: the organization's capability of understanding what is happening in the environment, which is related to equivocality; the perception of the environment risk that causes uncertainty.

Besides the richness theory, another factor that influences protocol definition is the availability of time to communicate, which can hinder people from using rich media.

The fact that a protocol has not yet become popular may also affect people's choice as well as personal perceptions of which protocol is better or not.

The list of conditions that influence the definition of the best media to be used increases when inter-organizational aspects are included. According to Takeda et al. (1996), examples of these are firm's resourcefulness, inter-organizational context, and corporate policies.

The use of certain protocols requires resources that may be impossible for the firm to acquire. In other words, the cost of communication channels, internal information systems, and interfaces to

external systems can affect the decision of the firms in employing one medium or another.

In the inter-organizational context, the balance of power affects the choice of the protocol. Usually powerful firms tend to impose their communication systems on their partners.

The strategy adopted by a firm to relate with its partners is fundamental to choosing the protocol to be employed. If a firm wants to lock in customers and suppliers, it will adopt a very specific protocol. On the other hand, if switching flexibility is the most important factor, then widely accepted media will be preferred.

Methodology

The methodology used in this paper has two main scopes: the review of related references and the conduction of a case study that included qualitative research and observation.

Besides the formal references, the main documents analyzed were: “A proposal of the technological park to be installed in Pato Branco”, written in 1997; “Regional development project – Pato Branco Tecnopole”, written in 1998; and “The technopolis guidelines for 2001 to 2004”, elaborated in 2001.

The interviews were semi-structured with open questions. The interviewed persons were the representatives of the organizations directly involved in the technological changes that occurred in the city.

Besides the technological aspect that was considered in the case studied, social, political, economic and territorial aspects were also taken into account. Altogether these are the five pillars that support a technopolis development program: regional development through the new paradigm of the Knowledge Society.

As the focus of the methodology were considered the actual situation, theoretical aspects, and the analysis of the whole system.

The Case of Pato Branco Region

Pato Branco city is located in the southwest region of Paraná State, Brazil; its population is 62.167 inhabitants in 2002. The agriculture is based on small properties (0,2 to 0,5 km^2) that produces mainly soy beans and corn. The economy is based in commerce.

Considering the end of the industrial society paradigm, the willpower of the local politicians and the need for changing the social-economic matrix of the region (agriculture with no value aggregated to the products and commerce of products), the development of competencies in high technology related specially to electronics ant IT was stimulated. This action was considered to be one way to promote sustainable regional development.

One of the primary initiatives in the sense of making the link between professionals graduated at CEFET-PR/Campus of Pato Branco and the market was to stimulate entrepreneurship. These

initiatives included: entrepreneurship as optional subject at first, and as curricular subject afterwards; technological incubators to support prototype development, business plan elaboration and access to the market; and other mechanisms to give support to small enterprises. Meanwhile, medium and large enterprises related to electronics and IT were motivated to set up branches in Pato Branco, characterizing the region as a technological pole.

The process of planning a regional development program for Pato Branco started in 1997, when it was written a project that showed the importance of technology parks in helping developing regions to break the Industrial Society paradigm. The project pointed out the feasibility of implementing not only a technological park in Pato Branco, but also the possibility of transforming the city into a technopolis.

In 1998 the municipal government launched the project "Projeto Regional de Desenvolvimento – Pato Branco Tecnópole", The partners were CEFET-PR/Campus of Pato Branco, SEBRAE (brazilian version of SBA), and many other local organizations. This project defined the objectives and goals for each of the five pillars of a Technopolis (economy, territory, technology, policy and society). These actions converged to the creation of a non-governmental organization called Pato Branco Tecnópole Social Organization, the creation of a regional forum of development and other initiatives that foster regional development.

The Pato Branco Tecnópole guidelines for 2001 to 2004 were established by members of each partner organizations, through discussions that aimed to point out strategies to turn Pato Branco into an innovation center, generating tangible and intangible technological assets. The strategic objectives were directed to: management, organizational image, infrastructure, market and human resources. The actions were grouped according to the five pillars of a Technopolis:

Policy: it was intended to motivate the creation of new leaders, make the society more conscious of its political duties, and establish a social compromise.

Economy: increase the employment rate through the creation of new enterprises and increase the gross product.

Society: focused in culture, health, security and community policies.

Territory: aimed to reorganize urban and rural occupation, through the development of urban and environmental plans.

Technology: the objective was to promote education, research and development through an integrated process.

Technological Assets and their Articulation

The present case study is focused on technological aspects, however, it is considered that these aspects influence and are influenced by all the other five aspects considered in a Technopolis plan.

The project Pato Branco Tecnópole provides the guidelines for the regional development, and it is centered in the technological dimension. In this dimension the main objectives are to create mechanisms that promote technological modernization, creation of technology based enterprises, and development of knowledge intensive products and services.

The data gathered during the case study show that since 1997 the number of new service based enterprises and industries increased and the number of commercial establishments reduced. The most important mechanisms being used to induce the creation of technology based enterprises are:

The Hotel Tecnologico (Technology Hotel), that is a pre-incubator where groups of students, which present feasible business ideas, receive technical support to build prototypes.

A Centro Softex Genesis (Genesis Softex Center) that allows IT emergent enterprises, where the entrepreneurs may not be students, to execute their already refereed business plans and start commercialization.

An accelerator incubator is being created aiming to help IT related enterprises to reach the global market.

As a result of these initiatives Pato Branco became the 4th city in the state considering the number of recently created IT enterprises (Casara 2001).

In order to offer support to already existent technology based enterprises the CETIS (Technological and Industrial Center of Southwest Paraná) was implemented. This technological complex is managed as a condominium that includes LACTEC (Institute of Technology for Development). On September 2000 the OSCIP (Public Interest Civilian Society Organization) Pato Branco Tecnópole was created in order to serve as an integration agent that promotes regional economic and technological development utilizing Information and Communication Technology resources. This organization acts through supportive and articulated mechanisms attracting new investments for the city and fostering the generation of new businesses.

The FAZTIC (Information and Communication Technology Farm) is designed to integrate in the same location many of the technological agents.

Organizations such as OSCIP Pato Branco Tecnópole and FAZTIC are important in sustaining a regional development plan, because they are not government related organizations and tend to survive all elective public administrations.

Analyzing the case study through the theoretical references presented it is possible to design structuring guidelines to promote technological development in any region that wants to do so.

Proposed Model: Structuring Guidelines to technological development promotion

According to Spolidoro et al. (2001) a regional project for the future is a plan that a region stuck in the Industrial Society Paradigm must formulate and implement in order to jump to the new paradigm, the Knowledge Society Paradigm. Such a project must be continuously built-up from bottom to top through structuring initiatives that influence specific parts of the whole project. These initiatives can alter the regional present situation towards the project for the future. They are conceived and executed by regional agents and guided by the Paradigm Transition Theory (Spolidoro 2001), the Knowledge Society characteristics and regional particularities.

The results of this research show that there are some guidelines that integrate and articulate the

various phases of creation, attraction, consolidation and support of a technological development plan. This process grows stronger through the synergy created by the interaction of regional technological resources that are represented by either supportive initiatives (such as incubators, and research laboratories) or complimentary ones (such as specific projects, interorganizational cooperation for commercialization, exportation and market prospecting).

Through the present case study it is possible to build a model to promote sustainable regional development, that considers the five dimensions of a technopolis: policy, technology, society, economy and territory. In this paper the focus is the model to promote technology development (Figure 1).

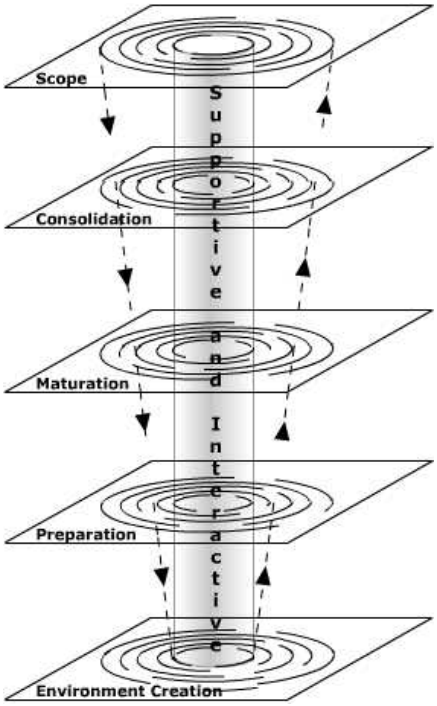

Figure 1 – Model to promote technology development

The axis represents a supportive and interactive structure, that has a network or chain format, with the aim of substituting the innovation linear model that does not satisfy any more the nowadays demand (Vedovello 2000). According to the linear model the innovation process begins with basic research activities, and sequentially evolves to development, production and sales activities, without any interaction among the different steps (OECD 1992). On the other hand, following an interactive innovation model, there are no isolated activities and the information and knowledge exchange is continuous, multidirectional and susceptible to changes that may happen during the process.

The geometrical figures that represent the phases symbolize a moment of creation and maturation, followed by knowledge dissemination.

During the environment creation phase, the development of knowledge intensive products and services is encouraged. The fact that entrepreneurism is part of the regular curricula, shows the importance of educating the students to become professionals aware of their role in society, as well as capable of accessing the market, either being employees or entrepreneurs. This phase is the basis of the whole process, it is when the communication channels are created and the communication protocols are

established.

During the preparation phase ideas, market demands and business plans are transformed into technological services or products. Sometimes, in this phase, it is necessary that the agents articulate solutions for specific market demands, such as, accelerated preparation of high level programmers. On the other hand, the entrepreneurs improve their business plan and develop prototypes. During this phase they also move further; they receive support to enhance their prototypes until the level of product or service ready to the market. Hence, there must be proper environment, equipment and conditions to realize tests concerning advanced technologies.

The consolidation of an enterprise happens during the maturation phase, when the enterprises begin acquiring significant share of its market.

The next phase, consolidation, congregates enterprises that already have significant market share and, also, mechanisms that help the enterprises reaching the global market, through strategies that make their products into competitive knowledge intensive products and services.

In this model, the communication occurs among all agents involved in all phases. It can be among agents in the same phase as well as in different ones, forming an alliance. As they have independent management, all of them must agree on communication protocols that allow information transfers. According to the Interorganizational Communication Section, while building the protocols to be used within the alliance it will be necessary to consider some factors that will serve as guidelines. Those aspects are: the information richness theory; the organizational situation of each agent; availability of time to communicate; acceptance of the protocol within the alliance; organizations' resourcefulness; interorganizational context, and; corporate policies.

Guidelines to implement and maintain an effective inter-organizational communication system in an alliance involving different independent organizations are suggested in Santos (2001). Using that model, the organizations cooperating in the alliance should be able to develop a communication system appropriate to their own requirements and they can also control its performance in order to correct possible deviations. The interorganizational communication model was also constructed based on the case of Pato Branco.

The three dimensional aspect of the surroundings of the presented model shows that it is immerse in a complex context. It is not linear, but it evolves and expands in time and space. Time expansion is due to the increasing synergy among the various participants. Space expansion is an effect of creation of new organizations or the incorporation of new members to the network.

As the model is immerse in a context that takes into consideration social, political, spatial and economic dimensions it can promote sustainable development.

The model follows a market pull approach as it is supposed to satisfy market needs, however the model also implies that a specific market can be created or identified in regions beyond regional frontiers.

Conclusion

The model proposed by this research describes the parts of a process of technological development and how they must interact. The whole process is supported by continuous synergy among local organizations as well as by complimentary actions, such as specific projects, exportation and market prospecting.

The model also shows that the process is responsible for its own regeneration, through the creation or attraction of new organizations and the restructuring of the existent ones.

In order to attain desired synergy among the various actors it is necessary to develop a common communication protocol. This protocol will facilitate the information and knowledge exchange among the organizations directly involved in the process. Hence, it is fundamental to the sustainability of the model.

This model was designed based upon a case study, however it is intended to be used in regions that want to achieve their development through a technological environment.

As future research it is still necessary to study in details the mechanisms that support the integration among the organizations; to describe the operational management mechanisms of the model; and qualify and analyze performance indicators of the process.

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