

Center of Technological Development for Industrial Maintenance: A Model of Operation for its Creation

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Abstract: The fundamental purpose of the present investigation was to present a functioning model of technological development center that serves as a support to boost the processes of science, technology and innovation in the companies that offer the different services of industrial maintenance in the city of Cartagena and that currently participate in the project of the conformation of the cluster “Competitive Maintenance”. Regarding the techniques and instruments for the collection of information, they were mainly based on the tracking of databases and web pages of technological development centers recognized by Colciencias as well as of works carried out in other countries that contained related topics with operating models. With the creation of CEMANTI, Cartagena de Indias, it would be the first city in Colombia to have an institution that offers technological services, especially, to this type of company which would become a point in favor of the economic development of the city.

Key words: Innovation management, business cluster, competitiveness, industrial maintenance, operating model, Colombia

INTRODUCTION

With the phenomenon of globalization of markets, all organizations in the world have been forced to seek strategies to enhance their knowledge absorption capacities and therefore be at the forefront in the face of the great challenges that present themselves (Marrungo *et al.*, 2018). After day, this is the reason why many companies currently invest large amounts of money in R&D&I activities which provide differentiating factors to be competent in national and international markets (Bedoya *et al.*, 2017).

In this context, it is vitally important that there is a need to create alliances with intermediary institutions that carry out innovation activities and produce new scientific and technological knowledge (research centers, universities, technological development centers and other entities) as well as agents of a governmental nature (Marrungo *et al.*, 2017). From this interaction, the so-called innovation ecosystems that relate science and technology to social and economic growth in a region originate as underpinned by the triple helix model proposed by Etzkowitz and Leydesdorf, cited in Manjarres, (Henriquirz *et al.*, 2013) In Colombia, one of the strategies that the state has implemented in support

with the Administrative Department of Science, Technology and Innovation (Colciencias) to increase the participation of the productive sectors in the international markets and competitive and technological capacity is the strengthening and creation of technological development centers. In the beginning, there were 31 CDTs of which ten corresponded to the industrial sector, six to the field of new technologies, one to the environment, six to the agricultural sector and two to the mining-energy sector. The remaining organizations corresponded to three regional productivity centers located in Cali, Barranquilla and Ibagué and three incubators of technology-based companies located in Medellín, Bogotá and Bucaramanga (Anonymous, 1997).

The present investigation is focused on presenting a functioning model of technological development center which supports the science, technology and innovation activities required for the consolidation of the competitive maintenance cluster in the city of Cartagena de Indias (North of Colombia).

Territorial models of innovation: The concept of Territorial models of Innovation emerged in the 18 and 19's which was initially introduced by the researchers Moulaert and Sekia (2003) to make reference to regional

innovation models where local institutional dynamics play a crucial role (Fong *et al.*, 2016). According to this perspective, in order to promote business innovation in organizations, it is necessary for socioeconomic actors and institutions at the regional level to carry out initiatives that promote the creation of suitable environments to facilitate the processes of development and/or absorption of innovations. The researchers identified seven territorial innovation models, namely: innovative environment, new industrial spaces, innovation cluster, regional innovation systems, intelligent regions or learning regions, industrial districts and local productive systems. However, in other studies carried out later on the same subject, they did not recognize industrial districts and local productive systems as models of innovation and that the former considered them more as a theory (Martinez, 2013).

Following is a brief conceptual description of each of the territorial innovation models identified by Moulaert and Sekia (2003) as well as some of their main features:

Innovative medium: In the traditional research carried out regarding innovation topics, they focused basically on analyzing the way the company generated and implemented innovations individually; however, in the middle of the years the European group of investigation on innovative means (GREMI, Groupement Recherche Europeen pour les Milieux Innovateurs) created the theory of the innovative environment which directed its efforts in examining the capacity that had the companies to innovate through his relations with the various agents of the same environment that is conceive of the “socio-institutional environment as the main driving force of innovative processes” cited by Romero (2006).

New industrial spaces: As expressed by Romero citing Scott and Storper and Mendez the main characteristics of industrial spaces are essentially based on the agglomeration of organizations with specialized services, infrastructure for innovation and financial resources, transport and communications infrastructure, qualified human resource with a high degree of training. The existence of economies of scale associated with the concentration of companies that facilitate the reduction of transaction costs between organizations as well as the exchange of information and knowledge.

Innovation cluster: One of the researches on the innovation cluster concept is the one proposed by Porter (1998) who defined it as “the geographical concentration of interconnected companies, specialized suppliers,

service providers, companies in nearby sectors and associated institutions (such as universities, government agencies, business associations, etc.), in particular areas that compete but also cooperate”. In some writings, they usually introduce the theory of innovation clusters into that of new industrial spaces. On the other hand, Saxenian cited by Martinez (2013), in his analysis of Silicon Valley, highlights the importance of the role played by local institutions and culture in industrial complexes as well as in comparative organisms for the increase of the economy. From Latorre’s point of view, Saxenian’s vision is much more complete than Porter’s, since, the latter is focused on competition and the market rather than on social interaction and interconnection as the success factors in a cluster of innovation and giving little interest to the regional innovation dimensions.

Regional innovation systems: The conceptual and theoretical bases of the regional innovation systems are linked to what they call the national systems of innovation which are the set of organizations and institutions in a country responsible for initiating, importing, modifying and disseminating everything related to issues of innovation cited by Martinez (2013). This concept of the national innovation system appeared to illustrate the interrelationships that exist between the agents involved in the innovation processes in a nation. However, it was observed that regional administrations had a great influence on development in general and it was decided to apply this concept at a regional and local level, to explain the behavior of innovation processes in a specific sector.

Smart regions or learning regions: Several researchers who have written documents on regional innovation topics agree that the innovation capacity of a company is directly related to the learning capacity of the region in which it is located. In this regard Boisier (1995), points out that smart regions refer to a specific group of innovative, creative or enlightened regions and that they show great interest in those factors that establish the economy of a meeting. Additionally, it shows that the concept of intelligent region can not differ from what is known as intelligence in people: the ability to learn from its behavior in context, in other words is the ability to change those practices that in the past led to unwanted results. To reach this goal, it is essential to constantly monitor the environment and unify the internal ties.

Industrial districts: The birth of this concept was coined to Alfred Marshall, who in his research “The principles of Economics”, refers to the industrial districts as a

concentration of specialized sectors which are located in a specific area which interact with each other same, they generate advantages for the existing companies in that place. Thus, all companies that are located in this area will enjoy the same competitive advantages as large companies. Under these conditions, trust among entrepreneurs would create the right conditions for the creation and dissemination of innovations among the companies themselves. As for the workers, they will have a greater sense of belonging to the territory in which they live and to the companies in which they work. For Marshall, there were two ways to achieve growth performance in the industrial zone. In the first instance, it mentioned the concentration of production in the vertically integrated large companies and in the second instance, the territorial concentration of a large number of small companies that cooperate and compete among them (Mendizabal, 2010).

Local productive systems: The term of local productive system was introduced initially by Garofoli to make reference to the networks constituted of small and medium-sized companies located in limited territorial spaces that have some specialization in which cooperative relations are given by Pyke and Sengenberger, Brusco, Lopez and Del Valle (2002). Over time, several contributing researchers have changed their meaning in some aspects. Other synonyms that have been adopted to refer to this term have been the local system of companies and localized industrial systems (Lopez, 1997).

Interface structures-EDI: In order to carry out the processes of innovation in a system, it is of vital importance that the interrelationships and cooperation between the agents of the same environment and different environments be given, since, if the relations do not take place, it could not truly be a system of innovation but of a set of innovative elements (Uranga and Alvarez, 1996). In those contexts in which the relationships between the actors of a national innovation system are insufficient or weak, it is necessary to organize intermediaries that seek to promote interactions and cooperation among the different agents of the same system (Malizia *et al.*, 2013). These organizations have been called Interface Structure or Interrelationship structure which is defined as a “unit established in an environment or in its area of influence that energizes, in terms of technological innovation, the elements of said environment or others and fosters and catalyzes the relationships between them (Gutierrez *et al.*, 2000). These units must create the

appropriate environment for teamwork as well as the transfer of information and knowledge among the elements of the system which is why they must generate policies that contribute to their proper functioning (DeLucio *et al.*, 2000).

In general, the objectives of an interface structure are the following (Uranga and Alvarez, 1996): dynamize the links between the elements of the media in which it operates with special emphasis on innovation relations.

Promote and catalyze the relationships between the agents of the environment with the agents of nearby environments through bilateral contacts or collective actions of various types. Promote the establishment of orderly, transparent and balanced cooperation frameworks among the agents of a specific environment, also from different environments.

On the other hand, De Lucio *et al.* (2000) argues that the main contribution of the interface structures to innovation systems is basically the power of articulation which in turn is a function of dynamization, who are capable to print to the agents of the different environments. The characteristics of the interaction function, the modus operandi of the interface structures and their number, determine the greater or lesser dynamism of the agents of the system.

National system of science, technology and innovation: In Colombia, one of the attempts to integrate science and technology to potential sectors in the country was the implementation of Law 29 of 1990 which established the National System of Science and Technology (SNCyT); subsequently, the National Innovation System (SNI) was created in 1995. Finally, this two systems were unified to compose the National System of Science, Technology and Innovation (SNCTI) with the entry into force of law 1286 of 2009, the “law of science and technology”. The entity responsible for coordinating all activities of the system in question is the Administrative Department of Science, Technology and Innovation (Colciencias).

The SNCTI is made up of different actors which are possible to associate in five groups: productive, technological, scientific-academic, financial and facilitator. In the productive sector, there are the companies of goods and services, production associations and business associations, non-governmental organizations and chambers of commerce; the technological group is made up of regional productivity centers, technological development centers, technological institutes, technology-based companies, technology parks and technical-technological training centers. In the scientific-academic field, research centers, universities,

Table 1: Main characteristics of the CDT's, CRP's and IEBT's

Characteristics	Technological Development Centers (TDC's)	Regional Productivity Centers (RPC's)	Incubators of Technology Based Companies (ITBC's)
Social reason	The execution of scientific and technological activities focused on the technologies for the completion of one or several productive sectors or economic activities-research and development- training-technological services	The promotion of the development of regional science and technology capabilities	Create spaces and environments conducive to innovation emerge through new companies or new business units existing businesses
Functions offered within the National System of Science and Technology	Transfer of knowledge and provision of technological services	Development of regional productive capacities and articulation of the instances of their environment	Support for new entrepreneurs from technology based companies
Main areas that develop	Organizational technologies-strategic management-competitiveness development-continuous improvement-technological management-human resources development	Generic technologies-promotion of regional capacity development management and development of human resources-technical assistance to impact factors that affect productivity	Creation of business units in existing companies-opening of new markets-technological management

Own elaboration from Garay (2004) and Galicia *et al.* (1996) Colombian

research groups and university institutes are part of the financial group consists of first-tier banks, second-tier banks, parafiscal funds, venture capital funds and national and international funds. Lastly, in the facilitating group, it is made up of the National Planning Department, Colciencias, Observatory of Science and Technology, the Seine and Ministries (Monroy Varela, 2006).

Currently, there are certain entities whose objective is to stimulate innovation processes and serve as a link between companies and universities. Among these entities there are three classes of institutions that perform different roles but at the same time complementary which seek to present successful solutions to different business problems, through, the use of knowledge formed in research, innovation and technological development. The institutions referred to are: Technological Development Centers (CDT's), Regional Productivity Centers (CRP's) and Technological-Based Business Incubators (IEBT's). Table 1, highlights some characteristics of this type of organizations such as their corporate name, their functions within the SNCTI and the main areas in which they are developed.

Although, according to the information contained in the previous table, it could be inferred that the technological development centers would be the potential entities for the strengthening of a particular sector, taking into account that these organizations contribute to the strengthening of business competitiveness through the establishment of cooperation networks and the development and transfer of technologies which is what is needed by the companies that offer industrial maintenance services in the city of Cartagena.

Sectorial system of innovation: According to Malerba (2005), the sectorial system of innovation contains “a base of knowledge, technologies, inputs and a demand

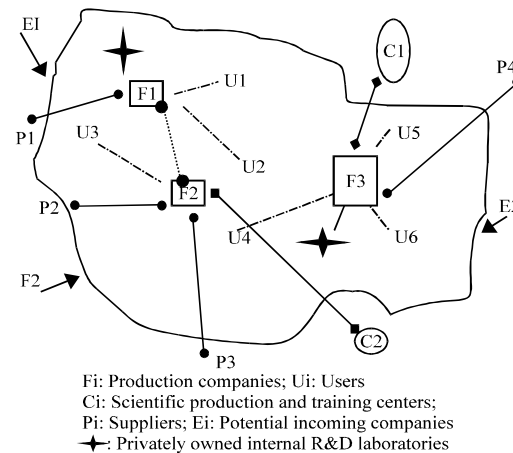


Fig. 1: Static representation of a sectorial system of innovation. Relations between agents: procurement, demand, competition, cooperation, R&D, training, financing, Villafranca and Beamonte (2003)

(potential or existing). They consist of a set of agents of market realization and non-market interactions for the creation, development and dissemination of new sector products. These agents are individuals and organizations at different levels of aggregation with specific learning processes, competencies organizational structure, beliefs and goals. They interact through communication processes, exchange, cooperation, competence and command. Their interaction is determined by institutions”.

Figure 1 shows the representation of a hypothetical sectorial system in a static way where companies act in competition, users and suppliers having different tastes and technologies linked to producer organizations in a certain way, generating centers and organizations of various types of knowledge connected with companies and potential entrants that examine the possibility of entering to compete.

MATERIALS AND METHODS

In the present case, changes are made aimed at improving relations between internal and external processes that generate competitiveness of creation and technology, identifying the types of technologies and how to acquire, adapt and create technology to monitor the competitive environment or transfer technology. In addition, it had a qualitative approach, since, the results focused on presenting the operating model of the technological development center for companies offering industry maintenance services, based on strategies for incorporating science, technology and innovation processes.

Regarding the techniques and instruments for the collection of information, they were mainly based on the tracking of databases and web pages of technological development centers recognized by Colciencias as well as of works carried out in other countries that had content related to them with operating models.

RESULTS AND DISCUSSION

The results presented below were based on the needs and challenges of the companies that offer maintenance services and that are part of the competitive maintenance cluster in the city of Cartagena, identified through their development plan.

Name: Technological Development Center for Industrial Maintenance (CEMANTI).

Mission: Develop and transfer scientific knowledge and technological solutions to the companies providing the maintenance services belonging to the competitive maintenance cluster in the city of Cartagena which allows to reinforce the productivity and competitiveness of the same and therefore, favors the economic development of the region.

Vision: CEMANTI is projected as a technological development center referenced locally and nationally for its high impact on technology solutions transfer projects and its contribution to strengthening the University-Enterprise-State link.

Corporate values: As part of the culture that is to be established in the center, the corporate values that should be adopted to guide the behavior and behavior of all workers are presented below:

Teamwork: Teamwork will be one of the main characteristics of the institution. The communication and

participation of all the work teams will be integrated with all the areas of the center in order to achieve the desired results.

Excellence: Excellence in daily research will be sought, reaching the quality levels required by the clients of the center to achieve successful results in achieving the objectives.

Innovation and creativity: For the center it will be a priority to expand the limits of knowledge to discover new ways of creating technologies that are really different and surprising and with it, always be one step ahead.

Commitment: All the professionals of the center will obey a positive and responsible attitude to achieve the objectives and goals proposed in each of the projects that are developed.

Confidentiality: Both the institution and the collaborators must act in a discreet manner and with enough prudence, in order to preserve the knowledge and information generated in the interior.

Integrity: At the center, care will be taken to maintain relational parameters such as professionalism, honesty, sincerity, transparency and communication in the daily behavior of all their human talent.

Differentiating factors

Collaborative alliances: Agreements will be built between key actors in the cluster, to carry out works that have great benefits for all participants. In the same way, it will focus its efforts on involving government entities that are key to the development of projects.

Innovative solutions: According to the needs and challenges of the sectors in which it is focused. He will always be monitoring the trends in his environment and in that way, he will look for alternative solutions to present to his clients.

Specialized knowledge: As far as possible, qualified personnel will be available in each of the center's functions, in order to always provide the required services with the highest levels of quality and reliability.

Legal nature: Because the technological development center will promote activities aimed at scientific research and technological development, in addition to requiring public-private investment without profit motive, it was determined that the legal nature will correspond to a corporation.

Table 2: Strategic objectives-lines of action-services

Strategic objectives	Lines of action	Services
Promote technological development in the competitive maintenance cluster that contributes to the increase of the technical capacities of the companies that offer the maintenance services	Generation of consultancies and training based on the short comings in the technical capabilities of the companies that offer the services of maintenance	Consultancies/specialized consultancies/laboratory services/teaching and young researcher's internship
Promote the participation of the maintenance sectors in research projects, technological development and innovation	Development of technology transfer projects to the companies that offer the maintenance services	Research projects/technological management
Promoting the culture of innovation within the cluster	Execution of creation and innovation activities	Training and training/entrepreneurship-spin off

Based on Article 1 of Decree 393 of 1991 of Law 29 of 1990 (The Law of Science and Technology) by which regulations are issued on partnership for scientific and technological activities, research projects and creation of technologies, determined models to build associations with the center's purposes are corporations and foundations.

"Article 1 modalities of association. To advance scientific and technological activities research projects and creation of technologies, the nation and its decentralized entities may associate with individuals under two modalities. Through the creation and organization of civil and commercial corporations and non-profit legal entities such as corporations and foundations".

Strategic objectives: Promote technological development in the competitive maintenance cluster which contributes to increasing the technical capabilities of the companies that offer maintenance services. Promote the participation of the maintenance sectors in research, technological development and innovation projects. Foster the culture of innovation within the cluster.

For each of the strategic objectives, lines of action were defined which will be met through the provision of specialized services as shown in Table 2.

Operating model: The operating model for the center presented is an adaptation of the model proposed by Fernandez which was designed, especially for technological development centers that operate in environments where innovation processes are not carried out or do not carry out frequency, taking into account that the companies to which the services that CEMANTI will provide are directed, most do not have strategies based on innovation processes, the referenced model would be ideal to systematize all its processes. The model has its foundation in four dimensions namely: operational, financial organizational and relational.

Operational dimension: Refers to all the activities of the center that generate money income such as the services that it makes available to its clients and the projects it executes with them.

Table 3: Monitoring and control indication

Dimensions	Indicators
Operational	Volume of income from services Volume of income for projects Number of patents Number of publications Number of present at ions in congresses
Financial	Financial income Self-financing level Volume of income from grants
Relationship	Number of new clients Number of participations in consortiums Revenue from new activities
Organizational	Diversity of sectors served Cost per employee Staff incorporations Equipment investments Deviation in terms Deviation in budget Degree of compliance with the objectives Edition of the strategic plan Degree of compliance with the strategic plan

Elaboration from Fernandez-Garcia

Financial dimension: Because CEMANTI is going to be a non-profit organization, it will require public-private investment for the start of its operational activities. The long-term objective will be to achieve self-financing, through contracts with its customers without depending on other entities.

Organizational dimension: This dimension requires having a highly qualified and qualified human resource which ensures a good performance in the processes, since, this will depend on the long-term relationships and loyalty of its client companies.

Relationship dimension: The links with universities, government agencies and companies will be crucial to obtain information about the opportunities that are found in the environment. For this, the center must open spaces where the links of interest are strengthened.

Although, the operating model also provides some tracking indicators for each of its dimensions. In the case of CEMANTI, those that will become necessary when they start their operations as shown in Table 3 are taken into account (Fig. 2).

Organizational structure: Figure 3 shows all the activities to be developed by CEMANTI an organizational chart by processes was established.

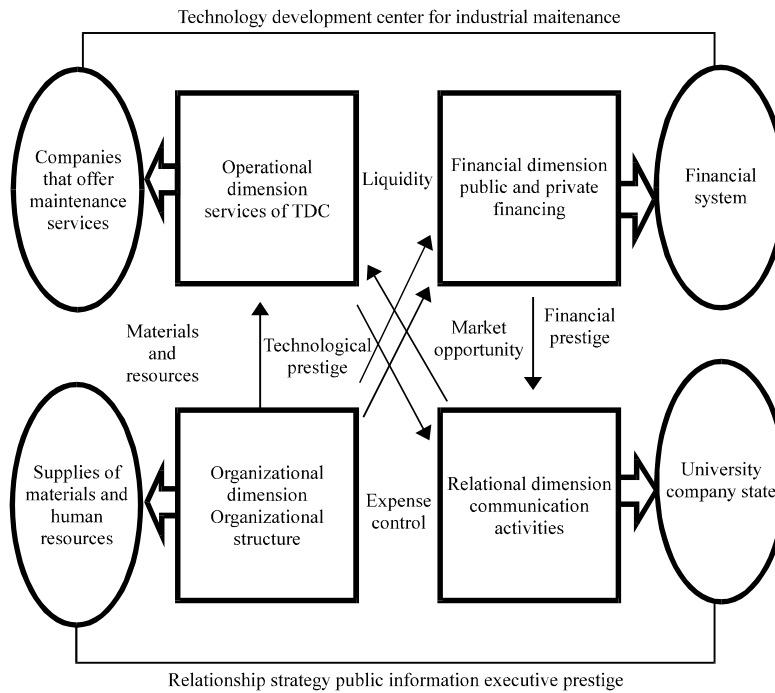


Fig. 2: CEMANTI operating model, adapted from Garcia's and Marino (2000)

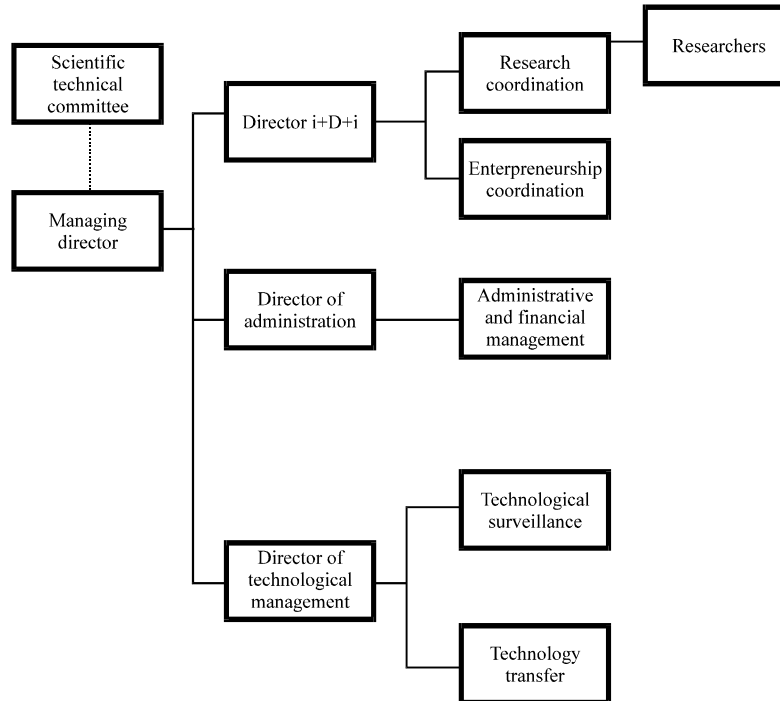


Fig. 3: Organization chart of CEMANTI

It should be noted that for the start of the center's activities it is essential to have the two main levels

(General Director, R&D Director, Administration Director and Technology Management Director).

CONCLUSION

From the results obtained, the following conclusion can be presented: the strategy of the creation of the technological development center for the industrial maintenance cluster is a crucial step to create awareness in the stakeholders that make up the cluster of the importance of innovation and organizational learning in the processes of change that are experienced in the news and above all, the generation of greater scientific and technological knowledge to create, strengthen and complement strategic alliances to remain in international competition. With the creation of CEMANTI, Cartagena de Indias, it would be the first city in Colombia to have an institution that offers technological services, especially to this type of company which would become a point in favor of the economic development of the city.

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