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TECHNOLOGY TRANSFER IN COLOMBIA

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ABSTRACT

Since 1945, when the concept of Technology Transfer was originated in the United States, it has been recognized as one of the main means for evolve, innovate, trade and bring the knowledge as well as inventions, ideas and technology to the hands of the community in a useful way.

This project is aimed to explain and deepen the concept of technology transfer, its forms, as well as its advantages and disadvantages among others. Once defined these ideas, the work is addressed to know and understand the process, evolution and applications of technology transfer in Colombia. Also, here are showed the policies and decrees by which technology transfer is enabled for being carried out and implemented in diverse sectors of Colombian industry.

Thus, here is presented when the transfer appeared in this South American country, this thanks to the government's cooperation, FTA's already signed and the joined work of some institutions such as Colciencias, CENICAÑA, CENIPALMA, CENICAFE, ICA, SENA, CIDETEXCO, etc., aimed at research and development of technologies and innovation in different areas, as: textiles, agriculture, automotive, oil production, medicine, biotechnology and others.

The last part of this document is focused on the incorporation and adoption of technology transfer and nanotechnology into the Textile sector, analyzing the impacts of some agreements between CIDETEXCO, PAD System Technologies and the Centre de Transfert Technologique Mode, also the donation of the Digital cutting machine carried out by the mayoralty of Milan into the framework of the project "innovation platform for the Textile and Clothing sector", with the aim of improving the process of cutting and digitization of fashion companies.

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I. INTRODUCTION

During decades, it has been considered that both, science and technology are clue variables for the economic and social development process of different nations as well as of many enterprises. This development has been achieved through technological changes processes in production systems and marketing practices of current goods and services, as these will, in the near future, be replaced by the introduction of more effective and efficient goods and services, this in order to satisfy both the existing and new and growing demand in consumption patterns. The technological change processes can be evidenced by different ways such as a result of local technological development or foreign technology transfer.

According to the above, one can say that technology transfer is one of the key mechanisms in the planning process of scientific and technological development in countries on the rise, such as Latin America countries. In this paper Colombia will be the main topic, referencing the consequences that employment, development and technology transfer have brought to this country in terms of salaries, training, and industry growth and at the same time economic competitiveness among others.

Currently, the Colombian economy is being considered as emerging and striking for the world mainly because the country has demonstrated with great effort that it is leaving behind certain problems that it has suffered during many years such as terrorism and drug trafficking.

Thanks to those efforts to move away of these stigmas Colombia, the country has become an attractive place for foreign investment which has meant an increase in investment around 250% since 2000 year. (3)

Nowadays, the economy of Colombia is considered the fourth largest in Latin America, behind of Brazil, Mexico and Argentina, ranking as the sixth largest economy-wide America, and the thirty-fourth largest in the world. (Fig. 1)

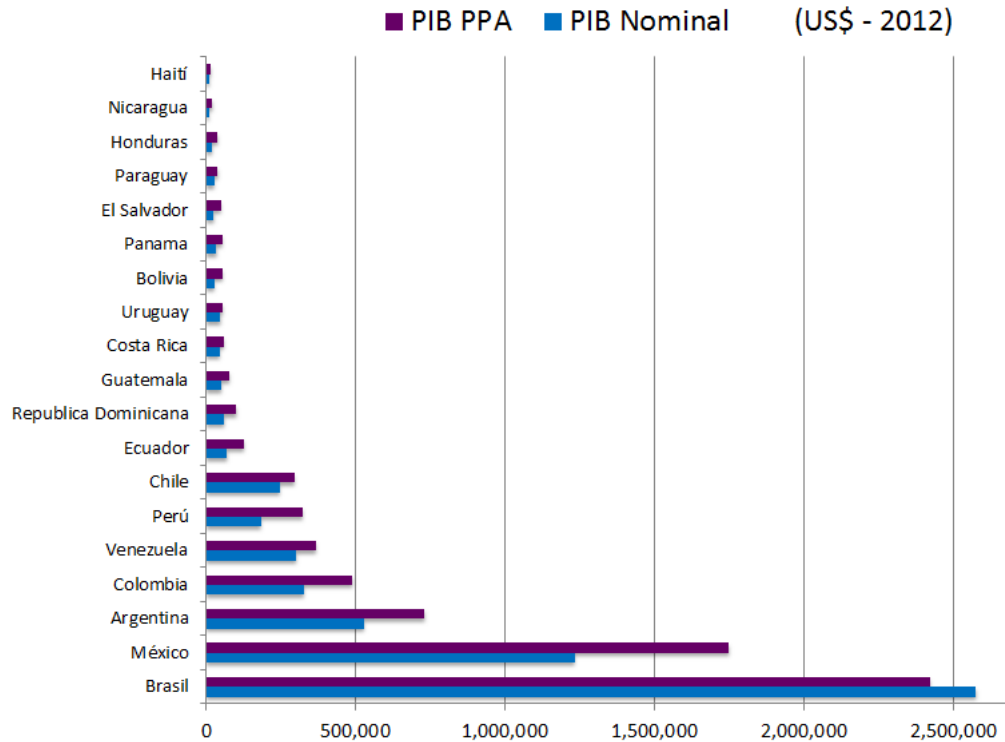


Fig.1 Latin America Gross Domestic Product (PIB) and Purchasing Power Parity (PPA)

The Colombian economy is mainly sustained by various sectors of national production, being one of their greatest products the coffee, making the country one of the major global exporters of this commodity; which, in turn, is characterized as the main economic sector of the country. También, su producción petrolífera es una de las más importantes del continente con 930.000 barriles diarios, lo que la convierte en el cuarto productor de América latina y el sexto de todo el continente. Also, its oil production is one of the most important of the continent with 930,000 barrels per day, which makes it the fourth largest producer in Latin America and the sixth of the entire continent. However, there are several sectors that make Colombia one of the countries most recognized by its production of emeralds and floriculture. It also highlights the sectors of agriculture, automotive, textiles and a major exporter of oil, gold, sapphires, diamonds, coal and natural gas, among other products.

Colombia is recognized internationally as a country with great strengths in the business of textiles and apparel, representing a significant percentage of manufacturing GDP 8% and 3% of GDP.

The current crisis which crosses the textile-clothing industry, due to several factors that came together against the Colombian market in the last three years as falling global demand for the effects of financial crisis, the appreciation of the peso, the fall in international prices of some commodities, smuggling as largely responsible for the crisis within the sector and unemployment.

On the other hand, as well as Mexico, Colombia suffer from the Chinese onslaught with the input of smuggled textile products and dumping practices, which has led to the decline of the textiles and clothing. For every ten items, at least five are the product of this illegal trade.

In addition, the same Colombian companies are quitting the manufacture of their products into the Chinese hands and other South American countries such as Ecuador, so the labor plant of operators and technicians has declined. Due to that many textile companies have closed their doors.

The supply of labor in this industry that represents for Colombia, one of their strong production arms has shifted to the areas of design, textile chemical technology, industrial chemical technology and operator training in spinning, weaving, textile finishing, etc.

Given the current economic crisis and the industry, the sector is forced to explore new niche market for diversification, for growth of companies and the internationalization of the economy. To this end the Ministry of Commerce Industry and Tourism has driven the transformation program of world class productive sectors, which set out to improve the competitiveness of the country where companies work to increase their skills in developing and marketing products and value added services, achieve greater participation in international markets through existing and negotiated trade agreements but awaiting ratification in the country, as well as develop skills to produce and export with cost, quality and be competitive.

II. THEORETICAL BACKGROUND

2. TECHNOLOGY TRANSFER

2.1 Technology Transfer Basis

To start talking about technology transfer, first is necessary to present the concept of technology.

Technology is understood as an ordered set of instruments, knowledge, methods and procedures applied in different industrial branches with the aim to achieve a specific goal, generally the production and the delivery of a good or a service.(1)

The technologies that are commonly used in technology and knowledge transfer are:

Property rights: materialized technology in the form of inventions (components, procedures, methodologies) protected by rights of intellectual properties. It is generally understood as existing technology, which comes from research and development processes and is in a state of more or less advanced development and requires a final adjustment to be used in the market with some degree of uncertainty.

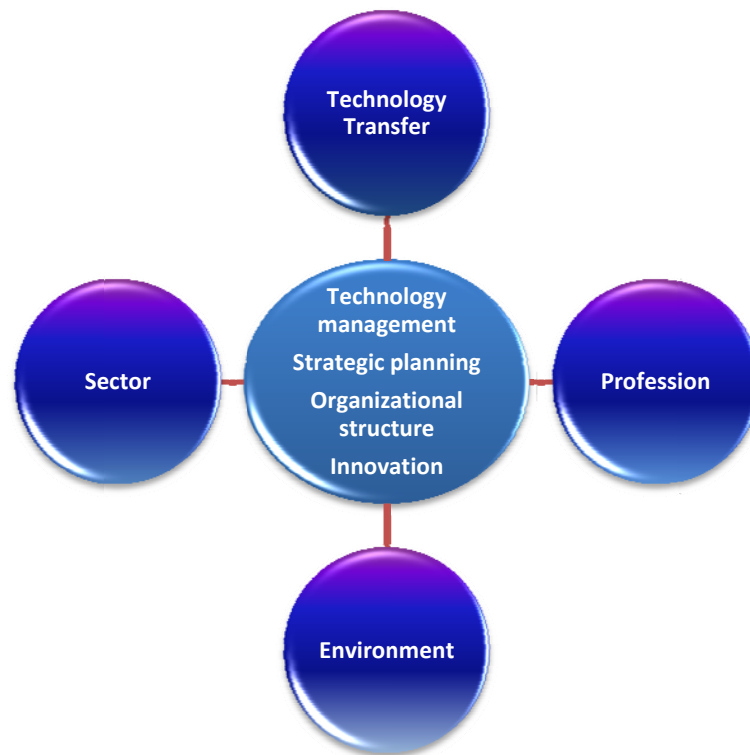
Scientific knowledge: this is the domain and knowledge of scientific capabilities in order to continue Research & Development processes.

ICT equipment goods.

Technical knowledge.

Once having cleared the concept of technology it is possible to go deep into the definition of technology transfer. It refers to the process by which two figures (hereinafter called the supplier and receiver) manage an exchange of skills, knowledge, human resources, know-how, technology, manufacturing methods or services between governments and other institutions to ensure that advances are translated into new products, processes, applications, materials or services.

Technology transfer occurs not only by the purchase of equipment and acquisitions of new technologies; also it is related to human resources and other organizational areas. To take place the transfer process, different stages should be accomplished in order to define its positive labor or not according to the characteristics of each organization. There is not a determined sequence of phases; it depends on the system adopted by the transfer as such. Among these steps the identification of needs is found, the generation of technology or its acquisition, assimilation and diffusion, innovation, market analysis and feasibility.



Source: Universidad Nacional. Elaborated by the author

Fig2. Technology Transfer

2.2 Technology Definition and Technology Transfer

Current Technological changes performed in productive apparatus of less evolved countries are placed in a high proportion by transferring technologies developed in more advanced countries, with scarce participation of engineering originated with local capacities in science and technology.

In general terms, the expression of technology transfer, makes reference to a process by means science and technology. Generally, the expression technology transfer refers to a process by which science and technology are spread in human activities.

However, in the field of economic activities is stated that technology transfer can be interpreted as the process of incorporation into a productive unit of knowledge developed outside of it.

Usually, this diffusion of knowledge is not free because the technology is a private owned asset, which has an exchange value in the market and thus, an ability to generate income to those who own, control and exploit it.

Unlike other goods, the "good" knowledge, which is ultimately the technology is not always an alienable good, but rentable, according to international practice in technology trade.

When technology is not public domain, the transfer is done through a technological agreement or contract for the usufruct of the operating profits of such knowledge, in exchange for payment or recognition of some rights to the grantor or owner of the technology.

Technology transfer has different characteristics depending on whether it is external or internal, that is, if it occurs between productive systems or countries, or between economic sectors or production units of a country.

Sachs (2) distinguishes several types of transfer in accordance with the participation of the infrastructure of science and technology system in the process and the time the system is linked to the transfer process. The author describes the transfer as adaptive when the scientific-technological system, through its infrastructure,

adapts foreign technology before incorporating it into productive activities. Instead, is typified as a full transfer, when is simultaneously adopted in the production system and is the subject of research in science and technology infrastructure for a better opportunity to increase assimilation and innovation. Finally, it is called pseudo-transfer when scientific and technological infrastructure is not involved in the process.

Technology transfer also can be classified as vertical when the knowledge generated by the research and development units (labs, institutes, centers, corporations and technological parks) are adopted and used in goods and services productive units; on the contrary it is typified as horizontal when the technology designed for a given economic or industrial sector is used in a different one.

In accordance, with many authors it is clear that if companies are interested in access to technology as a means of improvement in their activities and, or processes must agree to this proposal through two ways, either internally or externally.

- Internal: own departments of technical research and development.
- External: collaboration with external partners and suppliers outside the company for the acquisition of technology when it is already available or the development of it in case of having it immediately.

To further understanding of these concepts, when technology is obtained from an external source also refers to technology transfer. Due to that, technology transfer can be analyzed from another context.

- The company that access to technology and uses it as a business strategy to improve its competitiveness. (technology receiver)
- The entity that co-develop or market the technology and uses technology transfer to enhance its knowledge. (Technology provider)

Depending on the context of utilization, technology transfer can be called in the following ways:

- Technology transfer.
- Knowledge transfer.
- Technological cooperation.
- Buying and selling of technology.
- Technology acquisition and granting.
- Import – Export of technology.
- Technological Alliance.
- Etc.

2.3 Technology Transfer Forms

The technological knowledge that is transferred can adopt different forms. It can be exemplified in goods, services and people, and organizational arrangements, or codified in blueprints, designs, technical documents, and the content of innumerable types of training. Alternatively it can be communicated through flows of tacit knowledge which has not been fully codified, and can be identified in the skills of people.

The various forms that the knowledge acquires may vary in a way even more important. On the one hand, the transfer can be affected with the knowledge and use of technology in operation. And on the other hand, can be affected with the knowledge necessary to change the technology and innovation.

Taking into account the above, the transfer of technology may be evident in the following ways:

Access to the media: This mechanism includes all the ways of public dissemination of knowledge e.g., magazines, television, books and so on. From this perspective, libraries, educational institutions (schools, colleges, etc.), and the Internet are the most important source, today, to transfer knowledge.

The migration of people: consists on the movement of people from one country to another, usually from a less developed to a more developed, in order to return with a wealth of knowledge that are not held in their country of origin and then apply them to useful purposes . This form of transfer presents a risk that the reverse transfer occurs, i.e., the talented people who go to other countries can stay there with no intention of returning, due to multiple causes such as better foreign opportunities than national as well as higher wages.

Purchase of machinery and equipment: this act does not always involve technology transfer, since this occurs only when purchased equipment or machinery are accompanied by documentation on their production as well as its use, or when the purchase of machinery and team accompanied by other contracts or obligations concerning the use, technical assistance contracts. Otherwise, in case of not having documentation about the production or utilization of the acquired or ancillary obligations around the use or production, it is not possible to talk about technology transfer, because any useful knowledge is being transferred.

Foreign investment: has two strictly economic purposes: to produce at a lower cost than in other countries where it would cost more and the expansion of the market, but in order to achieve these objectives is necessary that investors industries train nationals who will be responsible for achieve the purposes stated. The transfer in these cases is clear.

Contractual transfer of technology: within this group are included all contracts involving the transfer of useful knowledge. As an example, may be referred to the provision of technical assistance, turnkey contracts, franchise contracts, contracts of license or assignment of patents and know-how, etc.

The true transference of technology, more than acquisition of a productive capacity, implies the transference of a technological capacity to use suitably, to adapt and to improve the bought technology. Therefore, all negotiating efforts should be addressed towards obtaining knowledge and skills or operational skills related to

products, processes and production methods, machines and equipment, raw materials and inputs, organization methods of business and labor, and the applications and usage of products.

2.4 Technology Transfer – Advantages and Disadvantages

The effects of technology transfer have been analyzed in different studies carried out to companies. Thanks to these results it becomes clear that one of the benefits generated is to achieve greater competitiveness and efficiency of processes. Customer satisfaction and goodwill are the most visible aspects when making comparisons between the obtained results. Other strengths are the accomplishment of prior studies to the acquisition of technology based on the comparison of offers from suppliers, in addition, the acquired technology is adjusted to the conditions of the company, then it is carried out the training in external centers and the decision to purchase depends on management and production area. Among the weaknesses identified in the studied companies are the deficiencies in the conceptualization of transference, lack of information about new technologies, negotiation problems, knowledge and partial handling of acquired technology and lack of training programs in the transferred technology.

III. TECHNOLOGY TRANSFER IN COLOMBIA

The technology is a good, and as such, it can be acquired, ceded, bought, sold or used as barter. Thus, the flow of technology to and from organizations is the process of technology transfer.

In recent years, an infinite number of new technologies from all corners of the world have come to the country. The process, which is part of the dynamics of globalization, goes from the transfer of information about physical phenomena, equipment or analytical techniques associated with the technology, up to the acquisition of included production techniques, in addition to the purchase of new equipment, machines and software, training programs, consultancy and technical advice.

Most of the technological developments of the last ten years revolve around informatics, telematics, biotechnology and astronautics, applied-sciences that allow getting innovations which are the target of incubators based on technology. Entities that if they can overcome the high degree of uncertainty due to the nature of its activities, the difficulties in obtaining the necessary support and, in many cases, the lack of credibility, may be the best strategy to bring together all members of the production chain around a common goal: research and technology as strategic elements in the development of the country.

3.1 History

Colombia began to talk about technology at the beginning of the year 1925, since industrial expansion process, when scientific and technological activities of major importance took place and explicit institutional support was evident.

During the government of Pedro Nel Ospina was given the policy of increasing promotion and economic development. But it is in the Lopez Pumarejo's government that was handled the economy and the promotion of industrial development. Furthermore, scientific-technological actives were pushed in a

continuous and institutionalized way. During this government activities such as agricultural, natural sciences and health were promoted.

This government also presented an increasing incorporation of technological innovations in different production sectors, all of them transferred through machinery imports, establishment of maintenance workshops and railroad repair as training school of technicians, college consolidation, training of Colombian technicians abroad, creation of research centers and services such as agricultural research division (ARD), Samper Martinez laboratory, National Institute radium and Agustin Codazzi Institute, National institute of natural sciences.

By the 60's, planning of scientific and technological development at national level is given and the creation of the ICA (Colombian Agricultural Institute) corporation dedicated to research, education and extension of agricultural sciences.

But it is until the century XVIII that tech & scientific activities took place in the country for the first place with all the activities involved in the process: researchers' training, research, technological development, supporting services and diffusion, and somehow its evolution is articulated to the overall economic and social development, particularly with the processes of industrial expansion and organization of the state.

3.2 Laws and Decrees

According to Colombian legislation there are different laws and decrees in charge of enunciating as well as establishing the specific characteristics for contracting scientific-technological activities depending on the concerned sector. In Colombia is possible to talk about both public and private contracting.

Law 29 of 1990, by means of which provisions for the promotion of scientific research and technological development are dictated and extraordinary faculties are granted.

Decrees: 393 and 591. The first dictates rules on association for scientific and technological activities, research projects, and creation of technologies and 591 by

which the specific modalities of contracts for the promotion of scientific and technological activities of 1991 are regulated.

In summary, the above mentioned constitute certain features of contracting for the scientific and technological activities that develop the entities of the nation and its decentralized entities, framed in the exclusive exercise of technological development. Therefore, the legal applicable regime allowed to these contracts is the Private Law and not by targeted recruitment for state entities. Similarly, these standards have instituted the modalities of the partnership for advancing scientific and technological activities, research projects, and development of new technologies, and the specific purposes for these partnerships.

Within the specific activities that involve science and technology, the Decree 591 of 1991 considers among others, scientific and technological services, the promotion and management of total quality systems and technology transfer, understood in this decree as an activity that includes the negotiation, appropriation, disaggregation, assimilation, adaptation and implementation of new technologies national or foreign.

The previous normative context is limited to activities called for Science and Technology which should be understood as strict research and development, ruling out any technology transfer of operation, or peripheral technology or any technology that stems from the daily action of the state entity.

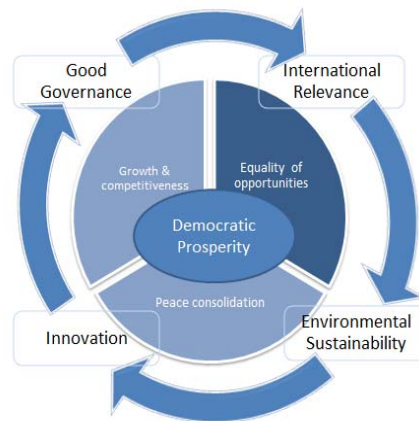
Taking into account the above mentioned, is important to enunciate that the Colombian state entities are governed by the *law 80 of 1993 and the law 1150 of 2007* and its regulatory decrees. In turn, this set of rules constitutes the general contracting statute for these entities, and among of these, is established that all contracting processes should be registered in SECOP (Electronic System for public procurement), only valid way for consulting this type of information.

3.3 Policies

One of the policy tools that allow the transfer of technology in Colombia is the national development plan. This is a document that serves as a basis and provides the strategic guidelines for public policies formulated by the President of the Republic, through its government team.

The general part identifies the purposes and national objectives of long-term goals and priorities of the state's action in the medium term and the strategies and general guidelines of the economic policy, social, and environmental which will be taken by the government.

In order to fulfill this aim, eight high axis have been identified which are summarized in the following figure.



Source: Departamento Nacional de Planeación Elaborated by the author.

Fig. 3 Pillars of the National Development Plan

- Innovation is necessary in new production activities as well as the existing ones, also in collaboration processes between the public and private sector, adaptation to climate change and sustainable development.

- A good government is needed as regent principle in the implementation of public policy, social programs, and in the relationship between the Government and the citizen.

- Greater international relevance of Colombia in the international markets is necessary, in international relations, and in the multilateral agenda of development and cooperation.

- It is necessary a society for which environmental sustainability is a priority and a practice as an essential element of the well-being and as a principle of equity with future generations.

A fundamental step forward toward a culture of innovation is strengthening mechanisms that facilitate and promote innovation. Mechanisms such as: (1) the reinforcement of the protection schemes to intellectual property, (2) the availability and diversity of financial instruments, (3) the highest and best use of information technology and communications, (4) the establishment of a system of higher education quality and relevance, (5) the promotion of schemes of associativity around the development of clusters based on innovation, and (6) consolidation of productive alliances regional and local between companies, universities and State entities.

One of the main enablers for the generation of innovation is technology transfer. Facilitate and promote the use and adaptation of technology are fundamental requirements in order that the innovation in the country evolves toward the frontier of knowledge. In order that innovation in the country evolves toward the frontier of knowledge, it is necessary to facilitate and promote the use and adaptation of technology.

This implies that, in parallel with the generation of new knowledge and innovation within the country, some mechanisms should be established to transfer and adapt innovative and scientific developments that are being generated.

That is to say, taking advantage of the immense development of new knowledge that day by day is taking place in the whole planet slowly and in parallel, increasing the contribution of Colombia to this generation of new knowledge.

Taking into account the culture of innovation that has been driving in the country and the strengthening plan for four-year period, and with the aim to increase the research capabilities of the productive sector, the State will cede the

intellectual property rights on the results of science projects that may correspond to the state, technology and innovation financed with resources provided by the national budget when they are executed by micro, small and medium enterprises, research centers or technological development recognized by Colciencias, as well as by basic primary education institutions, secondary, middle or high.

Likewise, differential actions will be implemented for each type of intellectual property protection, in order to encourage its use and exploitation.

Industrial property:

A program led by the SIC (Superintendence of Industry and Trade), Colciencias and SENA (National Apprenticeship Service), will be launched for the use of information technology available in the banks of patents for technology transfer, seeking to create knowledge-intensive companies and a greater adoption of available technologies in companies constituted so as to encourage imitation processes and closing technology gaps. It will include the development of innovation projects with technology transfer components that comprise the identification, evaluation, negotiation and acquisition of patents, unpatented inventions, licenses, designs, trademarks and software packages.

3.3.1 Advances in Science and technology policy in Colombia

In early 1996, the National Competitiveness Council adopted the National Strategy for Competitiveness. In order to translate the designed strategies some programs of the National Science and Technology have been developed. Various activities on strengthening innovation, development and technology transfer have been carried out through the National Innovation System. The most important advances in the articulation of *SNCTI* (National System of Science, Technology and Innovation) have occurred in areas such as modernizing the financing system, market activation of technology services and the integration of both sectors the sectorial and regional into the programs.

Four types of programs that relate to the modernization and integration of the financing system of technology development have been designed: credit lines with

subsidized interest rates, co-financing systems, which grant non-refundable funds up to 50%; venture capital, in which a qualified investor provides funds to a company, thus assuming the associated risk and obtaining a proportional profitability, and reduction of the amount of required guarantees to small and medium-sized enterprises to grant loans. In the framework of this strategy some projects of management of innovation, product and process technology and supporting projects to technological services have been financed.

Regarding the activation of technology services and human resources training, taking advantage on the experience of ICONTEC (Colombian Institute of technical standards and certification) and the National Center of Metrology and Standardization, technology services that promote quality and timeliness of the product on the national market have been expanded. On the other hand, by means of Colciencias and Sena agreements have been developed some business missions in different countries with the aim to promote strategic alliances, technology transfer and ensure greater access to the frontier of knowledge.

The National System of Innovation is conceived as a strategy that aims to integrate two dimensions: on the one hand, are conceived sectorial mechanisms – technology development centers among others, and moreover, innovation regional systems or departmental, regional centers of productivity and technology-based incubators are driven.

3.3.2 Technology development centers – TDC

They are one of the main strategies of innovation policy as well as National strategy of competitiveness. The current strengthening plan for technology development centers, unlike previous conception, gives a crucial role in the joint participation of state and private sector, improving the research structure, human resource training and provision of technology services.

The TDC involve the construction of innovation networks to accommodate the link between companies, universities and other supporting entities to technical change, aimed at promoting innovation processes in productive sector. Its objective is

to increase the productivity and competitiveness of productive sectors by promoting a culture of business innovation based on cooperation and inter-company alliances and participative management.

As an essential strategy, centers should be both facilitating instruments of set of technology policy aimed at facilitating internal technology transfer, enhancing, streamlining and improving the negotiating capacity in the acquisition of imported technology, as well as technology generators of national origin with large opportunities for transfer to companies.

The main areas that centers should develop are: organizational technologies, strategic management, competitiveness development, continuous improvement, business cooperation, technological management and human resources development.

Regarding its structure, to guarantee sustainability and efficiency in its operation, has seen fit to adopt the approach of virtual centers or network centers mode that optimizes the use of existing research capabilities and technological services, while streamlining costs operation

These include research skills, technology services and training available in universities, enterprises and regional entities of technological development.

In the same sense, the CDT to perform the functions assigned must ensure that their services are in demand within the productive sector users, without attempting to replace the technological activity of the user companies but enhance and supplement it.

As a priority mission, the centers have to deploy activities aimed to provide supporting technology services and develop strategic pre-competitive technologies for the country that can hardly be addressed by individual companies because of its high cost and risk.

The financing of this centers count on the contribution of public capital in the form of seed capital essential in the maturation period of the center. It notes the need to maintain this form for enough time to achieve consolidation, and subsequently replaced it by macro contracts that would increase the technological capacity of the center.

TDC have well defined the services portfolio and practically all of them agree that the most important are: training, technical assistance, consulting and information.

In some centers there is an incipient interest in R & D, which answers in all cases to a reality of the industrial sectors that have not yet incorporated the technology as a tool of competitiveness. However, in other centers, the development and implementation of R & D is considered a priority activity.

3.3.3 Colombia in the technology transition process

Currently Colombia is in a phase of scope or convergence. An indicator of having reached this stage is an adequate level of education of its workforce, with a good functioning of universities.

In addition to the response of firms to improve quality, carrying out a practice for incorporating new technology mainly in agriculture and other sectors of primary goods, or producing relatively standard goods, but at reduced cost, is also necessary to facilitate this process by developing innovative entities which are interrelated and by increasing interactions with the private sector.

The before mentioned should go hand in hand with research and development activities, which will allow the occupational competencies, to be more specialized and in turn facilitate those adaptations of existing technology to be more viable.

In this phase, the government begins to play a role more decisive in the conduct of the process, establishing the main components of the National System of Innovation, overcoming market and coordination failures, and providing economic and fiscal incentives for research and development and collaboration between actors in within the system. As well as the improvement of financing of Research & Development and the generalization with respect of intellectual property rights.

In obedience to the above, both Science, Technology, Innovation and in turn transfer of these, have considered cooperation areas, they have been considered fields of cooperation in which the National Government works day by day, understanding them as a pillar of development.

To do this and as part of the commitments made in the CONPES (National Council on Economic and Social Policy) 3582 on Science, Technology and Innovation,

the Ministry of Foreign Affairs is working, in coordination with other entities of the State, in the promotion of this public policy that seeks to identify, produce, disseminate, use and integrate scientific and technological knowledge, to improve competitiveness and contribute to the transformation of the country's production.

In this sense, Colombia signed with the United States of America a Convention of Science, Technology and Innovation which entered into force in September 2010, what is being looked for is to exchange knowledge and skills that will lead to the economic and social development of the Nation.

Likewise, and to strengthen international cooperation and promote activities related to this topic, approaches have been made with the European Union, Australia and Korea, among other countries. In addition there is an Agreement for Scientific and Technological Cooperation between Colombia and Brazil which seeks to strengthen research partnerships. Similarly, Colombia, as an active member of some regional organizations, is part of various initiatives in the field of Science, Technology and Innovation.

Regarding Technological innovation it can be defined as:

-The transformation of an idea into a new and improved product introduced on the market,

-It is a new or better process used into the industry.

Innovation is characterized by a global process, which involves decision making and integration of technology to the company; the innovative strategy should interrelate with the competitive and not to allow the R&D isolate itself from the rest of the organization.

According to Colciencias, innovation is defined as a business strategy related to the development of new processes and products, with the acquisition and adaption of new technologies and organizational and managerial changes. This innovation can be both in technological domains as in non-material domains (in commercial,

organizational and institutional fields). Among the covered areas are: opportunity recognition, idea generation and formulation, process technologies, equipment and operation.

Depending on the objective to be achieved the innovative activity is carried out in two different contexts. In a technological context, what is wanted is to generate new markets, to adapt technologies, to create technical developments and change production methods. Regarding the economic context, it is intended to replace goods, maintain market share, open new markets, increase production flexibility, decrease costs and reduce the impact on the environment.

In Colombia, the basic characteristics of innovation are focused on human resources, technology and management of innovation. Although the management of technology has had little importance, responsibility of management is mainly found in academia and in schools that deal with management issues. The research and development could be moderate, and difficult to project, but not impossible. However, it must be accepted that this issue is emerging and has increasingly become a determining factor for the economic sustainability of the productive sector.

3.4 Foreign Investment in Colombia

The regime of foreign investment considers as foreign direct investment, those contributions that perform the investor through acts or consistent contracts, among others, in technology transfer, when the contribution does not represent a participation in a society and the income to be generated by the investment for its holder are dependent on the profits of an enterprise. Also, it is attributed as a form of foreign investment, tangible or intangible contributions to the capital of a company through technological contributions in the terms provided in the Code of Commerce.

3.5 Colombia produces Technology

In the last decade the technology has been introduced as an inherent element of human life, its functionality, operation and development depend, in large measure, on the joint work of the private companies, public sector and universities. In some of the major cities in Colombia, this joint work has enabled the creation of new strategies that aim to a downsizing of the only consumption of technology, a staggered production quality.

Colombia has succeeded in generating and adapting technologies which have contributed to economic and industrial development of the country; a good example of this is the national engineering. However, it is clear the lack of a coordinated system of science and technology where planning, human resources and infrastructure are synergistically complemented to innovation, which is essential in achieving an economic and social development.

According to Colciencias, approximately three million people in the world currently dedicated to scientific research, 94% are located in developed countries. Latin America only contributes with 1% of the scientists of the world and of these only about 1% are Colombians.

On the other hand, regarding the registration of patents is considered that Colombia has had poor management. Until 1994, the Colombian inventors only recorded in the system of Patent and Trademark Office of the United States, 130 patents from 5,350,000 existing to date.

In addition, to achieve optimal technological development it is required the allocation of a significant percentage of Gross Domestic Product (GDP) to finance the expenses arisen from various programs of research and technological development, training, technology transfer, innovation, staffing physical infrastructure and laboratories.

According to the Colombian Petroleum Institute, unlike the U.S., Japan or Germany, where it is assigned between 2 and 3% of GDP to technological development, in Colombia, during the year 94, only 0.5% was assigned including international technical cooperation, private investment and operating costs of the

science and technology system, without which the investment had not even reached 0.2%. It is worth noting that in the year 98 the investment rose up to 1%, percentage that is maintained to date. However, it is thought that the future can be hopeful since besides of the efforts of Colciencias, promoting body, coordinator and financer of science and technology activities in the country, is now seeing a more aggressive policy on research as a strategy for economic and social development.

And perhaps it makes sense, since the research and development have been taken as elements of progress and competitiveness by several sectors. Among them are the agricultural with the Colombian Agricultural Institute (ICA) and nowadays with CORPOICA (Colombian Corporation of Agricultural Research), CENICAFÉ (National Center for Coffee Research), CENICANÑA (Research Center of Sugarcane in Colombia.), and CENIPALMA(Corporate Research Center for Oil Palm), centers that within their investigative work have achieved innovations in cereals, grass, coffee, sugar cane, palm and many other vegetables.

It also highlights the industrial sectors with the work of the plastic and rubber center of research in communications and electronics (CINTEL), the ITEC of TELECOM, Corporation for research in Corrosion, the Institute of Food Technology and several research centers at universities.

In the health sector stand out the National Institute of Health, Immunology Research Group of San Juan de Dios Hospital, led by Dr. Manuel Elkin Patarroyo, research centers in cardiovascular and transplant clinics, where it is important to note the work of the group of transplants from the University of Antioquia, with the latest developments in the tracheal transplant and the Clinica las Americas, which in 2002 began operation of the Unit for transplants of bone marrow.

3.6 Technology Transfer Agreements

The technology transfer agreements that are now in force, as well as those that once existed in Colombia, arose as a result of free trade agreements between Colombia and other countries of the world and also between different companies in the industrial sectors of Colombia such as textiles, agricultural and automotive among others, as well as of institutions responsible for research, development, technology and education as is the case of the SENA.

3.6.1 Free Trade Agreements

It is an agreement whereby two or more countries regulate in a comprehensive way their commercial relations with the aim of increasing trade and investment flows and in that way, their level of economic and social development.

Actually Colombia has nine free trade agreements in force:

- Colombia – México (FTA)
- Colombia – Cuba (Agreement)
- El Salvador – Guatemala – Honduras
- CARICOM
- CAN
- MERCOSUR
- Chile
- Canada
- EFTA

In addition to these treaties Colombia has agreements with: The United States of America and the European Union. European Union: is the second investor in Colombia. Cumulative investment of the period from January 2002 to September 2009 of the European Union in Colombia (without including the oil sector) reaches 6 thousand \$350 million. With the Agreement, the investment flow between the EU and Colombia will be promoted, given the commitments of stability, transparency and protection of investments.

In regard to intellectual property agreement includes provisions which have as their object the adequate and effective protection to intellectual property rights, maintaining a balance between the rights of the holders and the interests of the general public, particularly in the field of education, research, public health and access to information. It was also agreed commitments in the field of protection of biodiversity, technology transfer and cooperation, reaching an appropriate balance between the protection afforded to agricultural products in the field of geographical indications and that will be assigned to products derived from biodiversity. "The arrangement will open a new framework for bilateral trade and investment relations between the EU and the Andean countries," the EU said in a statement. Brussels considers that the agreement offers new opportunities for market access for European economic operators, Peruvians and Colombians.

The deal "takes into account" the different levels of development between the countries involved and provides a chapter of cooperation aimed at promoting competitiveness and innovation, as well as to facilitate the transfer of technology.

On the other hand, Colombia is currently negotiating with Panama, Turkey and Korea. Although these have not entered into force the governments have conducted several meetings that have strengthened the issues raised by the national government.

Korea: The trade agreement with South Korea is due to an effort that the country has developed to achieve preferential access in different markets for Colombian products and services, as well as the objective of strengthening trade ties with Asian countries and attract productive investment of the same.

In general terms what it means to have a trade agreement with South Korea is:

A free trade agreement between Colombia and one of the Asian countries will allow closer relations to encourage negotiations with other countries of that continent. This situation may ensure similar conditions for Colombian companies against their competitors of countries like Chile and Peru, which benefited or will benefit from preferential market.

Among the benefits of the agreement are lower prices and better options in goods and services for the Colombian consumers, the development of production conditions and promoting productive alliances in Colombia through greater access to raw materials, technologies and capital goods. It also means strengthening cooperative links for technology and knowledge transfer. Today Colombia has a Memorandum of Understanding for cooperation in industrial areas, and the NAFTA account with a chapter of cooperation.

3.6.1.1 Asia and Pacific

In the case of Colombia, exports to Asia contain a greater participation of high value added products and a smaller share of primary products that toward the rest of the world. In addition to this, the country exports mainly commodities and based on natural resources toward this region and has been importing goods of high and medium technological level. This is complemented by analyzing the results of the indicator grübel-Lloyd (g-l) that compares in terms of product, the complementarity of the trade between two countries or regions. This indicator shows that there is a great complementarity, both between Colombia and other countries in Asia Pacific, as between the Latin American countries of the Pacific Rim and Asia Pacific.

The ten products greater trade between Colombia and Asia Pacific have all with an index g-l lower than 10 %, refuting the existence of intra-industry trade; i.e. trade of the same product or industry that flows in both directions in relative magnitudes similar. Some of the products more exchanged are motor vehicles and their parts, coffee, rubber products, telecommunications equipment, and textiles. Of the 250 products exchanged between Colombia and the Asia-pacific Region, only 31 have evidence of intra-industry trade, in accordance with the results of this indicator.

	AREA	NATIONAL POLICY	LINE	ACTIVITY
INDIA	Information technology and telecommunications	Development and competitiveness of the ICT industry	Technology transfer and innovation	MOU implementation on ICT
	Technology and science	Law 29 1990, COMPES S & T	Technology transfer and innovation	Formulation of projects, exchange of knowledge in energy, oil, natural gas, BPO, KPO, steel, auto parts, jewelry, biotechnology
	Environment	Climate change policy guidelines.	Technology transfer	Projects for the elimination of hazardous waste.
	Energy	CONPES-Biofuels	Technology transfer	Machinery, technology and biofuels production.
		Renewable energies.	Technology transfer	Solar energy, electrical interconnection and hydroelectric projects.
JAPAN	Technology and science	CONPES of S & T	Technology transfer	Applied sciences, ICT, biochemistry, auto parts
CHINA	ENERGY	National Energy Plan	Technology transfer	Construction of hydroelectric dams.
AUSTRALIA	ENERGY	National Energy Plan, CONPES Biofuels	Technology transfer	Mining agreements and exchange of experiences in production of liquid fuels. Commercialization of biofuels

Table1. Agreements with Asia and Pacific

3.6.1.2 FTA between Mexico, Colombia and Venezuela G3

The Treaty of the Group of Three (G-3), composed by Mexico, Colombia and Venezuela, was signed on June 13, 1994 and entered into force on January 1, 1995. Trade between Colombia and Venezuela will continue to be governed by the Cartagena Agreement. (Andean Group).

In accordance with the agreement of the Group of Three, the tariffs over a period of 10 years will be completely eliminated. The exceptions are particularly important in the agricultural sector. Unlike most of the trade agreements between Latin American countries, the agreement of the Group of Three not only contains provisions on tariffs, but refers to matters such as intellectual property rights, services, government procurement, and investments.

The treaty seeks a broad and safe access to the respective markets, through a gradual elimination of tariffs, recognizing the sensitive sectors in each country. Establishes disciplines to ensure that the implementation of the domestic measures for the protection of health and human life, animal or plant, the environment and the consumer, they would not become unnecessary obstacles to trade. Also fixed disciplines to avoid unfair trading practices and contains an efficient mechanism for the settlement of disputes that may arise in the commercial relationship between those countries.

-Objectives

- Those related to the processes of Latin American integration.
- To foster the active participation of the various economic agents, in particular the private sector, in the efforts to deepen economic relations between the Parties and to develop.
- Strengthen the special ties of friendship, solidarity and cooperation between their peoples.
- Contribute to the harmonious development and expansion of world trade and the expansion of international cooperation.

-Create a broad and secure market for goods and services produced in their territories.

-Reduce distortions in trade.

-Establish clear rules and mutual benefit to their trade.

-Ensure a predictable commercial framework for the planning of productive activities and investment.

-Strengthen the competitiveness of their companies in global markets.

-Encourage innovation and creativity through the protection of intellectual property rights.

-Create new employment opportunities, improving the working conditions and living standards in their respective territories.

-Preserve its ability to safeguard the public welfare.

-Promote sustainable development.

-Section D – Technology Transfer

Article 18-24: Promotion of technology transfer

The Parties shall contribute to the promotion of technological innovation and the transfer and dissemination of technology by government regulations favorable to industry and commerce that are not anticompetitive.

The Parties will contribute to the promotion of technological innovation and the transfer and dissemination of technology through government regulations favorable to industry and trade that are not contrary to the competition.

IV. TECHNOLOGY TRANSFER IN THE COLOMBIAN TEXTILE SECTOR

Throughout the history of Colombia technology transfer has been evident in different sectors, such as: Agricultural, automotive, textile, telecommunications, etc...

In this work we will deepen in the textile sector, which had its beginnings in Colombia toward the 18th century, when artisans in the department of Santander, provided a domestic market for woolen fabrics and cotton, using rudimentary technology. With industrialization, cloths, linen, silks and other tissue textiles from England began to dominate the Colombian market and because of this local activity of the weaving machines went to bankrupt.

Between the years 1900 and 1921 the first factories in the country were established. Many of these were located in Medellin and the surrounding area, since this city was the epicenter of the coffee economy, which provided the initial capital needed. As a result of the great depression of the 1930s, the textile industry was re-structured and two major leading companies emerged: Coltejer and Fabricato

These companies with Tejicondor established an oligopoly, in accordance with an industrial census carried out in 1945, representing 60% of the total production capacity of yarns and tissue textiles of 66 registered companies.

On the other hand, since its creation in 1940, the Institute for industrial promotion IFI has played an important role by creating and funding important textile Colombian companies.

Eventually Colombia became an exporter of cotton, yarns, tissue textiles and clothing. In 1995, exports of textiles exceeded for the first time to imports, being the first US\$12 million, against US\$5 million of the latter.

In addition to this, it is important to mention the interest that Colombia has, to strengthen commercial relations with different countries, through negotiation of free trade agreements, such is the case of EFTA, countries of the Northern Triangle, Canada,

European Union and USA The Sector Textile-s has actively participated in these negotiations and has been involved in the positions that need to be more convenient for the sector.

4.1 Strategic alliance with PAD system technologies and CTTM to benefit companies of clothing in Latin America.

CIDETEXCO, PAD System Technologies and the Centre de Transfert Technologique Mode (CTTM), with the support of the Canadian cooperation and Colciencias, agreed on a strategy to support small and medium-sized clothing enterprises from all over Latin America, which will allow transfer of advanced technology for the design and development of products in the industry.

The convention allows for small apparel companies have access to CAD technologies for the design and development of their collections with minimum investment with respect to the actual costs of the systems. The process of CAD technology transfer involves a high component of training of human talent.

To start this process CIDETEXCO and PAD System signed an agreement that strengthens the network of cooperation between the center and proposed operational activities of dissemination and implementation of technology.

The activities started in the month of July 2006, with a training program for the working team of CIDETEXCO, who received training in the CAD/CAM technologies, and formalized cooperation agreements for carrying out technology transfer projects. As a result of this training, CIDETEXCO, PAD System Technologies and CTTM have established a strategic alliance for the transfer of CAD/CAM technology in Colombia and Latin America.

PAD System Technologies is a Canadian company dedicated to the production of CAD/CAM solutions of high technology, simple, efficient and flexible geared to the textile and clothing sector.

The Centre of Transfert Technologique Mode (CTTM) is an entity that aims to provide up to the fashion industry with access to the most innovative procedures, the most recent technology and a wide range of services including subsidised programs for research and development for the improvement of productivity and corporate profitability.

CIDETEXCO, with the support of COLCIENCIAS and the Secretary of Economic Development of the Capital District, develops a project that will be transferred to companies in the clothing sector in the city of Bogotá a model for the management of the technical office supported in the computer technologies specialized developed by GESCOM.

The transfer of these management model and specialized information technologies for support develops capacities in the company to:

- Perform operations analysis, subsets and lists of phases.
- Determine the times of manufacturing of direct labor.
- Systematically record the lists of operations and methods.
- Calculate the production costs in own plants or satellites.
- The balancing of the plant to any contingency, lack of personnel, machinery, organization by jobs.
- Plan and schedule the production in a technical way.

Through the implementation of this project, CIDETEXCO plans to consolidate and to socialize the management model of the technical office and the required technology for the continuous improvement of productivity and competitiveness. This progress will allow the SMes (Small and Medium enterprises) clothing companies to be able to meet their markets more competitive.

Problem

In a dynamic global environment where is the market who defines the selling price of the products, the high competitiveness and the quick response make the

difference at the moment of making business; hence it requires a special dynamic in the estimation and identification of time and costs, from the moment that a new design is conceived, until the product is sold, compiled and released to the client. The precision and level of confidence in the whole determination process of time and costing standards could mean the difference between profit and loss.

In most of the apparel companies the methodology for costs determination and their real control is poor, leading to a cost minute outdated in comparison with the international standard.

Diagnostic studies conducted by CIDETEXCO, show that the common denominator is that many companies lack a system and methodology appropriate for the application of engineering in analysis of working methods, definition of the standard times of production and studies on the consumption of materials, on which can be based a technical costing, the planning, programming, and production control; this situation is reflected in most of the cases in a poor utilization of installed generation capacity and the potential turnover of the company, generating low operational results and precarious return on equity and sales.

The implementation of the elements that make up the cost of the products (materials, direct labor, indirect labor and overhead costs among others), it is imprecise and without technical soundness. This is translated into sales prices do not accord with the costs of operation and incorrect margins, by subtracting negotiating capacity and competitiveness in the market.

In conclusion, the majority of companies in the garment industry have inadequate management and lack of a system and methodology for the determination of standard times, cost management, planning, programming, and production control.

Context

A Technological Balance study, carried out in the year 2005 and published in 2006 developed a technological characterization and identified the weaknesses and threats of the productive chain of women's underwear, but the results of this study are a reflection of the clothing chain in general.

The technological characterization of the productive chain carried out by the study revealed that companies face difficulties in general against the phenomena of globalization, and particularly from the impacts of the FTA with the United States.

A comparison of the global against the local carried out by the diagnosis of the Technological Balance Sheet shows gaps in each of the evaluated aspects, and is conclusive in the following fundamental aspects:

- The Colombian textiles and apparel industry linked to women's underwear, which is a reflection of the entire sector, needs to maintain its competitive advantage improving constantly the production technology and distribution methods and innovating through the design of new products. Investment in innovation, research and development and the rapid adoption of new information and communication technologies are crucial factors for success.
- Traditionally, the textiles and garments areas have been users but not generators of technology, however the situation is evolving: Some companies in the sector have become important generators of new technologies through the development of new materials and more efficient processing technologies of textiles; this allows the sector to obtain value-added products for applications for multiple sectors. }
- The sector is with new technological requirements created by the need to protect the environment, or consumers with requirements of labels that could hamper the proper functioning of the market. Divergent Requirements threaten to distort competition between countries if they cannot be harmonized at the level of the region and/or between the countries of Latin America and third countries that are not in harmony on a global level. What is more, it requires free access and non-discriminatory market to public procurement in order to fully exploit the potential of the domestic market.
- Given that the fashion and design are key competitive advantages of the textile industry, violations of intellectual property rights can undermine those advantages and reduce the return on investment in these areas.
- As soon as regards training and employment, the sector presents some difficulties concerning the recruitment of highly qualified staff in

information and communication technology. Another problem is the use of training programs for occupational competencies.

- In view of the increase in the degree of liberation in the world market, the opening up of export markets is of crucial importance for the Colombian industry. However, the companies have yet to face a broad scope of tariff and nontariff trade barriers applied by many trading partners. For this reason, the industry must seek access to the markets of other countries, for example with the European Union and China, through all available means including bilateral negotiations aimed at the improvement of access to mutual markets.

Taking these factors into account, the Technological Balance Sheet defined, together with the participating companies in its elaboration, a portfolio of technological projects with short, medium and long term for the closure of the identified gaps. This proposal is framed within the portfolio of projects.

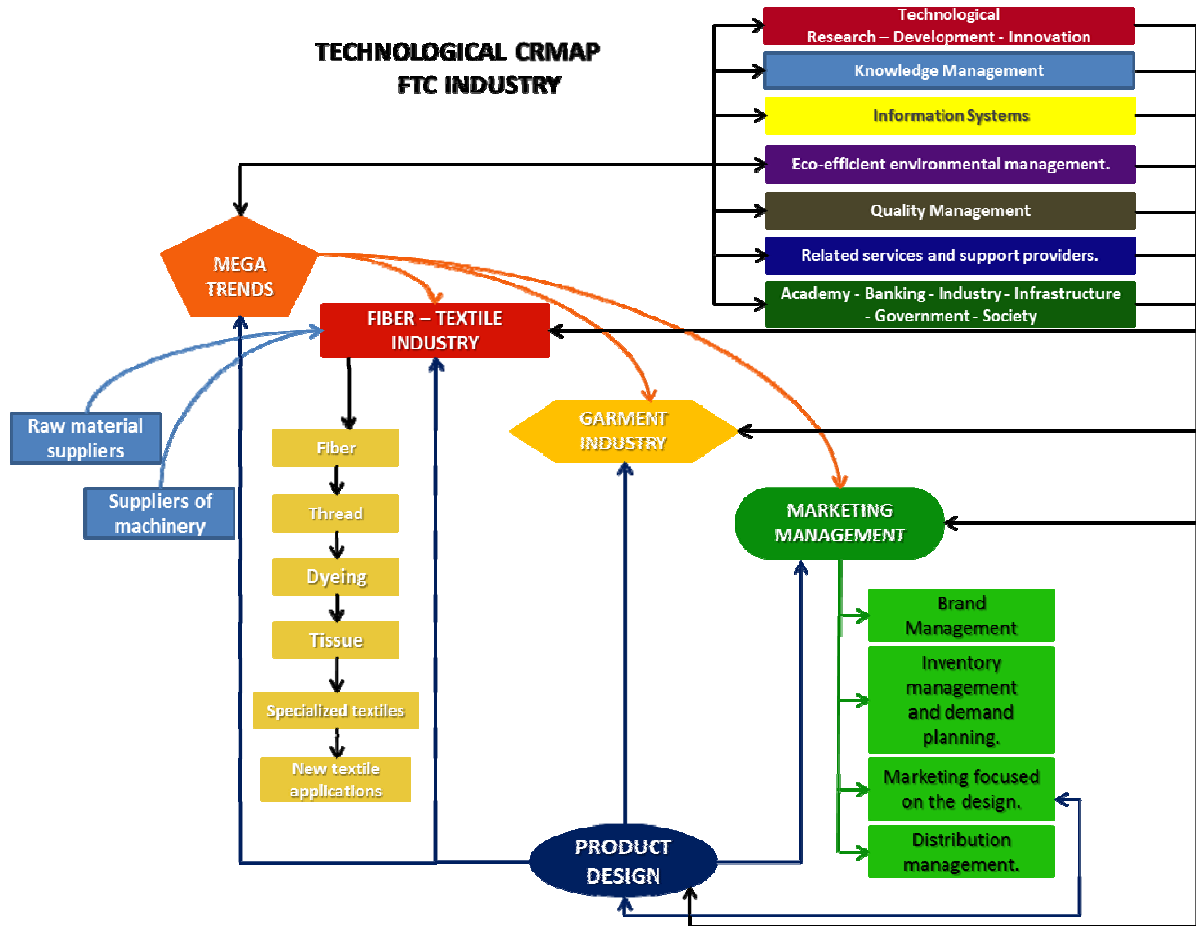
4.1.1 Strategic and Technological Map of the Fiber Chain

CIDETEXCO conducted an investigation that seeks to determine the positive and negative impacts that technological changes have on the Colombian chain Fiber-textile-clothing -FTC-, in the medium and long-term, and from there identify a portfolio of projects for the technological modernization of the different links in the production chain, considering from the raw materials, spinning, weaving, dyeing and finishing, to the marketing of finished products.

The study begins with the identification of technological trends in each link; it records the projects of technological prospective in the FTC chain made at the international level of centers of excellence. This is especially relevant and shows that the Colombian industry textiles and apparel has to improve its competitive advantage constantly innovating in production technologies and methods of distribution and products. Investment in innovation, research and development and the rapid adoption of information and communication technologies are crucial factors for success.

Until recently, the companies of textiles and apparel were considered as users of technology but not generators of this. Today the situation has evolved: some companies in the sector in the FTC chain have become important generators of new technologies, innovative processes, new, technical and intelligent basic materials. These advances allow industry to obtain more value-added products for applications in multiple industry sectors. The entire production chain faces astonishing technological challenges which are necessary to respond to a consumer who proposes on permanent basis new requirements and needs that are already being served by the main providers.

The new global map of the FTC chain shows the complexity of each of its components, three links perfectly aligned with each other, which implies a relationship of effectiveness-efficiency, requires organizational strategies, grouping and synchronization for their perfect logistics development and assimilation of the changes. The map also points out that the tissues, and the garments are much more than clothing and that by its spectrum of options in industrial and technical textiles are providing new competitive advantages and new commercial opportunities. Nowadays the location of the FTC chain has unique characteristics associated with its management of marketing, account with macro processes transversal support, where for the purposes of this study highlights the Research, Technological Development and mega trends.



Source: CIDETEXCO Elaborated by the author

Fig. 4 Map of FTC chain

The map identifies the core technologies and the sub-associated technologies, displays each one of the components of the generic chain, raw material, spinning, weaving, dyeing and finishing, also the different technologies that in one way or another have been driven by Research and Technological Development and Innovation. Thus, appears clear the influence of new biotechnology developments in the production of "natural or artificial" fibers and textile materials by making them more compatible with the needs and human performance.

New automation developments of industrial processes are helping to develop the production of friendly environment materials, even going to convert them into biomass for power generation, given the high recycling capacity that is expected to have with these new fabrics and textiles. In the garment industry, robotics is suggested as the new technology to explore to automate production activities. The

impacts of information technologies and communication -TICs - in trade, today they are already commonplace in the management of the global business, but in the local context it is very incipient, for example, the use of CAD/CAM and the appropriation of the Internet as a marketing tool.

The technological surveillance exercised by the main centers of research and technological development of the world brings a vision of the State of the art that allows the identification of five trends that mark today challenges and global challenges belonging to the FTC chain.

1. Business reconfigurable
2. Innovative products and processes,
3. New business models,
4. Development of new materials and
5. New human skills.

The technological development centers linked to the FTC chain located within the European Union, United States of America, Brazil, and the Republic of China (which stands today as a major producer and exporter of textiles and clothing), are developing new technologies that are expected to be marketed in the next few years.

The list of research projects (described below) is a clear sign of the profound technological change to become a reality in the near future, and that could make the Colombian companies more vulnerable against competitors that are associated with this technological change. The changes are being driven by competitive intelligence systems and technology watch that disseminate and encourage the associated policies to promote:

1. Research, technological development and innovation.
2. The strategic management of knowledge.
3. Industrial transformation.

The research carried out by CIDETEXCO on best practices, technology foresight in the FTC chain on a global level and its comparison with the local and identification of the main gaps, suggests actions designed to close them, taking into consideration the sectorial document of the Domestic Agenda, the long-term program for the sustained growth of the economy and employment, the Government's proposal on productive transformation to improve and generate a competitive offer in use of the spaces that Colombia has expanded in world trade, and that today give preferential access to markets in 45 countries, representing a greater potential to a billion consumers.

The results of this research show that the challenges for the modernization of the Colombian FTC chain should be the order of the day, since the obvious risk is quickly jump to the technological obsolescence with the due negative impacts on productivity of all factors and loss of competitive ability.

The portfolio of technological projects is primarily aimed at reducing technological and competitiveness gaps and meets the leaders who have imposed their world-class best practices. The projects are grouped in 8 categories, as follows:

1. Develop a Competitive Intelligence System of markets that would allow companies to identify customer needs customers and industry trends
2. Formation of the cluster to specialize the production of articles with high value added focused on specific markets.
3. Development and implementation of a generic model of logistics for the supply FTC chain industry in Colombia.
4. Investment Program for the modernization, productive transformation and innovation of the FTC chain.
5. Structuring a venture capital fund with international investors specialized in the FTC chain.
6. Massification of transversal technologies. (Supply Chain, CRM, ERP)

7. Massification of specific technologies for product design and development CAD/CAM systems.

8. Massification of specific technologies for applied engineering, times and standard costing in the garment industry.

The portfolio of proposed technological projects aims at reducing the competitiveness and technological gaps front to leaders who have imposed their best world's class practices. The projects have been grouped into 8 categories, as well.

The second project is aimed at the formation of the cluster of luxury items is directly related to two competitive constraints identified since long time: Economies of scale of the FTC chain producers; and specialization in the production and product differentiation.

The effort to create a cluster of Colombian luxury refers to take advantage of the existing enterprise tissue and look for generate the needed surplus to ensure that these companies can maintain in the business. This project must include the standardization of workplace competencies of the different specific jobs to each product in the FTC (Fiber – Textile- Confection*) chain.

The improvement in the supply chain for the reduction of the dead times as a strategy to reduce the needs of consolidated capital in inventories of raw materials and finished products, it is the goal of the third proposed project. This project is an important component of ICTs that are the ones that allow maintaining on-line communication and manage the volumes of information necessary to the requisite opportunity.

The fourth project is crucial. In this must intervene, the government, as well as private enterprise, and the financial system. The upgrade of the sector is possible and beneficial to the country due to the volume of wealth and employment that is capable of generating. However, this project requires a strong commitment to both the public sector, as the companies. This project includes the incorporation of standards and

technical regulations to the industry and its linkage to the National standardization subsystem, metrology and accreditation.

The sixth project implies that the companies rely on Ict's as tools for the consolidation of other projects, such as the formation of the luxury cluster or the one regarding the implementation of a logistics system. FTC companies must understand what these technologies are, how to use them and which the proper training for their correct use is.

The seventh and eighth projects are focused on strengthening the core business technologies of enterprises, the use of CAM CAD systems and the PLM in design as a requirement to compete in the global market, especially when the target market is luxury goods with a high dynamic response and rotation of collections. Product engineering is essential for the implementation of competitive production methods in conformity with the labor skills specific to each one of these specific methods.

As part of the project "innovation platform for the Textile and Clothing sector, which execution is in charge of the export and fashion Institute (Inexmoda) of Colombia, and the commitment of the Milanese institutions to share their knowhow with Colombia, the mayoralty of Milan with the leadership of the RIAL (Network Italy Latin America) and with support from the IDB (Inter-American Development Bank) through the MIF (Multilateral Investment Fund) carried out the donation of Digital cutting machine of latest technology with the aim of improving the process of cutting and digitization of fashion companies.

On the basis of this new tool for companies in the textile , clothing, fashion and design sector, Inexmoda as the executing institution of the project has established a partnership with the SENA (National Apprenticeship Service); Institution that hosts the machine, the CLUSTER textile/clothing, fashion and design, COMFAMA (Family Compensation Fund of Antioquia) and INTERACTUAR (Corporation for Social Development / Family Businesses who progress) for communication and service delivery technology available to entrepreneurs interested in improving their production processes of design, scale, digitization and cut of garments.

The donation of this machine for the Colombian textile and fashion sectors represents an improvement in the service of digital cutting, and a contribution in the competitiveness of this industry.

This transfer of technology is well received by Colombia, since it is key to boost its national industry in the generation of value, the differentiation and of course, the use of appropriate technology, which allows the sector to count with the highest-quality products and services. Innovation is crucial to the transformation of the sector and without any doubt, the service that the machine offers is very important to do this.

In addition thanks to an agreement signed around the service provided by the machine, the allied institutions are jointly working on other projects in favor of the competitiveness of the sector and the revision of the course offerings to provide better training to entrepreneurs and the provision of other joint technological services. This has been a very important achievement, gestated thanks to the donation of the machine: an interinstitutional articulation in pro of the sector.

Among the benefits offered by the machine are the following:

- Perfect cut: To get an item of value added, the cut should be perfect. The machine will allow textile industry to mechanize the cutting process.
- Not only providing the service to entrepreneurs but the technical qualifications of the machinery technicians.
- Consumes a quarter of the energy that a machine of its style; thanks to its technology "ECO-POWER".
- Savings in time thanks to the possibility of cutting simultaneously different quantities of parts (cuffs, collars, sleeves, etc.).
- Minimum wastage: acting on the weakest points in the production phase, will allow producers to estimate the costs of production from product development, making substantial savings in material. The fabric is the most costly element and the productive factor of greater relevance. This usually represents 50% of the total cost of the product.

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- Automatic System to extend the fabric.
 - Software compatible with other design programs that will support not only the cutting process but design and pattern (tech).

Some details about the machine and the supplier: The machine is automatic cutter of latest technology, reference/mark BILIARDO 60- 180/520, donated by the Mayor of the city of Milan - Italy, and provided by the FK Group located in Bergamo, Italy. The company operates in the market for 27 years and has a portfolio of 2500 customers (55% on the outside and 45% in Italy). These include Leading companies in the Textile-Apparel sector such as : Adidas, Armani, Basile, Bassetti, Benetton, Burberry, Christian dior, Dino Erre, Ferré, Hogo Boss, Kimberly Clark, Lacoste, La Perla, Louis Vuitton, Malizia, sisley, replay, Sara Lee, Think Pink, Trussardi, United Colors of Benetton. In Colombia there are around 60 similar systems (cutting machines), some of American technology, German and French. This is the first of Italian origin.

The seventh project above outlined "innovation platform for the textile sector - tailoring" is conceived as a result of a joint effort between multilateral institutions, public and private, that with their leadership have managed to strengthen and enhance the development of the city and the country.

Today, these institutions are united in order to contribute to the improvement of the competitiveness of the textile and clothing industry, design and fashion, from training strategies, innovation and access to new markets, among others.

The platform project for innovation for the textile-tailoring sector is aimed to contribute to improve the competitiveness of the sector and to consolidate the cluster textiles/clothing, fashion and design in Medellín-Antioquia, improving the level of associativity, productivity and innovation of companies.

The objectives of the Project are:

- Promote a culture of integration and collaboration between stakeholders in the cluster, from the formation of associative groups.

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- Promoting research, innovation and training of entrepreneurs in the pursuit of generating value-added processes, products and services.
 - Develop an intelligence system of permanent market that throw business opportunities for entrepreneurs in niches of high value added, both in new external and internal markets.
 - Generate quantitative and qualitative data on the performance of SMEs in the sector, from the creation of a National Observatory of textile and clothing industry.

The IDB - Inter-American Development Bank is a major financier of the Project and the support organizations are: in Milan; the Region of Lombardy, Milan's City Hall, the Chamber of Commerce of Milan and the RIAL - Network Italy Latin America. In Medellin, the Mayor of the city, the Chamber of Commerce of Medellin for Antioquia, the Cluster textiles/clothing, fashion and design and INEXMODA - Institute for export and the fashion, the project executing agency.

Among the benefits that bring to participate in this project are:

- Identify a new path of opportunity for companies: niches with a high value added under a concept known as Premium.
- Move along the path of the Premium, generating value added to its processes, products and/or services from training on issues of vanguard.
- Have all the information on sector opportunities in niche value added in the Canadian, European (including Spain, Greece, Italy and southern France) and Colombian market.
- Receive "know-how" of international experts, mainly from Italy, a country considered as great ally of the project on issues of value-added.
- Having the possibility of access to information produced by an exclusive economic observatory for the sector which will allow quantitative and qualitative information to support their decision making.

Taking into account the participation in the projects the beneficiaries could be:

- All formal enterprises and registered at the Chamber of Commerce.
- The project is mainly aimed to small and medium sized companies; however, those micro and large firms that have the generation of value added in its strategic plan may have a place in this project.
- All those who want to gamble on niches of very high value added can benefit from the activities of the project.

The inherent challenges in this project are:

- Leave installed capacity in the region to irradiate the results in Colombia and Latin America.
- Ensure that each component of the project is self-sustainable.

The results to be obtained from this project are:

- To create and train 12 associated groups.
- Promote the creation and consolidation of a long-term relationship company - university that would permit the generation of 9 research agreements (innovation projects)
 - Train 240 SMEs for the development of strategic plans.
 - Support the incursion of 240 SMEs in 5 new markets (3 internal and 2 external).
 - Create and strengthen the development of economic observatory of the sector.

In addition to the technology transfer agreements signed by CIDETEXCO with various entities such as: PAD System, the Center of Transfert Technologique Mode (CTTM) and the Mayoralty of Milan (Italy), all in order to improve the day-to-day production of the fiber-textiles chain in Colombia, the country has followed in a continuous search for viable innovation and therefore applicable in the FTC chain with

the aim not only to have an increase in the production with highest quality standards but also with the spirit to grow and gain a better position in this world market.

4.2 Nanotechnology and Nanotextiles

Within the framework of the innovation process in which is the Colombian textile sector, together with the help of the SENA and its nanotechnology area located in techno-park Bogota and the Universidad de Los Andes, some studies have been performed in the area of nanotechnology and its implementation in different industries, focusing on the use and the benefits that this technology can provide both the textile and the clothing field.

In this part of the work will be carried out a deepening in the development of nanotextiles in the country, but must be done before a brief conceptualization about nanotechnology, their uses and others.

Nanotechnology is defined as the study, creation, manipulation and design of matter at nano scales, which allow the industry to discover new properties and functionalities of matter. There are two types of Nanotechnology:

Top-down or reduction in size: For this the elements and structures are miniaturized to the Nano scale. This type of Nanotechnology has been the most common to date.

Bottom-Up or Auto assembly: It begins with a nano structure as a molecule and by a process of self-assembly; a larger object is created. In this manner allows the material can be controlled itself in an extremely precise way.

According to the progress that has now developed nanotechnology in the world can show their application in various fields such as: health, industry, construction, technology. From these sectors some products can be illustrated: medicines, clothes, food, construction materials, and computer applications and electronic among others.

Traditional companies may benefit from nanotechnology to improve its competitiveness in usual sectors such as textile, food, footwear, automotive, construction and health. It is intended that the companies belonging to traditional sectors incorporate and implement nanotechnology in their processes in order to contribute to the sustainability of the employment. Currently the number in daily use is 0.1 %. With the help of access programs in nanotechnology it is expected that in 2014 its use is of the 15 per cent in manufacturing production.

In the mid-twentieth century, major technological advances in the production of textiles were based on the use of natural materials such as cotton, wool and linen. Recently synthetic polymer fibers were developed, such as Lycra®, compound urea-segmented polyurethane that has elastic properties, and nylon. Also, in terms of resistant materials used for personal protection, has been used the Kevlar®, trade name of “*poliparafenileno tereftalamida*”, used in bulletproof vests. (Coyle et al., 2007).

Within the latest technologies that have been generated for textiles production, there are those in which they are used intrinsically conductive polymers (ICPS); similarly, carbon nanotubes (CNT), as well as a series of materials in forms of nanoparticles or nanofibers, have found a place in the production of textiles with features that give them a higher value added.

First, the technology based on intrinsically conductive polymer (ICP) such as polyacetylene, polyaniline, polythiophene among others, has been used in chemical sensors to detect vapors which, by interacting with PCI, change its conductivity, which is useful in textiles to protect people from poisoning by hazardous substances. Furthermore, its capacity for change in electrical potential makes them useful in the manufacture of smart textiles, which have utilities such as color change immediately in the presence of a specific substance; repel harmful substances and microorganisms, among many others. (Coyle et al., 2007).

The nanofibers are fibers of diameter less than 1 nanometer. The processes of conventional fiber spinning are able to produce polymer fibers with diameters in the nanometer range, for this reason, for this reason, there are processes to make them where the most widely used is the electro-spinning, which consists in

applying electrostatic forces to a filament polymer solution. The specific surface of tissue obtained from nanofibers, together with its high porosity and tiny pore size, make them well suited for use as membranes for filtration and separation. Currently polyester NYLON nanofibers are produced, which have hygroscopic properties better than those of cotton. (Prince, 2008).

4.2.1 Nanotextiles in the World

All the advances that have been made in the area of nanotextiles have enabled various sectors to perform applications in their fields, such as sports equipment, health care, protection and security, and tissues for daily use; such applications are currently marketed by companies that have specialized in bringing the knowledge generated in nanotechnology in the production of textiles novel.

Within these companies and institutions can be highlighted to Nanotex® (a pioneer in this field), BASF AG (who has 232 patents), Ciba Specialty Chemicals Holding Inc. (with 212 patents), E.I. DuPont (con 135 patents), SCIMED Life Systems Inc. (with 66 patents). At the global level, the industry has a set of 566 companies and institutes which in the year 2007 have generated about 2104 patents related to nanotextiles. (Escorsa, 2008).

4.2.2 Nanotextiles in Colombia

As is common in developing countries, from the point of view of value generation, employment and foreign exchange, the textile and garment industry is one of the most important in Colombia; however, it should be recalled that the country is not a major supplier in the international market for textiles. For the year 2003, the textiles and garments chain accounted for 14.7 % of the total industrial employment and 8.6 % of national production.

In addition, the domestic industry of textiles and apparel has high potential growth, as it benefits from special systems of export and import also incentives still in force such as the free zones, the Plan Vallejo among others (DNP, 2003).

On the other hand, the development of the existing supply chain in the country has enabled companies to jointly develop multiple processes (from the yarn, fabrics and the own clothing as the design, cutting, washing, embroidery, dyeing and printing), which has led to substantial partnerships between the national industry and recognized international brands of clothing (Department of National Planning, 2004).

However, Colombian textiles are facing new challenges generated by the free-trade agreements, such as the FTAA (Free Trade Area of the Americas) and those in the approval process, as the Free Trade Treaty with the United States, this makes necessary for this industry to acquire tools in order to increase its competitiveness against countries such as China, a worldwide leader in the market for textiles and apparel, Brazil and Mexico, where levels of competitiveness of its firms are higher than ours due in part to the fact that these countries have undertaken reforms through programs of industrial re-structuring which sought to improve the levels of productivity through partnerships between companies and support for research and innovation.

Taking into account the case of these Latin American countries, it is important to follow with the initiatives of institutes as INEXMODA and CIDETEXCO for formation of business groups or clusters, with which it is intended to provide support, both economic and technical, to a greater number of companies, and where is fundamental the action of training institutions and technological development such as the SENA and COLCIENCIAS, who are responsible for facilitating to the textile and garment sector the development of improved production practices and access to the implementation of new developments and technologies.

Within the technologies that are being implemented in the textile chain-apparel in the country with the support of CIDETEXCO and COLCIENCIAS, it is possible to find the related with the information and telecommunications, as well as the control, simulation and monitoring of production processes, environmental protection and quality control. In relation to the manufacturing processes of fibers, are being implemented innovative developments that seek to add value to garments and fabrics, such as mechanisms to increase the quality of inkjet printing on textiles, new microfiber where industrial technology of cold plasma is used, also coatings and reagents to reduce flammability or modify the cleaning of textiles, advances that involve

biological processes ranging from the genetic improvement of cotton, wool and silk, to the creation of new fibers from biopolymers are being utilized.

Within all of these developments it is important to highlight the researches related to nanotextiles, which are being carried out on institutes such as the University of The Andes, with the support of COLCIENCIAS. These studies are designed to achieve methods of manufacture of fibers containing carbon nanotubes, exhibiting conductive characteristics in order to obtain tissues antistatic, increase of electrical conductivity, among others. Furthermore, they are developing coatings with that attain a change of color to step of a low-voltage electric current (CIDETEXCO, 2003).

Considering that the country has research initiatives and is already implementing developments in textiles based on nanotechnology, it is necessary to create strategies which help to strengthen and guide the research projects, which are consider to be few in Colombia. For this reason, one of the strategies may be to link and build up alliances between research institutions, universities and COLCIENCIAS; and the aim clearly, is to create synergies between them and create new and more ambitious projects within the field of expertise, nanotextiles.

On the other hand, there should be alliances focused on acquire the latest knowledge and patents develop within the leaders in the field, like USA, Japan, Germany & Spain. In that sense is important to have the support of research institutions like INTEXTER (institute of textile research and industrial collaboration) in Cataluña, Spain; the Hinestroza Research Group Textiles Nanotechnology Laboratory which belong to Cornell University, in USA; among many others which are able to handle the latest developments in the field. (Hinestroza, 2007)

It is worthy to mention the paper of Colombian researchers within institutes of investigation in nanotextile field; that is the case of director of the second institute mentioned, Juan Pablo Hinestroza, who is BSc Chemical Engineer granted by Universidad industrial de Santander (UIS) and who at the beginning of the present year gave a seminar called the world changes: from innovation to eco-tecno.

In this manner, the finest results regarding technological developments within the previous mentioned alliances, at national or international level, should be taken to risk and feasibility analysis and then, implement it in the productive sector helped by universities and the SENA, entity that contributes to the competitiveness of Colombia through: the increase of productivity in businesses and social inclusion. That is why today the SENA through techno-park node Bogota has been developing projects of nanotechnology focused on the textile area, these advances have been achieved thanks to the use of equipment that have been obtained in the form of transfer of technology by Nanoink, also techno-park personnel has been trained by researchers from India.

4.2.2.1 Work in the area of nanotextiles by technopark node Bogota

As mentioned above much of the research and development in the area of nanotextiles is due to the work of Bogota Techno-park node, as it is in a constant search for technological tools that respond to social needs, environmental and economic of the region and the country, identifying the nanotechnology as an area of interest to position domestic productive sectors in the world.

Bearing in mind that the accelerated development of other countries in nanotechnology processes, evidence statistically that industrial production becomes more competitive, and improves the quality of their main products for export to the world.

Some of the nanotechnology services offered by technopark are:

- Training workshops for management of synthesis equipment, for Dip Pen nanolithography ® (DNP ®) and characterization by AFM and FM.

- I. Technology Outreach Events
- II. Accompaniment to nanotechnology projects
- III. Bank of projects of applied science to the productive sector in nanotechnology
- IV. Physical Infrastructure
- V. Accompaniment patents in nanotechnology (technological surveillance)
- VI. Surface characterization

In addition technopark has identified the areas of greatest interest at the national level in which the progress in nanotechnology can be of great use.

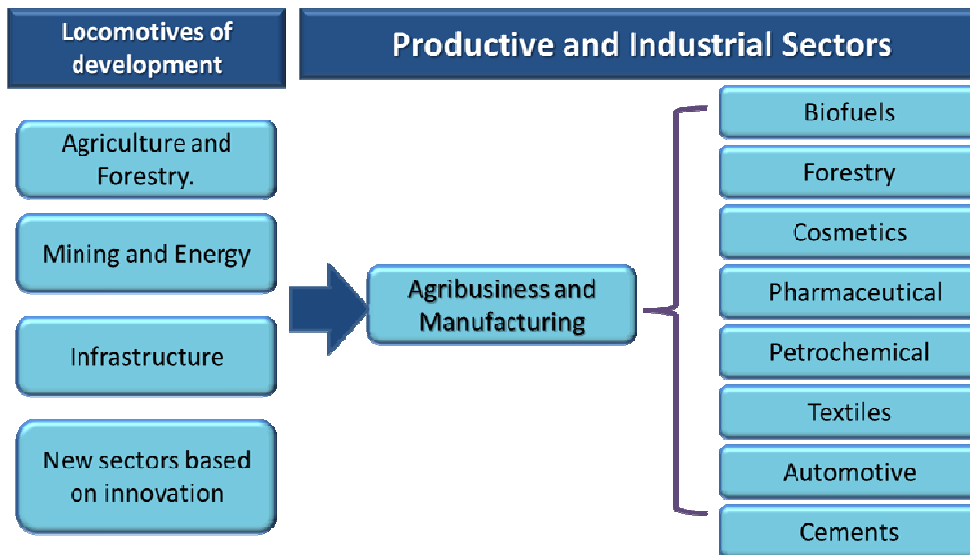


Fig. 5 Areas of interest

In accordance with Technopark about the future of the nanotextiles in Colombia would be represented as follows:

-Development of nanofibers: nanoclays, nanoparticles of metallic oxides and carbon nanofibers.

-Fibers with nanoporous structure: ultralight and high thermal insulation, encapsulation ability of chemical compounds.

-Nanostructured textile finishing: water repellent, grease and dirt, with antimicrobial functions

-Sport and the environment.

-Smart uniforms.

Finally, it is important to help and contribute to the companies to use these technologies by giving easy and low cost credits, consulting in best practice regarding production, marketing and fiscal management with the aim of reach easily the highest level of competitiveness in the textile industry.

V. CONCLUSIONS

Thanks to the agreements signed for technology transfer between CIDETEXCO, PAD System, the Center of CTTM transfert technologique Mode and Italy, Colombia has managed to maintain a good economic and productive position in the textile sector by allowing the industry not only to innovate but also create the possibility of better training for both technical, professional as well as for empirical obtaining in this way significant improvements in the production chain in this field.

It is evident that Colombia needs to strengthen its exports through optimization of their products; as well the area of nanotechnology in Technopark Colombia constitutes an important focus for improvement of the productive sectors, promoting applied research and carrying out projects aiming at the development of regions, countries through innovation and technology.

The textile industry in Colombia is one that has greater employment generation, but does not have a significant role in the international market. Therefore it is necessary to increase their competitiveness in order to respond to the challenges posed by the global market and specifically to the free trade agreements between Colombia and other countries.

Institutes such as CIDETEXCO and INEXMODA have drawn up plans to increase the competitiveness of the textile and garment sector, based on the implementation of best practices and the creation of business groups or clusters, with which it is intended to give the knowledge about new developments in a greater number of companies.

As it provides higher value-added products, it shows the importance of technological innovation and implementation of new development to increase competitiveness. In this sense, it is important to develop research projects looking for production methods that are feasible for implementation in the Colombian companies.

Nanotextiles research is useful in the country as they seek applications economically and technically feasible for the Colombian companies, and once these developments become available are brought to the industry by providing benefits to companies that are preparing to implement them. In this sense, partnerships are important national entities such as MMSU, SENA, universities, CIDETEXCO, INEXMODA and businesses.

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