SMART FABRICS: A CASE STUDY IN INDUSTRIAL REVIVAL

Radan (Ungureanu) Adriana
Doctoral Candidate, Department of International Economics and Business, The Bucharest University of Economic Studies, Bucharest, Romania
adriana.radan@rei.ase.ro

Abstract: *The movements on the world market suffered by the traditional textile industry bring us nowadays to reconsider the rebirth of the textile industry on new coordinates by the concentration of the latest technologies in order to satisfy the more and more demanding requests of the consumer. This paper tries to emphasize the idea that revitalization on a territory where there had been a strong development of a traditional textile industry in the past is possible now by configuring a new industry by means of some leader companies in their field of activity which create and develop new value sources with the advantages of the variant which integrates the latest interdisciplinary technologies, the so-called "key enabling technologies" (KETs), such as the microsystems, the smart materials, nano- and bio-technologies, and photonics. The KETs have a key role in creating the so-called industry of smart fabrics as it is shown in this summary case study for this very new born industry. All these technologies enable the appearance of some products fundamentally new of high interest, which furnish substantial economic advantages and involve industries with which they had no connection in the past. The main vectors in this effort of industrial transformation are the companies which are the best placed on the market of new industrial technologies generally called KETs, which combines the new ideas of economical organization through an intensive use of capital with the sustained effort of research-development, the usage of highly qualified labour force, and their geographical positioning at the points which best respond to their operational requirements. The competitive disadvantages of some countries with respect to the cheap labour force and the supply of raw materials essential for textile industry can be compensated by the re-orientation to the configuration of a new model of smart textiles and finally will contribute to re-launch the economic activity passing through recession, particularly in the areas more prepared from the point of view of high qualification and technical specialization.*

Keywords: KET; smart textiles; reindustrialization; competitiveness.

JEL classification: L67; O33; M16.

1. Introduction

Traditionally, the textile industry was developed based on the raw materials furnished by the agriculture and it used a labour force with the lowest qualification. These input features of industry expanded its geographical area to the zones with cheap labour force, which also had the capacity of satisfying the increasing demand of textile products at the global level.

As European Competitiveness Report (2012) shows due to the globalization, to the improvement of transport conditions and of technology, the production based on outsourcing enabled the strong optimization of costs and the development of production relations so that various stages of the technological process are deployed at the most efficient locations on the globe, which ensure the best possible industrial performance.This process also features another characteristic: the sophisticated products are the least likely to be included in the outsourcing phenomenon. In the presence of crisis phenomenon, the companies also tend to reduce the outsourcing and to keep their business on the national territory as assistance between the local companies inside the value chain.

The changes on the global market imply the adaptation of business to the best condition of price, quality, innovation, but they should also take into account at the same time the environmental restraints and create their own development opportunities. This painting of the movements on the world market suffered by the textile industry in particular, brings us in front of the question whether it is possible the revitalization of this industry on a territory where there had been a strong development in the past. Theoretically, the revitalization is possible in two variants: by upgrading the traditional industry by using the already accumulated expertise or by configuring a new industry by means of some leader companies in their field of activity which create and develop new value sources (Chiarvesio et al., 2010).

This paper intends to present a summary case study for a very new born industry as an alternative to the traditional one which integrates the latest interdisciplinary technologies, the so-called “key enabling technologies”, such as the microsystems, the smart materials, nano- and bio-technologies and photonics and creates the so-called “smart fabrics” industry. From the beginning a definition for this industry will be developed for a better understanding of its determinants regarding the competitive advantage in the new context. Due to the effort of research-development implied, the best approach starts from the involvement of strong companies which can reconfigure the industrial landscape because of their presence on the market at a significant level. They would seek for the best location both on the international arena, and at the national level, in so-called clusters. The way they approach the business is studied in the following sections.

2. Smart fabrics: industry boundaries and key competitive determinants

2.1. The theoretical approach of a general concept of industry

Some studies (Ghemawat, 2010) show that generally the industry structure defines the business landscape through the conduct of the buyers and sellers. Michael Porter presented the “five forces” framework for an industry analysis which is made by suppliers, new entrants, industry competitors, substitutes and buyers, but the main problem of the industry definition is to draw the boundaries of the business landscape. Sometimes the boundaries should be the segments that the business operates or the technology can be the delimiter. Regarding the things in their dynamic, each Porter’s force can modify the business landscape and redraw new boundaries of the industry. When an industry becomes poor or less attractive, new opportunities get born by migrating to more attractive settings. For a single company it’s difficult to change the entire structure of the industry, but its action can open a door to a more attractive direction and other players on the market can use this as a management tool. The success or the failure for the new business is in fact the result of interactions among firm’s choises as parts of its strategy. For getting a competitive advantage the business must be different from another one and offer a higher value which has to be unique. Teoretically a competitive advantage over the rivals “depends on driving a wider wedge between costs and buyer’s willingness to pay than one’s competitors can” (Ghemawat, 2010:64) but nowadays as Ralph Emerson anticipated “it’s better to strive for an edge over the competition” (Ghemawat, 2010:44). In our industry case, the “edge” means technology.

2.2 “Key Enabling Technologies”

The contribution of these technologies means more than the increase of certain parameters of competitiveness. It actually means the appearance of some products fundamentally new of high interest, which furnish substantial economic advantages, thus responding to some of the most various requirements and involve industries with which they had no connection in the past.

From the conceptual point of view, KETs are defined in the European Competitiveness Report (2010) as incorporating a high percentage of research and development (R&D), the intensive use of capital and of a highly qualified labour force within extremely fast innovative cycles. They refer to the microsystems, the smart materials, nano- and bio-technologies, as well as photonics. The small and medium enterprises, by their development dynamics, are the vehicle by means of which these technologies manifest multidisciplinary, thus imprinting within their industrial area a character of convergence and integration. Many times, these enterprises develop in a large number within the so-called clusters, where the technological and commercial development enables their affirmation as key factors for the national development and creation of jobs. The central point of interest of an innovation project is the determination of a fair relationship between the research expenses and the capability of covering them by the sale price, an activity in which there are involved the business partners, the suppliers, distributors and customers. At the national level, there is streamlined the increase of productivity and welfare by the efficient use of the production factors and of the changes of industrial structure.

The following KETs concepts and statistical data are taken from the European Competitiveness Report on 2010, which used the information gathered in the period 1991 - 2005.

2.2.1. Nano-technologies

Historically, they appeared in the 60s and they refer to the design, manufacture and use of structures at the molecular level, with dimensions smaller than 100 nm. The structures built at this scale feature electrical, magnetic, mechanical, chemical, biological, and optical characteristics much different from those at the macro scale. These changes of properties and characteristics are the engine of innovative power of the nano-technologies and they enable applications in all the fields where the materials are used. The most active zones in the world in the patent applications are Northern America, Eastern Asia, and Europe. In the rest of the world, the applications are at a low level. In Europe, Germany has the biggest number of application patents of the nano-technologies (34%), followed by France (17%), Great Britain (14%) and The Netherlands (8%). Without exhausting their huge potential, most of the products trade so far are currently based on the creation of nanostructures of carbon, silver and gold and metal oxides which have applications in all the fields, including the textiles.

In 2010, the Nobel Prize for physics was awarded for the discovery of a bi-dimensional structure of carbon atoms, which was called graphene. The structure has special mechanical properties which enable the resistance to extreme efforts,

being at the same time a very good conductor of electricity and transparent. The applications are in all the fields implying the use of materials with high resistance and which use very small quantities of raw material as it is shown at:
http://www.nobelprize.org/nobel_prizes/physics/laureates/2010/advanced-physicsprize2010.pdf
By comparison with the traditional textile industry which implies very high consumptions of raw materials, the use of these technologies allows a very small consumption of raw material with mechanical and electric properties higher than the traditional technologies.

2.2.2 Electronic Microsystems

They refer to the highly miniature semiconductor components integrated in products with large physical volume. The miniaturization is a factor which reduces the costs, helps in the fast long range transportation and enables the transformation of any product into a so-called "smart" one. The recent successes in miniaturization actually meant the combination of semiconductor technologies with the field of nano-technologies, as the silicon structures decreased to dimensions below 100 nm. Countries in Eastern Asia started to dominate the patent market in this field from 2001, followed by Northern America and then Europe; the rest of the countries have limited values for being recorded by the statistics. In Europe, Germany dominates by 41%, and then France 16%, The Netherlands 12%, and Great Britain 11%. Traditionally, the applications of electronic microsystems became applications such as memories, displays and processors, as well as products which enabled the communication between various components or systems. In the last years, the miniaturization extended to fields such as cars, medical and household appliances. The expansion of systems to other sectors shall continue, having a more and more important connection with the nano-technologies and advanced manufacture technologies.

2.2.3. Bio-technologies

These mean the use of microorganisms in the industrial processes of production of bio-materials, bio-fuels and, finally, the manufacture of textiles, leather and paper products. The bio-technology has the advantage of being environmentally-friendly, as it relies less upon the use of traditional energy resources, while it recycles what we usually call "waste", which are raw materials for that industry. In the world classification of patents of bio-technologie, Europe is on the first place, followed at a small distance by Northern America, each with about 35% of the market, and then Asia 23%. In Europe, the patent market is dominated by countries such as Germany, Great Britain, France, and The Netherlands.

2.2.4. Advanced Materials

These are the materials which have an internal structure enabling properties much enhanced than the traditional materials. Their importance is proved due to the special applications which they have in all the industries, and they help in the reduction of costs while increasing the performance, which means the increase of competitiveness. We should not omit their positive impact on the surrounding environment in comparison with the traditional products. The trend is to increase the number of applications for each newly discovered material by an average of 8, 6 applications per newly discovered material. The zones of applications cover the entire industrial spectrum: constructions, car industry, aviation, energy, medical, automations, semiconductors, textiles, appliances and security. Europe represents about half of the patents for advanced materials, 30% Northern America, and 20% Eastern Asia. In Europe, Germany covers 50% of the patents, followed by France 14%, and Great Britain 10%.

2.2.5. Photonics

These are defined as a branch of science and technology which uses the photons as carriers of energy and information, thus replacing step-by-step the role which belonged in the past to electrotechnics and electronics. Although it started in the 60s, the scientific foundations were placed by Einstein, who discovered that the light consists of elementary units which he called "quantum" and we call them photons. The development of electronics, of laser technologies, of optic fibres, enabled the creation of proper environment for the development of optical communications and the appearance of photonics, which combine subjects such as physics, nano-technologies, material science, bio-technology, chemistry, and electric engineering. The photonics is by excellence a „green" technology which enables the transport of energy without losses and the conversion of solar energy into other forms of energy. Interesting in this field is the fact that by 2001, Europe, Northern America and Eastern Asia were sharing equally the patent market. While Europe and Northern America remained with approximately equal percentages (29% Europe and 27% Northern America), Eastern Asia reached a quota of 42% of the total number of patents. The market potential of nano-technologies at the level of 2008 was of 150 billion dollars, and it is estimated for 2015 an amount of 3,100 billion dollars, which means an annual increase rate of 46%. With respect to the microsystems, in 2008 the market was of 250 billion dollars, with an estimate at the level of 2015 of 350 billion dollars, which means an increase of 13%; the bio-technologies are estimated to increase from 90 billion dollars $ in 2008 to 150 billion dollars, with an increase rate of 9%; the market of advanced materials shall increase from 100 billion dollars in 2008 to 150 billion dollars, with an annual increase rate of 6%, and the photonics shall increase from 230 billion dollars in 2008, to 480 billion dollars in 2015, with an increase rate of 8%.

All the information above shows a very high potential of development for these technologies, with many potential applications at the stage of commercial testing or as concept which strongly interfere. Even if the increase rhythm indicates a potential risk as well, the market values prove that these risks are worth being taken. In addition to their market values, their use presents substantial advantages which means a low consumption of raw material and energy, the preservation of surrounding environment, a very wide range of applications, the use of highly qualified labour force, the creation of new business, the national development and, last but not least, the achievement of a high degree of satisfaction of the final users.

2.3. Role of "Key Enabling Technologies" In Configuring the Smart Fabrics Industry

The textile industry, as it is traditionally known, is no more a profitable branch, in spite of huge investments, due to the high competition (Golra et al., 2011).

In order to face the strong competition, the entire manufacture process needs to be changed through the integration of technologies based on real time information. The concept of "smart manufacturing" was developed, which refers to the understanding and perceiving the reality in real time, and implies a rigorous planning and

coordination of the entire manufacture process. It integrates analyses of data based on advanced perceptions, under conditions of minimum consumption of materials and energy, and of maximizing the effects, which finally ensures the economic competitiveness of a country (Davis et al., 2012).
In order to outrun the current crisis and to create the conditions of economic development of a country, it is imposed the increase of investments in the process of innovation by intensifying the activity of research-development (Coccia, 2012).
The industry of smart textiles marks the beginning of a new industrial era by combining the traditional textile industry with other fields, such as IT, electronics, communications, design, where the research outcome in each individual field has impact on the creation of a new design of this industry. The central element is constituted by the individual with his needs of protection and defence, which are more and more satisfied by the integration of research in the above-mentioned fields with applicability in the areas of civil defence, military, medical monitoring, or location (Jayaraman et al., 2006).
The smart textiles originate in the field of chemical textile products which strongly developed starting from the 60s – 70s. In time, the technical materials were improved, but it was still considered that they fail to fully respond to the expectations. According to their usage, the technical textiles are classified into 12 categories (David Rigby Associates, 2010): agrotech (agriculture, horticulture, forestry), clothtech (technical components of footwear and clothes), hometech (components of furniture, household or floor coverage), medtech (hygiene and medicine), oekotech (environmental protection), protech (personal and property protection), builtech (constructions), geotech (geotextiles, civil constructions), indutech (filtration, industrial purification), mobiltech (cars, expeditions, railroads and air-spatial), pachtech (packaging), sportech (sport and leisure).
Currently, the way leads to the following level of transformation of the technical products as Jayaraman et al. (2006) show by the incorporation of sensors and microsystems inside the product or tissue. The new technology creates the concept of “smart clothing” and opens the way to new horizons of applicability. The research is directed towards a series of performance measurement parameters, by taking into account aspects related to costs, manufacture procedure, degree of ensuring the protection, the threat response.
The creation of “smart cloth” implies a hierarchic process (Bahadir et al., 2012) combining the textile materials with systems able to sense and generate response to the external stimuli (Spontak et al., 2009).
At each level there are elements making the clothes become more interactive, intelligent and ensure the information processing, by the integration of hardware and software (Bahadir et al., 2012).
Begriche et al. (2010) show in a study that the first projects associated with “smart cloth” were applied by American Army and NASA, which were involved in the creation of the equipment that could adapt to a hostile environment. The pioneer project was called MotherBoard, it was developed by Georgia Tech University for NASA, and it represents a suite that could detect the vital signs of the carrier, by means of integrated optic fibres. Starting from 1990 untill nowadays, companies in Europe were intensively involved in the field of integrating the electronics into textiles. The current research in the field of smart textiles rely upon the integrated components conferring sensorial perception, “actuators” – monitoring of some

parameters, source of energy, data transfer, computer processing, connectivity, user interface (control and/or display).
As Jayaraman et al. (2006) show the fabrics used for “smart clothing” involve a structure of materials which allows it to be made according to the size of its carrier, to adapt to the conditions of land, to be pre-configured and re-configured according to the needs, to be resistant, comfortable when washed, easily wearable, to be easily decontaminated, easy to make and cheap. The fabrics should be lightweight, flexible, resistant, and to adapt to the shape desired upon manufacture; thus, they can be created of various elements, of newly discovered threads and fibres by new manufacture processes which allow their adaptability to the environment; they should allow the incorporation or attachment of various electronic devices.
The latest and most dynamic field of innovation with perspective of continuous development is incorporing the KET’s mentioned before and creating the “smart fabrics” considered as the industry of future, which shall use the most highly qualified labour force.
The European Competitiveness Report (2010) indicates the current applications of nano-technologies in the textile industry refer to the nano-particles for preventing the contamination, the silver nano-particles for antibacterial textiles and the nano-containers for the impregnation with certain flavours. There were recently launched materials with titanium oxides obtained by nano-technology for the protection against ultraviolet rays, nano-gels for the thermal protection and ceramic nano-particles for the resistance to abrasion. At the stage of research there are the textiles which have integrated the nano-sensors and actuators for controlling the operation of human body, and textiles which have integrated digital control nano-systems.
As a conclusion to the above, we could say that the borders of smart fabrics industry are actually provided by the technological borders in several fields which are in a permanent dynamics and interconnectivity.

2.4. The Development of Business Environment in the Reconfiguration of the Textile Industry

The appearance of new technologies determines the appearance of new standards of manufacture, innovation, creation, organization and delivery (Davis et al., 2012).
In his study Jolly (2012) shows the way of organizing the industry determines the entry barriers. When a new technology becomes attractive and is the creator of a new business, there will be numerous companies interested in entering the market, due to a low entry barrier of the market, but also because each company will try to impose its own technical standard in the market. In time, the number of companies on the market in the respective field will increase, which means that the business is attractive. If any company succeeds in imposing their own design on the market, the other will have low chances of imposing their standards. The design imposed on the market refers to a certain technology implemented, which becomes attractive for many others. It means that there will be many companies on the market when there will be attraction for a certain technology. The selectivity criterion of a technology takes into account financial classic aspects, such as the recovery rate of investment, or cash-flow, the main objective being the maximization of potential income by risk unit. In general, the technological analysis envisages two aspects: its importance in the future – as a volume and life cycle – and the power it confers to the company as compared to the competitor companies. Another criterion of analysing the technology refers to its lifetime, which also incorporates the life cycle of the product.

A third criterion for selecting the technology refers directly to the mode of applying the patents: on the one hand, it reflects the attraction towards the respective technology by a high demand for that patent or, on the other hand, it shows the position of the company by applying the respective patent. There are situations when there was attraction from the companies towards a certain technology, but the products resulting from using it failed as there was no real demand from the customers existing on the market. Therefore, the commercial outcome is another important criterion in using the technology and thus, all the financial aspects derived from them (costs, benefits, value perceived by customer). In the case of entirely new technologies, it is difficult to estimate the potential the technology market is completely new. In this case, there is considered that as the technology is more attractive and covers the highest volume and depends on the geographical coverage, on the demand, the duration of usage, the range of applicability in various fields or in various market segments.

The location characteristics influence the activity of the companies involved in the field of nano-technologies are small or medium and are incorporated into a chain of value creation. Schimke et al. (2013) argue that these companies can only operate in regions with high degree of regional specialization, being the users of well-trained external labour force. There are situations when the regional specialization is counter-productive for the companies of nano-technology, as the level of qualification of the labour force is extremely important. Usually, the nano-technology is a creator of highly qualified labour force and the activity is carried out by clusters. Qing (2012) shows that most of the clusters have the support of local governments, which created favourable institutional environment and policies. By these measures, the entire arsenal of geographical, cultural, and business factors are valued thus ensuring the conditions for obtaining profit and creating new industrial branches besides those traditionally existing in the area, as well as the formation of specialized labour force and the increase of opening degree of the area, which should finally enable the attraction of capital and the intensification of entrepreneurial activity.

The entrepreneurial activity is a creator of economic development if it implies a high degree of innovation. As Lerner (2012) explains, the governments have the essential role of providing the conditions of a healthy entrepreneurial environment, which ensures the access of talents in a country by a flexible system of visas, enables the fluctuation of labour force between companies, provides the conditions of an efficient educational system for creating the future qualified labour force and finally, ensures the advantageous taxation policy. Also, the government has an essential role in providing the best conditions for dealing with the innovations, as well as in establishing clear rules of patent awarding. A modality of entering the market which is specific to the companies operating in the field of high technologies is presented in the form of the concept of "hybrid model", which combines the research activity in a laboratory and a start-up company sustained by an investment fund.

The development of business environment related to the smart textile industry depends on the creation of conditions for the investment by providing a friendly entrepreneurial environment, on the orientation of capital to the fields with high potential of development, which should use the highly qualified labour force, and on the type of technology implemented.

3. Conclusions

The traditional textile industry is in full transformation at the world level. The competitive disadvantages of some countries with respect to the cheap labour force and the supply of raw materials essential for this field can be compensated by the re-orientation to the configuration of a new model of industry, the one of smart textiles. And the main vectors in this effort of industrial transformation are the companies which are the best placed on the market of new industrial technologies generally called KETs, which combines the intensive use of capital with the sustained effort of research-development, the usage of highly qualified labour force, and their geographical positioning at the points which best respond to their operational requirements.

The advantages of creating and developing such an industry are the following:

- Low consumption of raw materials;
- Preservation of surrounding environment;
- Application of results in a wide range of fields with impact on the development of the entire economic environment;
- Usage of highly qualified labour force;
- Assumes the implication of Government in the creation of conditions for the development of a friendly business environment for the companies using the highest technologies, and the training and education of the labour force necessary for advancing in that direction;
- It means the future for a traditional industry;
- International cooperation in scientific matters.

All these will re-launch the economic activity passing through recession, particularly in the areas more prepared from the point of view of high qualification and technical specialization. And the Government is required to lay optimally the economic environment on coordinates favourable to such a process. This work responds to such challenges, by telling us how we could take benefit of this effervescence in the active areas of technical research, of the industrial and business development.

References

Bahadir, S.K., Koncar, V. and Kalaoglu, F. (2012) “Wearable obstacle detection system fully integrated to textile structures for visually impaired people”, Sensors and Actuators A: Physical 179, pp 297-311

Begriche, A. and Lachapelle, D.(2010) “Intelligent Textiles in the field of Protexion”, Canadian Textile Journal Apr 127,2, ProQuest Central, p 56

Chiarvesio, M. and Di Maria, E. (2010) “Global Value Chain and Open Networks: The Case of Italian Industrial Districts”, European Planning Studies Vol 18, No 3

Coccia, M. (2012) “Political economy of R&D to support the modern competitiveness of nations and determinants of economic optimization and inertia”, Technovation 32, pp 370-379

David Rigby Associates (2010) International Consultantas in textiles strategy, marketing and technology http://www.davidrigbyassociates.co.uk/DRA%20WEBSITE%2003/assets/TTandN.pdf [15 Feb 2013]

Davis, J., Edgar, T., Porter, J., Bernaden, J. and Sarli, M. (2012) “Smart manufacturing, manufacturing intelligence and demand-dynamic performance” Computers and Chemical Engineering 47, pp 145-156

European Competitiveness Report (2010) European Comission, Enterprise and Industry Magazine, Publications Office of the European Union, Luxemburg, pp 131 – 133
European Competitiveness Report (2012) “Reaping the benefits of globalization”, European Comission, Directorate for Enterprize and Industry, Brusseles, pp 10-68
Ghemawat, P. (2010) Strategy and the Business Landscape, Pearson, New Jersey
Golra, O.A., Tariq, J., Ehsan,N and Mirza,E.(2011) “Strategy for introducing 3D fiber reinforced composites weaving technology”, Procedia Technology 1/2012, pp 211-216
http://www.nobelprize.org/nobel_prizes/physics/laureates/2010/advanced-physicsprize2010.pdf [4 Apr 2013]
Jayaraman, S., Kiekens, P. and Grancaric, A.M. (2006) “Intelligent Textiles for Personal Protection and Safety” IOS Press Published in Cooperation with NATO Public Diplomacy Division, Netherlands
Jolly, D. (2012) “Development of two-dimensional scale for evaluating technologies in high-tech companies: An empirical examination”, Journal of Engineering and Technology Management 29, pp 307-329
Lerner, J. (2012) The Architecture of Innovation, Harvard Business School Publishing Corporation, United States of America
Qing, Z. (2012)”The Research on Influence of Industrial Clusters on Regional Economic Development”, IERI Procedia 3, pp 206-212
Schimke, A., Teichert, N. and Ott, I. (2013) “Impact of local knowledge endowment on employment growth in nanotechnology”, Industrial and Corporate Change Advance Access published January 8, pp 1-31
Spontak, R., Muth, J. and Ghosh, T.K.(2009) Emerging Technologies and Research in Smart Textiles, North Carolina State University, Releigh, NC http://www.thenonwovensinstitute.com/ncrc/italian_showcase/presentations/speaker/ghosh_emerging_technology_and_research_in_smart_textiles.pdf