Tools for Managing Knowledge in SMEs and Laggard Regions

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1. Introduction

The Technological Institutes have attempted to promote the diffusion of innovation and improve the competitiveness of the regional productive system. For our purposes, the following Technological Institutes in the region of Valencia have been chosen: INESCOP (the footwear technological institute), AICE (the ceramics institute), AITEX (textiles) and AIJU (toys).

The central thesis of this paper is that the Technological Institutes, an instrument designed in the seventies based on an interactive interpretation of technological policy and implemented in the eighties, have become less efficient. They have been very useful as an instrument for restructuring local productive systems in the Region of Valencia. But at present they are at a halfway point between traditional instruments based on linear innovation models and what was expected to be an interactive model. This is particularly due to the fact that the institutes have not been capable of stimulating learning processes in local firms nor of promoting organization, support and learning capacity within the organizations that constitute the local innovation systems.

The investigation was carried out through the analysis and interpretation of the following sources of information: secondary information (documents and statistics), primary information through documentary interviews with Technological Institute management and key local actors, the polling of a sample of innovative firms in Valencia, clients of the Technological Institutes, and group discussions with local actors[1].

[1] A methodological note will be supply by the authors upon request.

The paper begins with a theoretical introduction describing the authors's concept of the innovation process within the dynamics of local productive systems. The innovative process in Valencian SMEs is then analyzed with specific emphasis on the local productive system in footwear, ceramics, textiles and toys, sectors whose instruments of technological diffusion have been researched. Special attention is given at this point to the evaluation of the services offered at present by the Technological Institutes and the weak and strong points of this type of instrument are discussed in the light of recent concepts of technological policy. Finally, the report offers some comments on the new generation of industrial development policies.

2. Innovation and the Dinamics of Local Economies

It is generally recognized that economic development of cities, regions and countries comes about as a result of technological progress. Economic growth is the consequence of capital accumulation which, in turn, incorporates technological growth. In the final analysis, it can be stated that economic growth is the accumulation of technology.

Firms introduce innovation into the productive system through investment decisions. Therefore, the content and the effect of innovation depends on the way production is organized, on the strategies used by firms to maintain or increase their output and their market share and on the existence of needed services to introduce technical progress into the productive organizations. When firms are not capable of incorporating innovation, then they must resort to private and/or public external services. Therefore, technological policy plays a strategic role in the processes of economic development.

In recent decades there have been important changes in the way production and regulation of capital are organized (Vázquez-Barquero, 1992 and 1999). The crisis of the fordism has favored the development of flexible organizational structures, at times through the formation or consolidation of local entrepreneurial systems, and at others through more organizational flexibility within large firms. However, these structures have always been strongly rooted and integrated in the territory. Changes in organizational models of production have been accompanied by changes in capital regulation so that the focus of spatial and industrial policies has gradually moved from

centralized policies (top down) to local policy initiatives (bottom up), from linear innovation systems to interactive models (Aheim and Isaksen, 1998).

In reality, the coexistence of diverse organizational production models has led to the presence of policy instruments which try to fulfill the needs of different types of SMEs. A process of transformation that combines rigid centralized policies with more decentralized and flexible forms of regulation can be observed. This combination of instruments is due to the fact that the processes of accumulation and regulation occur progressively and according to firm strategies and institutional changes. For this reason, the successful completion of the process requires time to test, adjust and integrate the new forms. Technological policy is not exempt from the general process of regulation of capital accumulation.

2.1. Innovation, a social process

The evolutionary model, as Freeman (1988) points out, considers that innovation occurs when ideas about products, production methods, marketing or organizational strategies go beyond the point of mere discovery to be implemented within the productive reality.[2] Through investment, firms apply new technological knowledge to the production process and the marketing of their products which allow them to become more efficient. Thus innovation is, primarily, an economic activity since it requires the use of financial resources to obtain better yields and profits.

Since it is the firms themselves who make decisions to invest in new procedures, organization or markets, they are the strategic agents in processes of technological evolution. Nelson and Winter (1974 and 1982) indicate that enterprises are organizations, each with its distinctive characteristics and levels of profitability. In any case, they may be considered the true incubators of innovation. Firms "transport" technologies and all those practices that determine what is produced and how it is produced. That is, they are the carriers of what Nelson and Winter have conceived as "routines". [3]

In an increasingly competitive environment in which firms deploy their strategies in order to preserve market share and improve or maintain profitability, the

[2] Schumpeter (1934) refers to five types of innovation: new products, new processes, new forms of industrial organization, new markets and new sources of raw materials.

process of selecting innovations (and, therefore, firms) depends on market results which identify winning and losing technologies. However, it is not luck alone that makes a technology successful, i.e. adopted by the group of firms competing in a given market; it must be accompanied by improvements in the enterprise itself and its enviroment which are decisive in the struggle to compete with rival innovations.

In turn, the transformation of institutions participating in the process of innovative evolution is complex since there are usually significant repercussions in the social environment. As Pérez (1986) points out, the diffusion of innovation requires that institutions adapt to the new situation and act as facilitators of the technological change. The increased flexibility during adaptation favors technological and structural change and, therefore, economic development.

Innovation is a learning process that takes place as a consequence of productive and entrepreneurial capacities and of those that arise through the use of goods and services produced. Innovation's social and territorial dimensions mean that the increase in knowledge will transcend the individuality of the firms and agents to become a collective learning process. From this perspective one can speak of interactive learning among the actors within the environment in which firms make decisions to invest and locate.

Thus we are dealing with a learning process, rooted in society and the territory, in which knowledge, embedded in capital goods as well as non-embedded, is exchanged. This knowledge is external to the firms and actors but internal to the network and is introduced due to the relations among the actors. In sum, innovative processes would not be of the linear type but rather interactive.

In reality there are few firms that make the decision to incorporate innovations, whether radical or incremental. These are competitive firms, well endowed with quality resources and capable of relating to their environment with an internal organization that facilitates information flow from one department to another.

As held by Smallbone, North and Vickers (1988) and Morgan (1997), size is not necessarily a relative factor, but sector context is. As Dosi (1998) points out, there are great differences in opportunities, incentives, investments in R&D and innovative procedures from one industry to another. Pavit (1984) identified four large groups of manufacturing activities with various behaviors toward innovation: "Supplier-

[3] The concept of routine is analogous to the gene in biology and firms would represent living organisms.

dominated Sectors (agriculture, textiles, ready-wear, leather, printing and publications, wood products and simple metal products); “Specialized Suppliers” (mechanical and instrumental engineering); “Scale-intensive Sectors” (transportation, durable electrical consumer goods, metal products, food products, glass and cement); and “Science-based Sectors” (electronics, most of the organic chemical industries, drugs and bio-engineering).

In most of the productive activities and sectors considered traditional, innovations tend to occur particularly in the productive process where they are embedded in the capital goods and/or in intermediate products outside of the activity. The possibilities that investments in R&D will be made are rather limited. At most, the more competitive firms implement instrumental investments such as slight improvements in the product or in marketing, the introduction of machinery which incorporates innovations or the use of new materials.

On the contrary, radical innovations would involve the incorporation of modern activities linked to new technological paradigms where the possibilities for innovation are high and innovations are truly new to the industry.

The question of the small size of an enterprise seems residual since, as sustained by evolutionary thought, the relevant factor is the ability to compete and the market is the selective mechanism. As Tödtling and Kaufmann (1998) state, this type of enterprise suffers from problems associated with their size and type of activity which make innovation difficult. However, in reality innovative firms may be small since their ability to compete may be the consequence of local productive systems, of participating in a network of subcontracting firms with vertical ties through which technical knowledge is diffused or of having competitive advantages in that they carry out innovative activities within a modern and innovative field.

Innovation, then, is a real challenge for firms competing in the markets (Alfonso 2001). The introduction of new products and/or production methods, changes in the markets and competitor response force firms to react strategically.

2.2. Diffusion of innovation in Local Productive Systems

Firms adopt strategies, in particular technological strategies, in function of the industrial context, that is, the way production is organized within the territory.[4] When firms are part of local productive systems, each and every one of them become more competitive due to the fact that the system of internal relations favors diffusion of innovation in the district. Commercial exchanges and non-economic relations are the mechanisms that favor diffusion of technical knowledge in local productive systems.

A district is a network of firms that contribute to the joint production of a good or a line of related products. When the firms in a network produce differentiated goods and/or specialize in different phases of the productive process, the formation of a system of multiple exchanges is encouraged which, besides creating scale economies in the network, also promotes the diffusion of technical knowledge among the firms. Exchange of information and technological knowledge within a physically limited context will bring about the reduction of transaction costs among enterprises and diffusion of innovations, all of which generate non-commercial external economies.

One of the cohesion mechanisms of the local productive system that Marshall points out when he analyzes industrial districts is that network firms benefit from their location in areas with a specific industrial ambience (Grabher, 1993). Firms can benefit from the exchange of ideas and technical knowledge generated within the network through personal contacts and informal relations that occur in the environment. Also, the existence of a supply of qualified labor for the tasks carried out and the mobility of labor from one firm to another within the district gives rise to the diffusion of tacit non-embedded knowledge by the system of local firms.

Moreover, in the productive systems the network is staunchly inserted in the territory. As Becattini (1997) points out, local firms are the vehicle which facilitates the articulation of productive systems within the structure of social and cultural relations within the district. Through exchange and cooperation, firms incorporate social conditions, culture and the codes of the local population into the productive system. This articulation of the network of firms with institutions and organizations expands the interaction among the agents within the milieu thus facilitating learning processes that, in turn, promote the development of innovation in the district. Multiple exchanges, industrial atmosphere and the system of informal relations are, without a doubt,

[4] Strategy follows organization for which it is possible to extend the foregoing thesis to include the system of relations in the territory and, eventually, the territorial display of the firm's offices and

agglutinating factors within the district. Moreover, as Ottati (1994) points out, mutual knowledge and confidence of the agents in each other strengthens the articulation of the system and reduces transaction costs. Both factors facilitate the introduction and diffusion of innovation within the district (Asheim, 1992 and 1994).

In sum, industrial districts are composed of a system of internal networks that make up the organization of the productive system. Through a multiplicity of internal markets, formal and informal relations are established among firms, suppliers and clients (Becattini, 1997). As Christensen, Phillipsen and Toftild (1998) point out, they are more than a "cluster" of firms since their firms share production, organization and learning routines; that is, they coordinate to produce and to innovate. In addition, interaction among the economic, social and cultural mechanisms generate economies of agglomeration in the localities in which the districts are integrated.

In local productive systems, particularly in those specialized in traditional activities such as textiles, clothing, footwear and wood and metal products, innovative process is limited to the diffusion of capital goods, intermediate products and raw materials of firms from other sectors. Relevant local innovations are not those that occur in organization and marketing, but improvements made in the manufacturing plants by specialized workers constitute incremental innovations.

These incremental innovations refer to those changes and technological adaptations that bring about a progressive improvement in products and processes. Small engineering changes introduced into the productive processes to incorporate available resources more efficiently, and changes in product design and specifications in response to consumer demand express the interaction of production with market and bring about an increase in the firm's productivity and output.

As Freeman and Soete (1997) point out, in recent decades, the importance placed on change in processes and products developed in small laboratories installed within the production plants themselves has increased. Incremental innovations not only respond to market indications but also to production, investment and learning routines in the firms and these are what ultimately determine the ability to compete in the market for most firms (Rosenberg, 1976). Therefore, when one admits that the market plays a strategic role in the selection of innovations, as the theory of endogenous evolution of

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production plants.

innovation proposes, this kind of innovation becomes particularly important since it brings products nearer to market demand and contributes to output.

Development of incremental innovations is based on the ability to learn of enterprises that must face the challenge of competition in the markets and must necessarily provide efficient responses in order to maintain productive activity. Knowledge accumulated as a consequence of continual adaptations and solutions in the manufacturing plant is not to be considered one more expense for the firm, but rather "profit" since it contributes to improvement in efficiency.[5] The diffusion of technology in local productive systems is, without a doubt, a slow but continuous process which usually occurs in a hierarchical way throughout the network of firms in a district. Once the leaders have adopted an innovation in response to production needs or demand, a process of technological diffusion among the firms in the productive system usually emerges through the system of formal and informal relationships described above.

Imitation is also a mechanism of diffusion of innovations among firms in the network and territories in which they are located. The demonstration effect and competitiveness induce firms to adopt innovations in order to maintain or improve their market shares and profits. An important factor in the speed of the diffusion process will be the benefits that new technology or equipment, adaptations in machinery or products or small organizational changes bring to the firm that first adopted the innovation.

Imitation processes in local productive systems transcend the actual dynamics of local enterprises. The productive specialization that characterizes the diverse urban nuclei induces them to act as innovative centers in their area of influence so that, when a process of diffusion is initiated in one of them, it spreads to nearby nuclei. When processes of diversification of the productive activity are initiated or innovations in product, process, marketing or organization occur in, for example, the industrial cities of Alicante studied in this project, territorial diffusion usually operates as described above.

However, organization of production within the territory is a factor that attracts external investment generally from large enterprises (Vázquez-Barquero, 1999a). The "clusters" that form networks of competitive firms capable of generating economies of agglomeration attract firms searching for quality resources and external economies that will help them maintain or improve their share in an ever-more global market.

[5] This merely confirms that technological change is endogenous to enterprise and technological evolution is explained by the need of firms to respond strategically in order to maintain their profitability.

Subcontracting allows large firms to reduce their production costs, benefit from the specialization of suppliers, reduce internal costs and improve their ability to compete. However, this factor introduces new dynamics into local productive systems. Subcontracting involves the exchange of knowledge and know-how between the large firm and the local system of enterprises. This relationship between suppliers and the entrepreneurial group is often stable and its efficiency is only possible through a strong network of information and coordination among the members.

However, only certain territories such as technological or industrial districts have the specific resources and assets available to attract external investment. Firms in technological districts (and the most dynamic metropolitan spaces), where highly qualified human resources are available and new technologies are deployed, maintain a position of power over external firms with whom they eventually cooperate in innovative projects.

Subcontractors forming part of dynamic industrial districts are of interest because they use technologies that make them competitive in the markets. The network of firms in the district guarantee efficiency in subcontracting production and service tasks all of which allow an external enterprise to improve its ability to compete and its position in the markets. In these cases, the conditions necessary to bring about diffusion of innovations between subcontracting and external firms are usually present.

In reality, globalization of productive activity is causing the integration of local productive systems into global productive systems and, vice-versa, global systems into the local productive system.[6] Essential to the question is the compatibility of production, organizational and learning routines and, above all, the power structure and mechanisms of innovational transfer between the local system of firms and the innovative firms that perform in global markets.

2.3. Policy for the diffusion of innovation

We have said that innovation is an interactive process led by firms that decide to invest, but supported by the ensemble of research institutions: Universities, National

[6] However, as Dupuy and Gilly (1997) point out, this is a rather complex phenomenon since it depends, in part, on the position of the local unit in the group organization, the legal and financial relations that tie it to the group, management structure and decision-making and group control procedures. But it is also

Research Council and other Technological Centers and Institutes. Cooperation among firms, universities and public and private institutions conditions the evolution of the process. Actors that carry out technological and scientific activities form the system through which learning processes are generated. They contribute to the development of innovations with more or less efficiency depending on the flow of the relationships and exchanges among them.

This view of the innovation process has brought about significant changes in industrial and spatial policies whose goal is to improve the innovative content of the productive structure. Interest in linear views of innovation[7] has progressively decreased while the appeal of interactive models is on the increase. Interactive models provide technological services to the firms, strengthen the system of relationships among agents and encourage cooperation among entrepreneurs, researchers and teachers (Nauwelaers et al., 1998; Storper and Scott, 1995; Vázquez-Barquero, 1993 and 1998).

Technological policies based on a linear view of innovation are policies of supply. That is, they attempt to overcome problems in the market by providing those investments in knowledge that firms would not spontaneously carry out themselves due to the low benefits expected or the economic risks involved. They adopt a functional, hierarchical (top down) view of knowledge (science, invention, innovation) and of its diffusion through the network of scientific and technological institutions that operate in each country. On the contrary, interactive innovation policies aim to satisfy the needs and demands of innovative firms by providing services to their R&D departments. This type of policies is implemented territorially in the sense that they cater to the demands of local firms through services provided by a network of local agents. It is, therefore, a bottom up policy since it involves the fulfilling of needs from resources within the territory itself.

The goal of policies that take a linear view of innovative processes is, on the one hand, to encourage research and development within firms (normally large, high technology firms that produce technology intensive goods and have R&D laboratories) and, on the other, to facilitate access to knowledge embedded in capital goods

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conditioned by the system of procedures, signs and conventions and the coordinating structure which characterize the local and territorial productive system.

[7] Linear models of innovation hold that scientific advances occur and are transmitted sequentially. They emerge within the institutions and scientific centers and are progressively transferred to the economic sector. On the contrary, interactive models consider that innovation emerges as a consequence of

Interactive policies promote learning and diffusion of codified and non-codified knowledge throughout networks of local firms, basically small firms, and provide technological services to the enterprises which facilitate the introduction of their products into the market.

Linear policies are instrumented through direct technological support to each firm by providing specific public financing through incentives and subsidies of R&D programs and/or the creation of infrastructures. Interactive policies, on the contrary, are implemented through services provided by intermediary organizations on a continuous basis at a price to its clients. Besides supplying the actual technological services (those related to generic or specific technologies of a sector or activity), other complementary but necessary services are supplied such as formation of human resources, information related to equipment and raw materials or market counseling.

Finally, differences in organization and management between the two types of policies must be added to those already mentioned in the area of structure, objectives and implementation. The management of linear policies is centralized through central or regional administration offices that apply the norms governing incentives to innovate. On the contrary, the management of interactive policies is decentralized, implemented by intermediary organizations in charge of rendering services. Both firms (potential clients) and other local actors interested in the initiative participate in these intermediary organizations. One of the objectives of these organizations is that they be self-supporting through the sale of services provided, although public administrations often contribute from their budgets.

3. The Technological Institutes target ed: INESCOP, AICE, AITEX and AIJU

Four Technological Institutes were selected: INESCOP in the footwear industry, AICE in ceramic activities, AITEX in the textile sector and AIJU in toys. As regards territorial considerations, an important element in the Institutes' effectiveness, these four centers are located in the areas of industrial specialization and their principle clients are SMEs located in the same areas.

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interaction between firms and the market through contacts between local and/or regional agents within the network.

Each Institute would basically serve as a support and platform for the achievement of more and better technological levels both in production organization and processes as well as in the innovation and launching of new products. Since this occurred within a clearly defined time frame and space, that is, within an industrial fabric with considerable historical inertia, all technical change in firms would have an effect on the work force employed in each sector and, from there, would reverberate in Valencian society. It was hoped that the historical industrial nuclei would not only persist but also become vehicles for social improvement and welfare by potentiating their technological possibilities.

It was also thought that functional flexibility was crucial to the success of the Technological Institutes in order to avoid the natural tendency toward bureaucratization implicit in all public organizations. Two important policy decisions were made in the hopes of making this flexibility a reality.

First, the governing organisms of the Institutes in charge of designing operational policy are composed of representatives from the firms in each sector. In this way, the Institutes' activities are more likely to reflect the general interests of the sector and a tendency toward bureaucratic positions is avoided.

The second decision made was that the Institutes should tend toward self-funding. As mentioned above, they depended and still depend on the IMPIVA network which, by "birth right" assured them of public funding. This fact could have insolated the Institutes from the market in their funding potential. However, the self-funding aspect of these Centers has always been encouraged both in fact and in their statutes. Efforts in this direction have been relatively successful: at present, the four Technological Institutes studied here are self-funded at an average rate of 60%, corresponding to income received for dues and services rendered, in comparison to an average rate of 15% ten years ago (see table 1).

Both policies described above distinctly contribute to the independence and efficiency of the Technological Institutes in the Valencian Region. The more financial independence, the greater the possibility of designing their own policy in function of the market demand alone.

But, what have the Institutes done to improve their funding in the 15 years of their existence? To answer this question, we have grouped the activities of the four Institutes according to the aggregation of various uniform quantitative indicators in

order to better study the services rendered by the Institutes to the local productive system in the Valencian Region.

Table 1 Budget of Technological Institutes: INESCOP, AICE, AITEX and AIJU; 1986/87 and 1997/98.

TECHNOLOGICAL INSTITUTE	1986/87 millions of pesetas (millions of ecus)	1997/98 millions of pesetas (millions of ecus)
INESCOP's budget	490 millions of pesetas (3,563 millions of ecus)	1.000 millions of pesetas (6,027 millions of ecus)
% National Programmes, MINER and CICYT	52,30%	15,00%
% IMPIVA and Generalitat Valenciana	16,00%	20,00%
% Payment of services and association from firms	22,00%	60,00%
% European Union	-	5,00%
AICE's budget	259 millions of pesetas (1,883 millions of ecus)	400 millions of pesetas (2,411 millions of ecus)
% National Programmes, MINER and CICYT	20,00%	12,50%
% University Jaume I of Castellón	-	10,00%
% IMPIVA and Generalitat Valenciana	55,00%	18,75%
% Payment of services and association from firms	25,00%	55,00%
% European Union	-	3,25%
AITEX's budget	140 millions of pesetas (1,018 millions of ecus)	450 millions of pesetas (2,712 millions of ecus)
% National Programmes, MINER and CICYT	15,00%	-
% IMPIVA and Generalitat Valenciana	76,00%	25,00%
% Payment of services and association from firms	9,00%	65,00%
% European Union	-	10,00%
AIJU's budget	152 millions of pesetas (1,105 millions of ecus)	300 millions of pesetas (1,808 millions of ecus)
% National Programmes, MINER and CICYT	42,76%	17,34%*
% IMPIVA and Generalitat Valenciana	52,63%	26,00%
% Payment of services and association from firms	4,60%	56,66%
% European Union	-	17,34%*

* The % includes funds from National Government and European Union.

Source: Self elaborated from *Memorias del IMPIVA, INESCOP, AITEX, AICE, AIJU* and SMEPOL enterviews.

3.1 The Technological Institutes' model for innovative support

From 1989 to 1996, both firms associated with the Technological Institutes in the Valencian Community and clients of their services increased considerably, as did the number of services rendered by these centers. This situation is also manifest in the four sectors studied (see table 2). However, these figures alone do not fully reflect the diffusion of the Institutes since, one of the characteristics of the sectors studied, is the interaction and interdependence existing among the firms. Thus, final consumer goods producers, as in the footwear, toy or textile sectors, tend to outsource, relying on a large number of firms to execute the various stages of the production process. Obviously, these firms must work together in regard to design, process, quality and requirements of the final producers. As a result, when the Technological Institutes enter into a service relationship with some of these firms, usually the leaders, they establish at least indirect relations with many other firms in the sector.

Table 2 Services provided by Technological Institutes: INESCOP, AICE, AITEX and AIJU, 1996 (number and %)

Technological Institute	Firms Associated	Client firms	Laboratory Testing	Technological Assessment	R&D projets	Training	Information
INESCOP	566 (40,34%)	701 (37,20%)	18.709 (24,25%)	235 (12,38%)	75 (42,13%)	544 (18,18%)	41.793 (91,94%)
AICE	227 (16,17%)	170 (9,02%)	10.592 (13,73%)	1465 (77,18%)	57 (32,00%)	144 (4,81%)	1.515 (3,33%)
AITEX	336 (23,94%)	674 (35,77%)	8.398 (10,88%)	9 (0,47%)	23 (12,92%)	1.568 (52,42%)	7 (0,015%)
AIJU	274 (19,52%)	339 (17,99%)	39.441 (51,12%)	189 (9,95%)	23 (12,92%)	735 (24,57%)	2.139 (4,70%)
TOTAL	**1.403 (100%)**	**1.884 (100%)**	**77.140 (100%)**	**1.898 (100%)**	**178 (100%)**	**2.991 (100%)**	**45.454 (100%)**

Source: Self elaborated from *Memoria del IMPIVA*, 1996.

According to official figures concerning the four Institutes studied, the provision of laboratory testing, student training and information on topics of interest to the sector describe most of the services rendered. Almost all client firms use the Institutes'

laboratories to perform analyses, tests, studies and technical reports. Also, 62% of the firms resort to the Institutes to supply their training demands and more than half request information from these centers on diverse topics related to their sectors. However, technological transfer consulting and participation in R&D projects are less solicited: 22% and 42% respectively.

This implies that the Institutes have mainly emphasized support and diffusion of basic standards among the firms that were outside their reach. Laboratory quality testing is an exogenous service to firms that either was not available to them or the official certificate requested by the firms could only be issued by an accredited Institute. Membership in the European Union is key to the development of testing practice because of EU required quality standards and/or technical barriers implemented by many countries on the continent and the European Commission itself. One may argue as to whether testing practice is important or not, from the point of view of technical change, but we believe that the testing requirement indirectly puts pressure on firms to achieve higher quality standards in their products and, therefore, in their processes.

Information services are mainly requests from firms for information on design and fashion. Again this is essential exogenous assistance, although it is a one-time activity and does not involve long-term interaction between Institutes and firms. This role of "external consultant" could also be applied to the training courses. They are obviously useful and necessary but, by themselves, they cannot justify the creation of a permanent Technological Institute.

This would tend to confirm the observation made above concerning the role of the Institutes in diffusion of technological practices aimed at standardization and organization of labor to insert firms into existing European industrial usage. The consolidation of sectors with solid basic practices, absolutely essential to compete internationally, is the most outstanding service rendered by Valencian Technological Institutes.

According to the literature on technical change, even if the entrepreneurs of the territory simply adapt or imitate technology in use abroad, they will find it necessary to innovate in order to adapt the foreign technology to the specific needs of the imitating environment. It is mainly this type of innovation that the Technological Institutes have promoted and supported throughout their existence.

Technological counseling and R&D projects are, a priori, the two areas in which there is a greater transfer of knowledge from the Institutes to the firms. In general, the results in both areas demonstrate the relative frugality of these contributions in comparison with the rest of the services rendered. Figures corresponding to the various types of services offered by Technological Institutes in the Valencian territory from 1989 to 1996 confirm this statement. The data does not contradict our belief that little attention has been paid to R&D by these centers. Thus, until 1992, there were practically no research projects developed in the Institutes. It is only after 1992 that this type of project begins to appear, gradually increasing to reach 383 in 1996 for all of the Technological Institutes in the IMPIVA network. The distribution of these R&D projects among the four sectors studied here in 1996 is as follows: of 178 projects, 23 each were carried out in AITEX and AIJU, 57 were in AICE and 75 in INESCOP.

Once again we might conclude that the Institutes were not prepared to meet the needs of the firms once they were inserted in the European industrial environment and routine. If there is little insufficient research into innovation, the industrial sector and, in turn, society, is forced to depend on the purchase and/or imitation of foreign technology, particularly from Italy in our case, if they want to follow in the wake of the inventors of new embedded knowledge whether it be in the form of a machine or production organization.

Beyond helping firms to embark on essential innovative projects, the Technological Institutes, within the framework of the EU, would do well to increasingly direct their activities toward joint research programs with firms, perhaps the leading firms in particular, so that the rest of the industrial and labor fabric within the territories studied may indirectly benefit from this research. Therefore, R&D projects should receive priority attention from the Institutes in the immediate future.

There is clearly a tendency toward cooperation between Technological Institutes and the EU as can be seen in the funding they receive. Between 3.2% and 17.3% of the targeted Technological Institutes' budgets is tied to research projects with the EU and, although this income represents rather small percentages, there is no doubt that the research is very important to innovation in the firms involved in these projects. The overall analysis of the four Technological Institutes indicates that the percentage of R&D projects undertaken in these centers has evolved positively since their creation. This fact is manifested in a greater cooperation between Institutes and firms in the field

of technology and innovation and in the growing participation of the Institutes in regional, national and, particularly, European programs. INESCOP and AICE are presently participating in the CRAFT and BRITR-EURAM programs in the area of R&D and technological transfer; AICE and AIJU participate in other European R&D programs such as EUROCERAM II, RECITE II and SPRINT. Also INESCOP is involved in the RTT and IMPACT programs in the area of software and electronics in the footwear sector and in the LIFE program in the area of environment and recycling. In the field of human resource training, AITEX is participating in the ADAPT initiative and in two projects within the European Program for Vocational Training, "Leonardo da Vinci". Likewise, INESCOP is also involved in four projects in the Leonardo da Vinci program and another within the structure of the INNOVATION Program in which AIJU also participates.

This is, without a doubt, one of the directions in which the Technological Institutes should move, evolving toward the joint participation in the creation and diffusion of innovation instead of focusing mainly on consulting tasks.

3.2. Relative specialization of the Institutes

To obtain a more detailed idea of the profiles of each one of the four Technological Institutes studied, specialization ratios were elaborated for each Institute over the total services rendered per client firm between 1986/87 and 1997/98 (see table 3). The analysis of the indicators, along with personal interviews with Institute directors and polls in the firms have allowed us to describe the following basic profiles for each of the Institutes.

Table 3 Specialization Ratios of Technological Institutes targeted.

Technological Institute	Number Of Client firms*		Technological Assessment / Client firms		R&D Projets/ Client firms		Training / Client firms		Laboratory Testing / Client firms		Informations / Client firms	
Years	*86/87*	*97/98*	*86/87*	*97/98*	*86/87*	*97/98*	*86/87*	*97/98*	*86/87*	*97/98*	*86/87*	*97/98*
INESCOP	**381**	**701**	**0,23**	**0,33**	**0,02**	**0,06**	**1,04**	**0,77**	**19,68**	**26,68**	**5,77**	**59,61**
AITEX	**230**	**674**	**0,02**	**0,01**	**0,01**	**0,01**	**0,17**	**2,32**	**8,69**	**12,45**	**3,47**	**0,01**
AICE	**172**	**170**	**1,45**	**8,61**	**0,03**	**0,22**	**2,15**	**0,84**	**34,88**	**62,30**	**4,06**	**8,91**
AIJU	**80**	**339**	**0,22**	**0,55**	**0,05**	**0,07**	**0,86**	**2,16**	**62,5**	**116,34**	**1,25**	**6,30**

* The number of Client firms is the group of firms that use one or more services provided by each Technological Institute.
Source: Self elaborated from *Memorias del IMPIVA, INESCOP, AITEX, AICE, AIJU* and SMEPOL enterviews.

AICE focuses its activity on R&D projects and technological consulting or transfer, both of which are undertaken in cooperation with the most innovative firms in the sector and within regional, national and EU programs. At present, these activities are aimed at improving productive process and the creation of new ceramic products in the sub-sectors of frits, glazes and colors and ceramic floor tiles. AICE shows a relative specialization ratio of 8,61 in the rendering of technological consulting services, much higher than the other Institutes. AICE also has a comparative advantage in the rendering of services aimed at launching R&D projects per client firm, with a ratio of 0,22, also the highest graph in the Institutes targeted. However, the importance of these R&D projects is not in quantity of research but in quality as regards greater technological content since less client firms in the ceramics sector participate in R&D projects with the Institute than the rest of the sectors studied.

We have stated that R&D projects and technical consulting are the most significant services provided by the Institutes to promote innovation. If this is true, it can be said that AICE is the organization that provided services with the highest technological content to firms. On the other hand, ceramics firms tend to demand this type of services more often, through joint research projects. One must remember that AICE has close ties to the university and maintains a determined research policy within the sector.

AITEX has focused on human resource training and the elaboration of multimedia training products. It tends to use the training courses as a platform for technological transfer and knowledge transmission. This Institute provides an extensive gamut of courses to firms in the textile industry, most specialized in computer and business applications based on knowledge collected from R&D projects in new computer technologies, software and CAD/CAM in the sector. Thus AITEX reflects a relative specialization in services related to training with a ratio per client firm of 2,32, the highest of the four Institutes.

AIJU, however, is the Institute with the highest percentage of client firms using training services. Therefore, one of the strengths of AIJU is the training provided to client firms in the toy sector: 80% of the firms state that they use these services. Moreover, AIJU shows a ratio of 2,16 for 1997/98, similar to that of the textile sector. AIJU is clearly specialized in providing laboratory testing to firms. The ratio per client gives us 116,34, much more than in the rest of the Institutes and more than 95% of the

firms do testing and analysis at AIJU. The frequent use of laboratory testing reflects the need to comply with requirements related to the population that will consume these products, both in regard to materials and to elaboration. Standards are exhaustive and exist for all of the firms, which will force those firms that don't have their own laboratories to use those of the Technological Institutes. Also, certification of these products requires various official reports in order to receive official accreditation which they cannot obtain by themselves.

Finally, INESCOP has increasingly specialized in providing information services to the footwear industry: in 1996, INESCOP attended to 41.793 requests, 39,59 more than in 1986/87 (see table 2). Information services, then, would seem to be the specialty of this Institute with a ratio of 59,61 per client, far higher than in the rest of the Institutes. The demand for information on the part of footwear firms is confirmed when we observe the data obtained: 65% of client firms use these services while the overall average for the four sectors is 53%.

3.3. Effects of services offered by the Technological Institutes on the diffusion of innovation

Approximately 58% of the firms indicate that services provided by the Technological Institutes have helped them innovate. Nevertheless, each Institute showed significant differences as to the kinds of innovations encouraged. Promotion of innovation was particularly high in the case of AICE, both in creation of new products (57% of the firms) and in improvement of existing products (35,7%). In the footwear and toy sectors, services provided have had a less positive influence on the introduction of product innovations (23,5% of the firms in INESCOP and 30% in AIJU). This fact is due to the high degree of imitation present in these sectors and to the distrust felt by some of the producers as to sharing their most innovative activities. AITEX (the textile Institute) has promoted the introduction of new processes (19% of the firms) and the improvement of existing products (4,8%) less, mainly due to dependence on European machinery suppliers and the deficient capacity of the local economy to develop their own prototypes.

The services provided by the Technological Institutes studied here have contributed to improvement of three essential variables related to innovative capacity of

SMEs: product quality, level of skills of the work force and competitiveness. In the case of AICE, their services have also facilitated the modernization of the productive process, improvement in productivity and the diversification of production in firms of the ceramics sector. In textiles, the use of AITEX's services has facilitated modernization of the productive process, an increase in sales and greater access to foreign markets. In the toy sector, AIJU's services have influenced sales positively and in the footwear sector, firms cooperate more efficiently thanks to the services of INESCOP.

Diffusion of knowledge and innovations between the Technological Institutes and their client firms is determined by the integration of these centers in the productive and social fabric through proximity and the frequency of contacts between firms and technicians from the Institutes. The Institutes' strong points, then, are their nearness to the firms, their connections to other international centers of this type and the knowledge transferred to the firms through them. The considerable increase in the number of services contracted by the firms and in the demand for these services since the Institutes' creation in the 80s are proof of their integration in the territory of the Valencian region and their close ties to the local economy.

The diffusion of innovation is affected by the way production is organized in the sectors and in the region and by the kind of firms targeted by the Institutes. The SMEs that form local productive systems are inserted in a latticework of horizontal and vertical relations in which knowledge transmitted through the Technological Institutes' services and projects eventually impregnates the entire local economy through exchanges among final consumer goods producers, auxiliary producers and marketing agents. Thus, Institute policy and their orientation toward a given type of firms or stages in the value chain plays a crucial role when promoting the diffusion of knowledge and innovations within the productive system.

In general, the great majority of client firms can now be characterized as "adapting SMEs" whereas in the past they were imitators. The Institutes have facilitated this qualitative change in the innovative capacity of the firms in the region's local productive systems. Only a small percentage of local firms are capable of creating technologies and these firms can be considered leaders (about 10% of the textile, footwear and toy sectors and about 13% in the ceramics industry). The Institutes usually prefer to develop their most important projects with these enterprises, the most dynamic

in their milieu. A good deal of the diffusion of innovation takes place through the leading firms by way of the Technological Institutes, market relations or imitation.

This general tendency is particularly clear in the ceramics sector where AICE usually collaborates with the largest firms within the group of SMEs that show a greater innovative capacity, whether they are producers of final goods or of frits and glazes, and it is these firms that become the main diffusers of innovation. In the case of the footwear sector, however, the opposite tendency can be observed: INESCOP seems to orient its services toward smaller enterprises (less than 50 employees) and gives equal attention to firms in the various stages of the value chain as well as to final goods producers. The diffusion of innovation through this Technological Institute seems to occur through the funding of small R&D projects whose results are diffused in the local economy through a network of relations existing among the agents participating in the value chain.

The Technological Institutes show a high degree of effectivity in adapting to innovation support needs as expressed by the entrepreneurs of the SMEs in the four sectors studied. Eighty-two percent of them point out that the services offered by the Institutes adapted to their specific innovation needs. Here, the toy sector stands out with respect to AIJU (86,7%) as well as the ceramics sector as regards AICE (85,7%). In general, the ensemble of services rendered by the Institutes adapt to the firms' expectations (in 87,7% of the cases). Only in the ceramics sector can lower satisfaction be observed (71,4%) due mainly to the greater dynamism of the sector and the technological transformations undergone in the last two decades. These factors lead ceramics firms to demand advanced services from the Institute more often than those of other sectors.

4. Final Comments

A decrease in funding by public administrations has required the Technological Institutes to adopt an entrepreneurial attitude toward their activities by not only considering the effectiveness of their policies but also their efficiency. There are organizations and entities in the market offering the same services as the Institutes which causes competition in prices, quality and other aspects that may be evaluated by the firms. Although the Technological Institutes concentrate their provision of services

in the Valencian Region, in the last three years, they have had to search for new markets in the rest of Spain, and in some cases, abroad. Likewise, the Institutes have had to work not only with SMEs but also with larger firms. Nevertheless, most of their clients are SMEs located in the same specialized areas as the Technological Institutes.

Opinion as regards the Institutes is positive in all four cases, although entrepreneurs state that these centers should change and improve in some aspects. In general, firms seems to demand some new services which would better adapt to their needs and the modernization of existing services. Their main demand is for manufacturing of machinery, R&D projects, research consulting services on productive machinery and processes as well as more advanced services such as marketing and internationalization. Moreover, specific needs have been detected depending on the sector.

The services provided by the Technological Institutes studied here are focused on technological aspects related to innovation in products and production processes, while only marginally dealing with marketing and organizational aspects. Likewise, they do not offer services already in the market such as labor, financial, accounting or fiscal services. Normally, the Institutes systematically drop those services that are being provided in the private sector.

During the second half of the 80s, the Technological Institutes directed their activities at making firms aware of the need to achieve uniformity and quality control in production and at creating a "quality image" of the services offered due to the fact that entrepreneurs in the local productive systems were not accustomed to using this kind of support organisms. Firms are now used to working with the Institutes to the point that these centers are completely integrated into the local economy and even prevail as service providers in the local market. Nevertheless, in the case of AIJU and INESCOP, communication with local entrepreneurs is still causing some problems as there are entrepreneurs in both areas who do not use these services. AITEX has also encountered some difficulties in this respect due to the fact that not all of their services are known to the firms. In an attempt to remedy this problem, AITEX is marketing services in packages or groups.

Again, it is important to emphasize that local entrepreneurs belong to the "Consejo Rector", the governing body of the Technological Institutes, so that they participate in the design of activities and policies. Firms in the region are aware of the

local productive systems' needs and of the latest advances in their sectors. The Technological Institutes are aware that lack of financing for innovation is not now a significant problem for firms in the sectors targeted for study as it was in the 80s, although financial arrangements will, of course, affect their balance statements. The Institutes' management are convinced that the main problem in the footwear, textile and toy sectors is a shortage of skilled personnel. In these three sectors, the work force is very specialized in specific industrial activities but the academic level of qualification is low, that is, there is a lack of advanced technical knowledge. The only exception is the ceramics industry where human resource qualification has improved considerably due to activities provided jointly by AICE and the University Jaume I in Castellón.[8] Therefore, possible deficiencies in human resource training in the ceramics sector seem to have been overcome and the principle difficulties of the firms are related to product marketing and employees specialized in marketing, although this is a problem in all four sectors.

Initially, in the footwear, textile and toy Institutes quality was the crucial concern leading to innovation. However, design and adaptation of technologies from other sectors are now the motivators of innovative process. It is for this reason that firms require support in adopting and adapting technologies; services aimed at this task should not be limited to testing and laboratory reports. INESCOP is providing specialized training, industrial design and fashion, development of new technologies, technical consulting, support for the incorporation of information technologies, technological support and R&D concerns. AITEX provides specialized training in the sector, software training products and R&D in its installations. AIJU does research, training, computer applications, product development and quality systems.

Finally, AICE, as said before, presents a special case since the qualification of human resources and the technological level achieved by firms in the ceramics sector is higher than in the other sectors studied. Innovation processes are focused on improvement and change in capital goods and design. The Institute's activities have accompanied this process so that, at present, they provide very qualified training as well as high level technological consulting and R&D projects.

[8] At present, AICE is linked to the university through the University Institute of Technical Chemistry which offers specialized courses in aspects of the ceramics industry. AICE also participates in Vocational Training in this industry.

Finally, the most important problems encountered by the Institutes are in two areas. On the one hand, they are aware that often their services are not rendered fast enough and that they need to respond to demands more promptly, particularly in INESCOP and AITEX. Besides the bureaucratic difficulties typical of the administration of organisms of this kind, these problems are clearly a result of a growing demand for services supporting innovation on the part of local SMEs. Not only is this demand for an increasing quantity of services but also for more quality in the services and constant up-dating on the latest technological contributions in national and international markets.

On the other hand, managers of the Technological Institutes consider that budget cuts on the part of the Administration and, consequently, the decrease in public funding forces them to manage the Institutes as if they were private firms. This, they feel, limits their possibilities to focus on technological transfer and R&D activities which are still behind European levels. Nevertheless, if the Technological Institutes are able to respond to an increasing entrepreneurial demand for quantity and quality, they could be self-financing which would go hand in hand with the development of their own research. If the Institutes do not adapt to the new demands of the firms, their funding will continue to depend on decreasing public financing and their role as an instrument of support to innovation will tend to be more and more insignificant.

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