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The Long Way of the Success: From Idea to the Market

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Abstract

Due to the changes in the textile field, effective solutions come from two directions: incorporating ideas in physical new and very modern products or giving value to new ideas that can impulse later discoveries and potential applications by identifying specific niches. New trends ask to cultivate a culture of entrepreneurship not only in terms of business but even at the level of research as the last chance for those who cannot produce traditionally in market conditions. The commercial or research (innovative) niches must be identified at the national and international levels and conducted to new advancements that should guide to commercial destination by responding to special human needs. The purpose of this chapter is to reveal five case studies as examples of integrating smart textiles into the value chain. This research shows that success is a consequence of intensive- and commercial-oriented company policy, an effect of updating to nowadays conditions, and an inspired movement to the right business way. The chapter also represents an invitation for creative people to focus on developing innovative value chains.

Keywords: smart fibers, smart textiles, fibrous structures, technical textiles

1. Introduction

The international trade liberalization had an important impact on modeling the map of the textile industry. Thus, the elimination of quantitative restrictions forced relocation to cheap labor zones able to respond to a higher demand. Generally, the global changes supposed business updates in terms of price, quality, and innovation, but flexibility was required in front of the market threats, and it created new development opportunities. The studies [1] show that during crisis, the companies tend to reduce the outsourcing and keep the activity within their national borders as a help between the local actors inside their value chain. More than this, sophisticated products (technical or smart) become a feature of developed countries without being the subject of the outsourcing phenomenon.

Textile reports [2] show that the behavior of textile actors is reactive (including those involved in research activity), which means they react in accordance with the trends of the markets.

Due to all the last changes from the textile field, effective solutions come from two directions: first, incorporating ideas in physical new and very modern products or second, giving value to new ideas and incorporate them in patents that can impulse later discoveries and potential applications by identifying specific niches. In other words, new trends ask to cultivate a culture of entrepreneurship not only in terms of selling but even at the level of research as the last chance for those who cannot produce traditionally in market conditions any more. The commercial or research (innovative) niches must be identified at the national and international levels and conducted to new advancements that should guide to commercial destination by responding to special human needs. For a value chain integration, a huge effort is dedicated to make well known the idea or the concept in front of those who could be interested in.

The main weakness of this subject is that expensive discoveries once registered in a patent, the researchers lose curiosity to cross the edge of theory and searching if there is possibility to extend the application, if there is any efficiency from the economical point of view, if there is a cover for some human needs to respond. So, their attention will be dedicated to new ideas, with no connection to the last ones, concentrating on other opportunities.

Reading carefully the literature dedicated to smart textiles, it is easy to notice that they cross by far the limits of "fashion" and they are in fact a superior form of technical textiles bringing unexpected solutions for every industry and offering obvious competitive advantages to those who use them. Another feature noticed is that traditional textile industry migrates toward a smart level due to specific technologies. Concluding, it is easy to understand that every discovery connected to new technology could offer one step in front of competitors. But the key to success is kept by the final user who often is not aware of the advantage of using smart textiles.

Not too many years ago, few people knew the meaning of "smart textiles," and this was a good motivation to focus on collecting information, dedicate researches on this subject, and then disseminate through specific ways: conferences, articles, meetings with important actors from textile field, and creating dedicated platforms. Some critics and old-fashioned mentalities became another good reason for continuing this work and improving discoveries and awareness about this new trend. Maybe the best way to persuade is to identify examples of good practice, to analyze them, and to focus on their secrets of success, from idea to the market.

That is why the purpose of this chapter is to reveal some European examples of successful companies involved in smart textiles. Their story started from a genius idea, but their secret was materialized through intensive efforts focused on the step to find the next user. These case studies bring essential information regarding the smart textile potential in solving some important human needs, the receipt of the success in very new, competitive, and money-demanding field.

Using the same algorithm of thinking, this chapter covers five different situations for integrating ideas in value chains, divided in two main perspectives: commercial (three case studies) and innovative (two case studies). Four case studies represent good examples of finding the best way to success, and the last case study is more a simulation, a good reason for an imaginative exercise to find the next step to the final user.

As methodology, this research collected information from the Internet (sites, press releases, and international databases), sometimes combined with data obtained during interviews or from materials supplied by companies in specific cases. Since the target was to identify competitive advantages, the Michael Porter's model, the value chain configuration, and a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis were very helpful. Also, the literature dedicated to new technologies underlines the necessity to identify more examples and new products, and this was a good inspiration to simulate a patent analysis and a proposal for the next stage of the research as a step closer to the final consumer.

This chapter contains three main parts: introduction, the second part contains five sections dedicated to each case study, and the third part concentrates on the conclusions. All the references will be inserted at the end of this chapter in order of their appearance.

2. Commercial versus innovative value chain

2.1. Integrating smart textiles into commercial value chain

Before digging the secret of success for some companies involved in smart textiles field, theoretical economic perspectives are required to emphasize the systemic interdependencies of competitive advantages into the triangle company-business environment-market.

Thus, some researchers [3, 4] argue the same view regarding the competitive advantages when they come from two directions: from the market and from the companies. They consider that at the market level, the demand and the offer represent the start for advantages, and they are shaped in a specific environment, where industries and companies are connected and guided by regulations created to ensure a healthy cooperation. In the same time, they consider that at the company level, the competitiveness is a result of the best strategy selected. Compressing the information, a double influence is noticed, the market has an impact on the companies' behavior, and the companies can change the market through new directions by using proper strategies or unexpected technologies.

Different opinions [5] consider competitiveness as a feature of companies rather than that of market, due to their strategies.

Some economists [6] consider that all industries due their existence as individual decisions and their amplitude and quality depend on accumulated experiences and on local advantages where they operate.

A short resume of the economic literature [3] shows that the analysis of competitive advantages may be observed from three perspectives:

- From the direction of demand and offer—this represents the oldest way to analyze a market; this method is not recommended during crises.
- Focusing on the net value—as an optimization of all factors involved from the subsidiary offers, this method is recommended for mature markets or products.

- From the perspective of Porter's five forces—this method allows an analysis in real conditions, by considering the entrances on the market, competitors, and substitutions (horizontally) and suppliers and buyers (vertically).

From these three perspectives above, the Porter's method brought its contributions to develop and build the entire specialized literature covering all the five dimensions and enriching the strategy theory. This method is used the most when market analyzing is required since it is easy to concentrate and translate all the information collected.

This subchapter presents the landscape of three companies—Elmarco (Czech Republic), Holmenkol (Germany), and Siderma (Romania)—where Michael Porter's five forces are adopted to build the market configuration for their smart products and understand their positioning into the value chain. Then, a SWOT matrix-table will reveal where the advantage comes from, what is the key of the success, and how these companies turned their advantage to become leaders. These case studies are built [7] by using information from the Internet (sites, international databases, or press releases). In case of Siderma, besides information supplied by the Internet, an in-depth interview and further brochures and documents [7] fulfilled the research. The main purpose is to understand whether they have some similar features by following the same rules guided by the market or do they discover their own roles?

2.1.1. Case study I: nanofibers from Elmarco S.R.O.

Elmarco [8] is a private company from Czech Republic specialized in producing nanofibers equipment with a lot of applications in many industries. The headquarter is in Liberec, and there are two more branches in the USA (Morrisville) and Japan (Tokyo). In 2013, the company had 35 researchers from a total of 80 employees. The activity started in 2000 as a semiconductor producer, but a partnership signed in 2004 with Technical University from Liberec changed the business way. In 2005, the Nanospider technology was created, and this became the key patent the entire company concentrated the efforts on. Nanospider represents an organic or inorganic electrospinning process, a versatile technology that allows production of fibers with a capillarity about 500 nm which means 1000 times thinner than the human hair. The nanofibers production using the Nanospider technology has the following advantages:

- High scalability—allowing a high productivity and a large dimensional demand.
- Uniformity of the fibers, and as consequences, uniformity of the tissues produced with these fibers.
- Good production conditions from the economical point of view and maintenance.
- Flexibility in raw materials used such as polymers and others.

The main characteristic of the nanofibers and nanomembranes is the possibility to use them in different fields such as: health industry—supplying the drugs *in vivo* system (dissolution into the human body) and *in vitro* system, wound patches, artificial tissues, organic tissues, or antiseptic textiles barriers for surgery; technical industry—separators for batteries, solar panels made up of titan dioxide nanofibers as a silicon substitute, air filtration systems, or water filtration as well as acoustic barriers; equipment for protection and high-performance clothing.

For 2017, the international market potential for nanofibers was estimated [9] at 852.3 million of dollars, and the perspective [10] of 2020 shows a market estimation of 2 billion dollars. This represents a chance for developing Elmarco business and keeping the international leader positioning.

During 2007–2010, Elmarco invested an important amount for building a research center with a production division. Most of its activity consists in nanofiber producing and selling (98% of its activity is dedicated to exports).

The business landscape of Elmarco is represented in two ways: first by using the five forces of Michael Porter for analyzing the market and second by configuring the value chain to understand the position where the company is integrated.

Entrance: Elmarco entered aggressively into the market since its Nanospider patent was unique, and it could be a leader from the start. To gain this, the company made a successful movement by signing a contract with academic environment and then obtaining strong funds from governments and European Union (EU) to sustain an intensive research activity. If another company wants to enter in the same field, it requires succeeding the patent barrier and considerable investments. Thus, the position of Elmarco is not easily threatened. Besides, the company signed a lot of international partnerships with famous universities and research institutes, which ensure a strong notoriety and a quick development potential. The position of Elmarco can be mined only by those companies that could bring new discoveries with low-cost implications and higher performances or large possibilities of scaling.

Competitors: The main nanofiber competitors [11] are as follows: Elmarco LTD., CONTIPRO, NAFIGATE CORPORATION, Nanopharma, and Nanovia LTD. From all these companies, the main actors are Elmarco, CONTIPRO, and NAFIGATE. The year 2010 was an important moment when ex-manager Ladislau Mares—the founder of Elmarco—created NAFIGATE, a real competitor since he knew all the vulnerabilities of this company. Starting from then, Elmarco met a regression at least at the personnel level when the number of employees decreased from 250 to 80. Meanwhile, NAFIGATE had an explosive development by signing partnerships with China.

Substitutes: Most of the products obtained through nanofibers can be replaced by traditional products, but Elmarco brought properties difficult to be replaced. For example, air filters or water filters can be obtained in better economic conditions and with better quality. Photovoltaic cells realized with nanofibers can successfully replace those made up of silicon. Classical impermeable fabrics are enriched with nanofibers, and new parameters such as air circulation are improved. In health field, new membranes are more soluble. In acoustic field, the porosity of fibers allows to improve isolation, ensuring a protection of 100%. New discoveries can pose a threat for the present ones. For instance, the researches concentrated on graphene could guide to surprising directions, and this could affect Elmarco in the future.

Suppliers: Poly Nano Tec is the main partner from the TransMIT GmbH (Germany), the largest raw materials producer for nanofibers, supplying polymers for extrusion processes and melting—blowing organic antibacterial agents. At the same time, the partnerships are an important source of information that could push Elmarco to new research developments. There are some spare parts suppliers, but the information about them is not available. Regarding the labor, Elmarco has an access to extremely qualified and cheap workforce in comparison with other states.

Customers: Until 2013, Elmarco produced 130 Nanospider equipment, and it is considered one of the most important international producers. The partnership policy was concentrated in two directions.

- Universities and Research institutes

To facilitate the research activity, Nanospider equipment was supplied to the Research Triangle Institute (USA), Kyoto Institute of Technology and Shinshu University (Japan), National Institute of Singapore, King Saud University from South Arabia, and Moscow State Textile University (Russia). A contract concerning the filtration with nanofabrics was signed with Akron University. Other partners are as follows: Nonwovens Institute (Raleigh, North Carolina, USA), Industrial Technology Research Institute (ITRI) from Taiwan, National Textile University of Faisalabad (Pakistan), and Ahmedabad Textile Industry Research Association—the biggest textile center from India with 98 units in the country. In 2011, the National Tissue Centre was inaugurated in Brno to develop modern methods for producing tissues and cells based on nanofibers. This project helped Czech Republic to be at the same level with the most famous institutes such as, Fraunhofer Institute (Germany), Bioheart (South of Korea), and Indiana Stemcell, Purdue Nanotechnology Centre, and Wake Forest University (USA), dedicated to nanotechnology research.

- Business to business—customers from business environment [12]

In 2005, when the Japan branch was inaugurated, a joint venture with Atracell was born (named Nanopeutics) and the main activity was producing wound patches. Another partnership dedicated to the same subject was signed with HemCon Medical Technologies Inc. (Portland, Oregon, USA). CEZ company became a new partner in the field of energy, and thus, the solar panels were produced by replacing silicon with nanofibers. These new cells allow a better efficiency (about 80%) in comparison with those made up of silicon. In this case, when large-scale production started, the cost decreased significantly. Oerlikon Neumag from Austria is Elmarco partner in acoustic barriers. Thus, the nanofibers create a protection of sound by absorbing 100% of it. The Middle East offered a great opportunity for air and water filtration cooperation, and thus an important number of equipment is sold here.

Shortly, the Elmarco market can be seen in **Figure 1**.

Collecting the entire information, the Elmarco value chain can be seen in **Figure 2**.

From these two figures, it can easily be noticed that Elmarco became a strategic supplier for those interested in obtaining products based on nanofibers since its strength was the Nanospider patent. The weakness of Elmarco was sometimes the final user, and the intermediary producers or dealers need to work on this subject. The opportunities are gained from the research partners and the threats come from competitors.

Concluding, the SWOT analysis can be synthesized as shown in **Table 1**.

It is obvious that Elmarco's advantages come from the way of using the patent created together with the University of Liberec. Concerning the value chain, its position is difficult to be replaced by other companies since the financial support was dedicated to get a very good image and consolidate international partnership that could help in future discoveries.

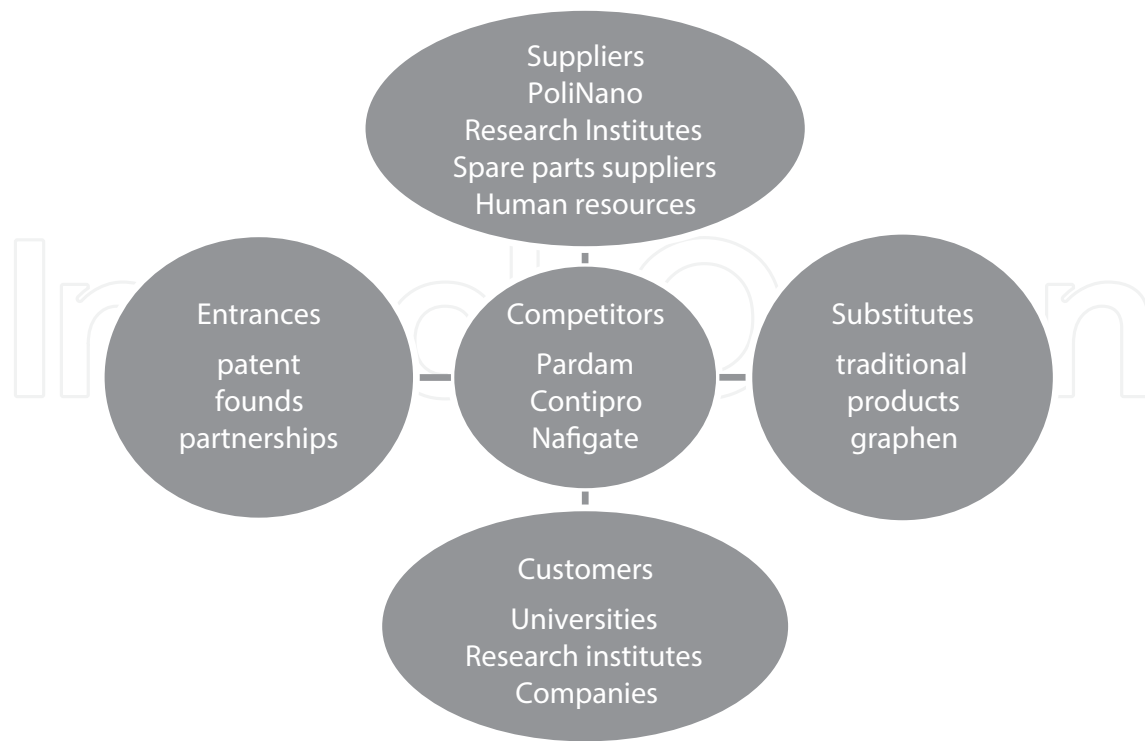


Figure 1. Elmarco market.

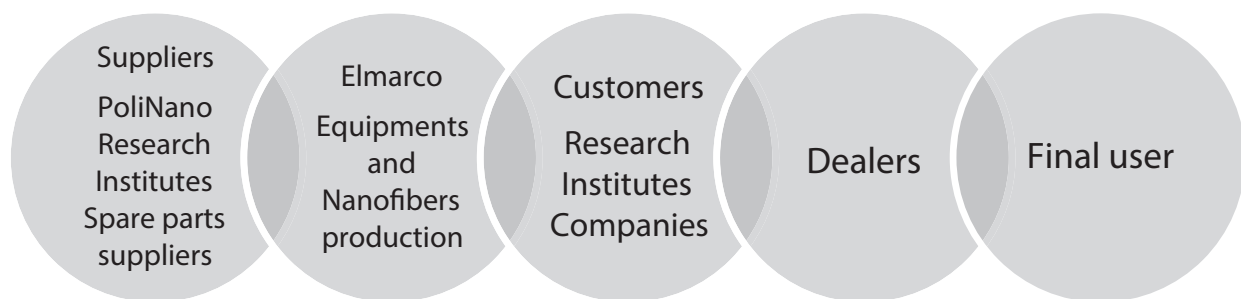


Figure 2. Elmarco value chain.

2.1.1.2. Case study II: nanoproducts dedicated to winter textiles from Holmenkol GmbH

Holmenkol GmbH [13] is one of the oldest companies in the world, whose history dates back to 1922, and it used to be a traditional wax producer. In 2001, the first liquid wax was realized through nanotechnology, and FORBES considered it the product of the year. Its headquarter is based in Heimerdingen, and there are branches in Germany, Norway, and Japan. Until 2008, Holmenkol worked as a division of LOBA company, the main shareholder from that moment, and due to its 18 patents, it became one of the most innovative companies in Germany. In 2006, 43 national teams' competitors attending the Winter Olympic Games used Holmenkol products.

In the start of 2008 [14], LOBA joined Holmekol and Nanogate—the most important investor dedicated to nanotechnologies—and all together built Holmenkol Sport-Technologies GmbH. In 2012, when 90 years of existence accomplished, the insolvency was declared, but at that

Strengths <ul style="list-style-type: none">• Strategic equipment supplier• Patent• Financial support• High qualified workforce• International reputation• Strong national and international relationships	Weaknesses <ul style="list-style-type: none">• Final user
Opportunities <ul style="list-style-type: none">• International research partnerships• New partners	Threats <ul style="list-style-type: none">• New discoveries• Graphen• Competitors (NAFIGATE)

Table 1. SWOT Elmarco market analysis.

moment, another company—Sporto-med GmbH, part of the Eimermarcher Group—became the main shareholder.

In the meantime, Holmenkol improved the traditional wax technology by creating the nano-CFC@technology patent, a hybrid technology which allows a certain cover and improves physical characteristics for skies, textiles, bicycles, and body care creams. This patent re-joined chemical characteristics of the materials used with nanotechnology discoveries, by changing the effect on the surface. A fluoride powder mixed with nanocomposites helps the water to change to a dry powder. During friction, the powder becomes liquid again and thus the abrasive resistance and slip rate are higher, permitting high speeds. The components are not used in their pure form, and they are integrated in a matrix. The products are sold as sprays, and the substances are not inhaled in lungs since the components are cemented on the product surface. The offer for textile winter clothes covers 16 nanoproducs. These were used to clean clothes at very low temperatures, conferring more water resistance, texture breathing at extreme temperatures, smell neutralizer, and extended textiles texture life.

Besides nano-CFC@technology, there are other types of technologies dedicated to textiles exclusively, such as Lotus-Hybrid Matrix (which stimulates a lotus water effect for different fabrics) and Hygiene Effect (which ensures a perfect cleaning during washing at very low temperatures by eliminating germs and bacteria).

Nowadays, Holmenkol is a Forumnano member and very active in public debates on Nanosafe platform regarding the risk exposure.

Collecting all the information, the market of Holmenkol can be designed by using the Porter five forces as follows:

Entrances: A company interested in joining this field is obliged to invest considerable amounts to produce similar products and to promote them since the notoriety of Holmenkol is difficult

to be reached. Ninety years of commercial existence is quite hard to equal the trust of investors and traditional customers. Thus, the barriers are very high, and the direct competition is low.

Competitors: Regarding the Holmenkol offer dedicated to textiles, there are a lot of competitors since the modern products can meet the traditional ones, but the performances are difficult to be reached. The relationships created in 90 years shaped the customers to be a very high quality demanding, and from this point of view, the competitors meet disadvantages.

Substitutes: These can appear from new discoveries or some traditional products and could be taken into consideration, but the effect will not be the same. The price is a consequence of technology used and could separate the qualities and product characteristics.

Suppliers: All the products dedicated to textiles are made in Germany. This is the key of the best reputation offered to customers. Being a LOBA division for years, it was supposed that the raw materials came directly from inside the consortium for long time, as a guarantee of quality.

Customers: A wide range of customers use Holmenkol products—top athletes, international and national federations, and sports clubs—and they are applied on technical, high-tech, or thermal isolated fabrics such as Gore-Tex, Sympatex, Schoeller, eVent, Coolmax, Soft Shell, Thinsulate, Thermolite, and PrimaLoft.

Shortly, the market for Holmenkol products dedicated to textiles can be seen in **Figure 3**.

The value chain is configured in **Figure 4**.

Figures 3 and 4 show that the advantage comes from important investments in research activity, incorporating nanotech discoveries in successful products and updated to new trends, patent portfolio, and rich past, marked by the trust of investors and top customers. Despite its economic difficulties, Holmenkol is still a leader in its market. The weakness comes from its insolvency in 2012. The opportunities come from the future discoveries and new way of developments. The market trend can be mined by other discoveries that could oblige the owner to stop the research activity. Concluding, a SWOT analysis can be synthesized into **Table 2**.

Table 2 reveals that competitive advantages for Holmenkol were built in time, and it is interesting how this company could keep the customers and offer always innovative products. When the company met difficulties, the investors did not hesitate to come and offer their help to continue the research activity especially. Also, the collaboration with German suppliers consolidated the “made in Germany” image and helped Holmekol to be always the market leader.

2.1.3. Case study III: SIDMAT 3, a revolutionary smart fabric from Siderma S.A.

The particularity of this case study consists in analyzing the first Romanian smart fabric, and the entire information was collected from the Internet site, press releases, in-depth interviews, and documents supplied by the company, and it represents an important international reference for the specialized literature that claims lack of practical examples.

Siderma S.A. was created in 1971, and its main activity was the production of spare parts for shoes, automotive, constructions, and furniture industries. Now, it is a nonwoven leader, and the production goes to domestic or international market. The technology is a classic one, combining different fibers (cellulose, polyamides, wool, polypropylenes, and polyesters). The

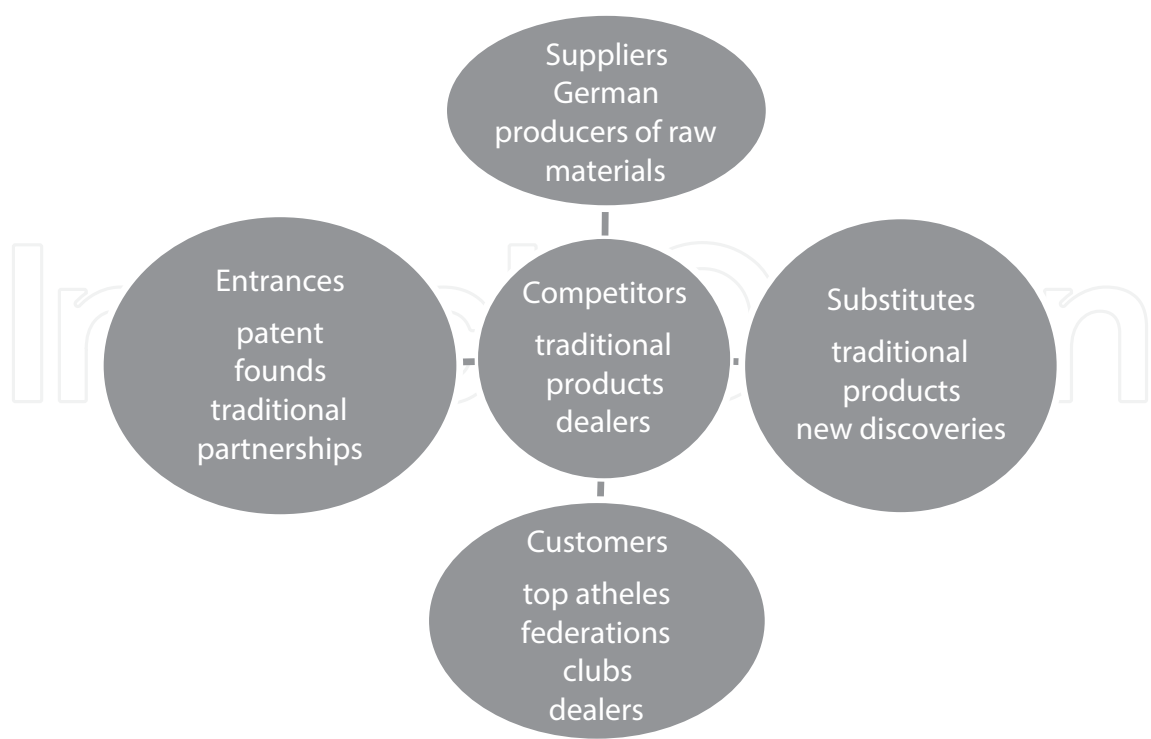


Figure 3. The Holmenkol market.

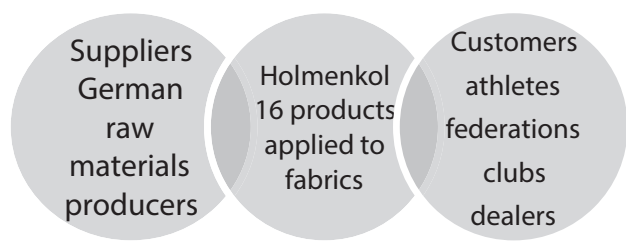


Figure 4. The Holmenkol value chain nanoproducts dedicated to winter textiles.

main technological process is carding-folding-punching, and the semi-finished fabrics have different widths, thickness, and density depending on applications.

Nowadays, Siderma has in its portfolio about 700 products, but 350 are available to be produced anytime. Generally, it produces shoes linings, knitted linings, thermobinding, interwoven in different colors, insoles, laminated assemblies, synthetic and wool furs, carpeting thermo-formable dedicated to automotive industry, geotextiles for construction industry, air and liquids filters, and nonwoven items for furniture industry.

Siderma offers a guarantee of its products by a high selection of the suppliers. Thus, the customers receive a REACH declaration (Registration, Evaluation, Authorization, and Restriction of Chemicals), which is a company statement, that the used substances are not in ECHA database (European Chemical Agency), where every 6 months, dangerous chemicals are listed.

Strengths	Weaknesses
Research investments	Insolvency in 2012
Patents	
Rich history	
Trust of investors	
German raw material	
Top customers	
Example of good practice in nanotechnology	
National and international relationships	
Opportunities	Threats
New discoveries	New discoveries
New collaborations	Slowing research investments

Table 2. SWOT analysis for Holmenkol nanoproducts dedicated to winter textiles.

Siderma owns a collection of technical fabrics dedicated to military shoes as: Army, Shock Absorbent, Multistrat, Low Temperature Resistant Materials. Breathable, Special Insoles, Fireproof. The name of each collection represents the meaning.

The company also owns a research department where special customer demands or needs are covered from new discoveries and where new products are waiting to be proposed in new markets. The most representative product is SIDMAT 3, which helped the company to become an international leader, leaving behind famous brands from Western Europe. This product uses 78.3% from the production process of the entire factory, and it is required by top clients from Europe and Russia.

The technology of SIDMAT 3 is very simple: there are three layers, each produced separately and all together united by interweaving or sewing. The first layer is a polyamides nonwoven product consolidated under pressure at high temperatures, and it can be painted in different colors as in **Figure 5**. The second layer is made up of 80% wool by a mechanical interweaving. The mixture of wool and polyesters gives the final color. The last layer is made up of aluminized polyethylene, the only part not produced by Siderma, which is imported from abroad.

The principle of this product is that the wool maintains the foot temperature, the aluminum layer rejects the cold air and humidity that enter inside the leather military shoe, and the temperature remains constant due to the wool layer. These three layers are united by sewing and not by chemicals because in this way, the foot can “breathe.”

SIDMAT 3 was tried in France twice, first at -50°C and later at -80°C . The result was a success, and the company obtained a certificate that proves its unicity.

SIMAT 3 (**Figure 5**) is a smart product since:

- it confers very low temperature and abrasive resistance.
- the technology combines classical production methods with modern ones, and the productivity is higher than that in the case of woven products.

- this product can be improved with other technologies, for instance, nanochemical substances for obtaining more particularities as fire protection, antistatic, odorizing, and many others. The product is supplied in rolls of 30 m or in plans, the width is 1.4 m, and the weight is about 650 g/sm.

The history of SIDMAT 3 is very interesting to be known. During communism time, the company had no idea about smart products since in that moment, it used to be the biggest synthetic leather producer from the South-East of Europe. In democratic times (after 1989), the economic situation of the company became worse and worse, and the conditions put pressure on the creative activity to activate the patents from the assets. SIDMAT 3 was born in this way, but it was different than nowadays.

During a fair in Turkey, Siderma met its future partner from Kazakhstan who owned a very modern technology, but was not able to produce. This was a great opportunity to recreate SIDMAT 3 for customers without being aware that this could be a smart product. During a business trip to ex-Russian countries, SIDMAT 3 was offered as a sample to a shoe factory from Azerbaijan. The owner of this factory made a test in a very cold room where the temperature was -40°C . During the test, ethyl alcohol was added to the shoes. It was an extremely dangerous test (simulating conditions of -65°C), and everything was filmed and posted on YouTube under the name of Daimoni Shoes (Test) [15].

Few weeks later after this film was posted, the first important customer of SIDMAT 3 appeared, who was already using a fabric from another competitor, but the physical properties of the fabric was changing at very low temperatures.

After this long introduction of SIDMAT 3, a market analysis was welcomed to emphasize how the company succeeded in creating competitive advantages and integrating this product into international value chain. The Porter model will be helpful again in constructing the whole commercial image of the product.



Figure 5. SIDMAT 3.

Entrances: There is a relative high barrier for those interested in entering this market due to the patented technology, but new discoveries or geopolitical situation could afford anytime the access for similar products. That is why Siderma avoids advertising to not inspire the competitors.

Competitors: Even if SIDMAT 3 is difficult to compete with, similar products are supplied by GoreTex (USA), Tessile Toschi (Italy), and Lenzi Technology (Germany).

Substitutes: The partner from Azerbaijan tested GoreTex fabric, but it could not keep its properties at extremely low temperature.

Suppliers: They are selected depending on raw materials. Usually, they are from Italy, Russia, Germany, Romania, and Bulgaria.

Customers: They are from ex-Russian countries, but some of them are from Romania and Italy. The main reason of keeping this customers' portfolio is connected to payment conditions. Customers from the Russian Federation usually demand very high quantities and pay in advance in comparison with others who demand small quantities and ask for long terms of payment.

The SIDMAT 3 represents 30% of total Siderma income since it is a seasonal product, and it is produced every 6 months. Its market can be configured as shown in **Figure 6**.

The SIDMAT 3 value chain can be design as shown in **Figure 7**.

SIDMAT 3 includes raw materials with a cost of about 3.10 euros, the cost production goes up to 3.5–4 euros, but the list price is between 6 and 7.5 euros, and then the final price arrives at 150 euros per one military shoe pair.

A quite similar product can be produced with 40–50% higher price than Siderma, and this confers a leadership position into the market.

A SWOT analysis for SIDMAT 3 is presented in **Table 3**.

Concerning the value chain, Siderma controls the suppliers' selection to obtain best cost of raw materials, and it can decide the selling price with no pressure from competition. Another competitive advantage comes from the acceptance of the customers outside EU or North Atlantic Treaty Organization (NATO). Sometimes, the commercial relations are reduced due to the geopolitical situation, but partners coming from the Russian Federation are preferred because of payment agreements. Another important advantage of Siderma is its headquarter in an EU country, which allows an international standardization of its products from the technical point of view.

In conclusion, the Siderma example is very difficult to replicate since it requires a specific behavior in a certain niche where the commercial collaboration meets obstacles in a turbulent geopolitical environment.

All these three examples bring similarities and some differences. For instance, all companies analyzed started from an idea incorporated in a patent that created a successful product as

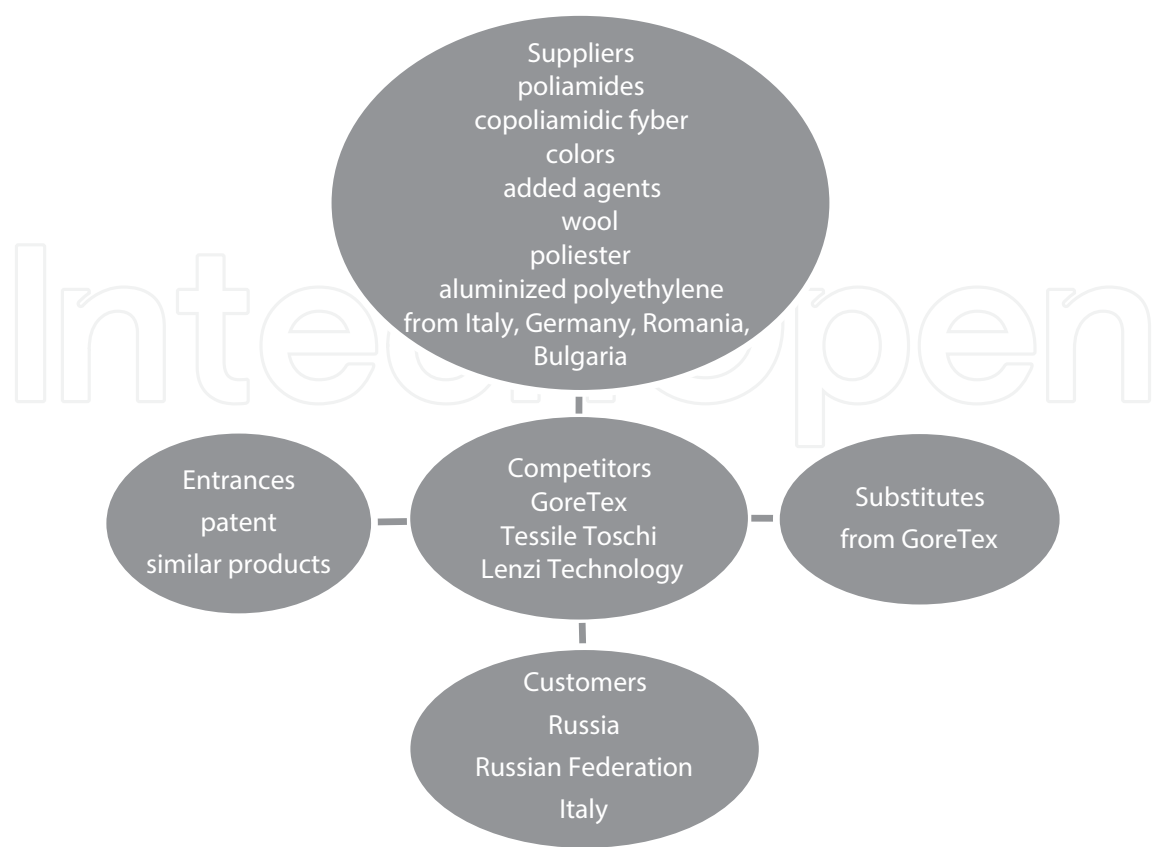


Figure 6. SIDMAT 3 market.

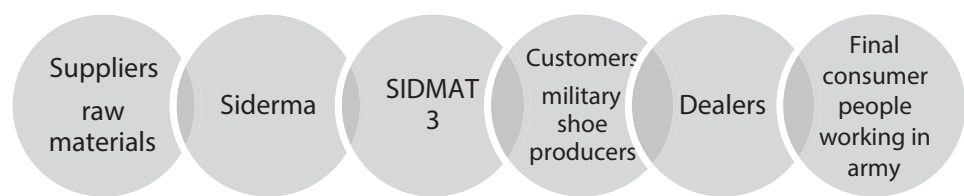


Figure 7. SIDMAT 3 value chain.

Strengths	Weaknesses
Patent	Imported raw materials
Partners	Payment conditions
Research activity	
Cheap price due to a cheap workforce	
Opportunities	Threats
New discoveries	Geopolitical situation
New markets	New competitors
New suppliers	New discoveries

Table 3. SWOT analysis for SIDMAT 3.

consequence of an intensive and costly research activity. Another common feature is represented by the international cooperation that brought strategic partners. New discoveries or new competitors could appear and undermining the position on the market. Opportunities are challenges toward new discoveries or new applications. Inside the value chain, the position is near the beginning and the suppliers are chosen carefully in terms of costs and quality. Also, all these examples offer unexpected approaches of textiles concepts in comparison with traditional ones.

The differences are in accordance with the field they act, the human needs they cover, and the partnerships they create. For instance, Elmarco is integrated into a commercial value chain, selling its products, but at the same time, it is a part of an innovative chain through the partnerships with universities and research institutes for spreading the potential discoveries. Also, Elmarco is a very open company, attending to all the nanotech international fairs. In the opposite way, Siderma plays very discreet, maybe because of the field where it is involved.

As a preliminary conclusion, all these three case studies showed that the company is looking to welcome human needs in the best conditions of price and quality. The market pressures them to do their best to let behind traditional products. But the financial effort is considerable, and they need to play big, at the international level.

2.2. Integration in an innovative value chain

Nowadays, business configures relationships depending on the way people and ideas interact. Allen et al. [16] show that people and companies create systems and the success supposed to be in the middle of a system. Relationships are created as consequence of needs or depending on market trends.

Lerner [17] considers that patents are essential for an innovative industry, and one of the most important inputs is the very high qualified workforce. He considers that usually companies cooperate directly with universities to start projects together, but the capacity is limited since a small company cannot play globally, and it can succeed with the help of a big one. Moreover, modern technologies are created by "hybrid models," where the research activity is concentrated in a laboratory, and this cooperates with a start-up financed by a venture capital. This helps small companies to reach a certain scalability of business since the researchers are the owners and their resources are constrained by tools, physical instruments, and equipment.

Finding different ways of financing a certain technology is the subject of a rich economic literature focused on. The main problem to find financial support [18] is that new technologies are difficult to estimate their potential, but it becomes attractive when competitive advantages are estimated.

Butaud-Stubb [19] underlines the 2020 European Strategy objectives, where research will be concentrated on energy efficiency, new materials and fabrics, IT integration, creating new products, and cross-fertilization. For a sustainable development, European companies will focus on ecological production processes, and the life cycle assessment will become a very important concept concerning recycling and carbon emissions. Thus, there it is a very important moment for the textile industry to reinvent and to respond to these European objectives. Starting from

the first industrial revolution, when the textile industry had its historical role in human modernity, now other premises are created to permit a step to a new era by adopting technologies and finding solutions for new industries with no connection to the past. Nanotechnologies, microsystems, biotechnologies, photonics, advanced manufacturing systems, or advanced materials offer a wide range of discoveries and a huge opportunity for textiles researches.

That is why the concept of value chain is now adapted to the research activity, and it can be named "innovative value chain" keeping in view all the aspects of the commercial value chain theory.

The next sessions are focused on two case studies as examples of integration into an innovative value chain. The first case is about a company that reinvented itself turning from clothing production to research activity; the second one is a simulation of how an idea incorporated in a patent can be pushed to a step further into research value chain taking in consideration with ecological and economic aspects.

2.2.1. Case study IV: lesson from Davo Star S.R.L.

This case study cumulates information obtained during an in-depth interview with the company's owner.

The story of Davo Star Impex S.R.L started in 1990 when it used to be one of the most important Romanian exporter of women clothing, with more than 400 employees. Its production activity is still alive, but nowadays the company has only 25 employees, and the process has changed from Lohn production to full-product production.

A turning moment for Davo was in 2006 when the economic conditions obliged to make something else to survive. One day, in a middle of a meeting, one of its partners invited Davo to be a part of a research project. At the beginning, Davo accepted since it has no other way to do something more dynamic and was not prepared to enter to this unknown world of the research. The first project was LIGUIN covering a large wide of fields, including textile. The total value of this project was 1 million euro, and Davo brought its own contribution of 65,000 euro. Four years were enough to understand this new type of activity, and step by step, the shock was forgotten. The new activity offered the chance to meet an unexpectable and fascinating world, meeting very educated people, and learning so many new things from textile and other fields that a usual producer will never learn. At the beginning, the working style was difficult to understand. Business requires a dynamic style, asking results at once, and every day reception of final products. At the opposite site, the research activity asks for study, reading, and collecting information from all the known discoveries concerning a certain subject, and experiments are repeated many times for analyzing and comparing results. The first lesson Davo learned was that interesting results can be obtained even if the working style is slow.

After its first trial, the second chance became a desire to be involved in, and the story of the second project (SONO) with a total value of about 12,000,000 euros started in 2010. This new project followed the idea of the first one, but this time, the Davo' contribution was 750,000 euros. The result obtained in 2014 was an equipment for printing nanoparticles on the cotton fabric by using ultrasounds. It was a real success, and the European Commission evaluated it

as a great impact on future technologies. Thus, Davo is now involved in the third project with a total value of 8,000,000 euros, and the company brought a contribution of 350,000 euros. The purpose of this new project is to continue the last project and to obtain nanoparticles from different active substances (and very expensive) that will be added on a wound patch. Davo has the responsibility of analyzing the inputs (quantity of energy used during experiences, quantity of substances, and fuel consumption) and the outputs (the quantities remaining inside the equipment, evaporation, and wastes). The main problem faced in these projects was waste management since Davo was in the situation to learn the process and to work carefully for collecting it. Another difficult moment was to identify the suppliers for these raw materials since very specific characteristics are required.

In this project, Davo is a part of a big team where three big universities (from Israel, Spain, and Portugal), a research institute (Austria), and small companies are involved (Germany, Great Britain, Austria, and Romania). When this project will be finished, the company from Great Britain will implement the product in its market.

Davo also learned also that during these projects, dissemination is very important. Since the owner is not a researcher, the information was propagated through commercial media (interviews, press releases, and textiles reviews), but its partners from research institutes or universities used to attend conferences and publish scientific articles in international journals.

The advantage of being a part of an international research project comes from reputation. A project attracts another one, and now, Davo is invited to be a part in other projects with new partners from Romania or abroad. The disadvantage of being part of an European project comes from EU long-term payments, and this forces Davo to find ways for financing the activity.

2.2.2. Case study V: patent integration into the innovative value chain

The idea of integrating a patent into an innovative value chain came after studying the methodology of potential sustainability [20] where the necessity to identify examples for new technologies was mentioned in very early stages. More than this, the production of a very new product considers not only economic aspects, but intangibles elements have an impact on the environment [21]. In the case of new discoveries, the knowledge is very important to be shared to gain the trust of potential customers.

These are enough reasons to consider an analysis of a patent potential since this is the earliest stage of a technology. The study will focus on a SWOT analysis that could reveal some directions to concentrate future research to improve its weaknesses and to spread the knowledge of problems that are solved. Thus, the weaknesses could be improved, and in this way, the next step could obtain a better position into the innovative value chain. Even this is an imaginative exercise closer to theory, and the steps proposed represent an algorithm of thinking available in every patent case and could invite patent owners to continue their research in the right direction to push the level of the discovery.

A deep analysis [7] shows a very large technical description of the entire process, but now a shorter explanation is concentrated in steps as a brainstorming of what should be done to

follow the path from a theoretical idea incorporated in a patent, and then moving into the applicative research and following next steps in the market. The logic will be focused on a magnetic-coated yarn patent registered under the codes D01H13/30 D07B7/12 and RO128302 [22], and it was built with the help of its owner.¹

2.2.2.1. Identification of advantages that could increase the possibility to integrate the patent in an innovative value chain

To identify advantages, it is very important to understand how the idea of this patent was born, what are the conditions to produce 1 km of magnetic-coated yarn in a laboratory condition and to identify sustainability indicators and their environment impact.

(a) Short idea history

The origin of this patent comes from the textronic field, by combining traditional textiles elements with magnetic ones, and the result could be multifunctional since the effect is magnetic flux, magnetic induction, magnetic permeability, and susceptibility [23, 24].

A method for making a magnetic yarn (**Figure 8**) includes coating the yarn [25] with one or more layers of magnetic mixture of ferromagnetic or ferrimagnetic powder, binders, plasticizers, and the like (deformer, maintaining in suspension) [26, 27].

(b) Producing magnetic coated yarns in laboratory conditions

To obtain magnetic yarns under the patent mixing formula, the following substances are required:

- Isotropic barium hexaferrite ($\text{BaFe}_{12}\text{O}_{19}$)—with BF symbol.
- Polyvinyl acetate ($\text{C}_4\text{H}_6\text{O}_2$)_n—with symbol PVAc.
- Polyurethane adhesive—with symbol PUR.
- Glycol ($\text{C}_3\text{H}_8\text{O}_3$)—with symbol GlyC.

The process of magnetic yarns manufacturing requires certain input of raw materials, some of organic origin (polyvinyl acetate, polyurethane, glue, glycerol), other of inorganic origin (barium hexaferrite), which may be performed by a laboratory employee or by supplier. Actual production in the laboratory involves employee exposure during preparation of raw material, resulting in a suspension.

(c) Potential sustainability analysis of the magnetic coated yarn patent

Dedicated literature [20] offers a number of methodologies according to the specific subject under review, through which certain criteria related to environmental benefits (energy, water, raw materials, emissions of greenhouse gases, and pollution), consumers (product functionality, exposure to disease through product use, and cost-benefit), of those involved

¹Grosu Marian Catalin – researcher at National Research and Development Institute for Textiles – Leather, Bucharest, Romania

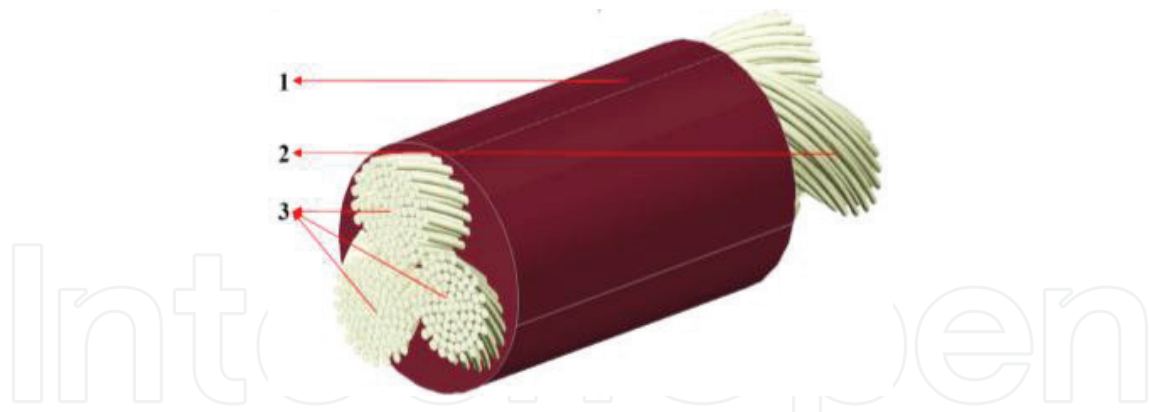


Figure 8. Representation of a magnetic yarn: (1) magnetic coating layer; (2) fiber; and (3) spun yarn within twisted yarn.

in the production (handling safety and health protection at work), and the company are to be observed (creation of markets, quality and performance at specific parameters, process optimizations, and efficiency). Relevant indicators for these criteria, which allow an analysis of magnetic yarns, include carbon footprint, energy efficiency, environmental risk, societal benefits, validity of resources, and risk perception.

Carbon footprint: This indicator regards emissions of greenhouse gases and usually is taken into consideration by studying similar products, but in this case, there is no reference. At a first glance, the barium hexaferrite has no carbon, and the rest of the raw materials, even if they have carbon, are not burned, so there is no CO_2 emission. From this point of view, the process is a clean one, but still there is a certain greenhouse emission of 0, 234 t of CO_2 because of the energy used in the process and the supply of the raw materials. Usually, it is taken into consideration that the emission during 1 year and the value should be around 2 t CO_2 /year for an individual transport, even if our value is 9 t CO_2 /year. Logistic should be treated carefully by the management team to be reduced.

Societal and users benefits: At this stage, it is required to develop applications within the field of sensors, electromagnetic protection of buildings, to respond to current societal needs. Recent researches have focused on the same area of interest. There were identified as research projects that generate the creation of unconventional technologies, to realize electromagnetic shields and multilayered conductive material shields. From the above-mentioned projects, the last one would approach to the magnetic wires as it uses polyester yarn, which attempts to be coated with aluminum nanoparticles and ferromagnetic material. Technological principle in this case is not similar, but the results can be compared. The project is ongoing, and the result is not yet known. But research in this direction emphasizes a focus area designed to bring solutions to pressing problems, confirming an attractive perspective for the future.

Incidents: During 3 years of experiments, there have been no recorded incidents such as disease inhalations and toxicity.

Environmental risk: At the experimental level, it results in a trace amount of magnetic waste, about 50% of the amount applied. An obvious problem identified is waste management, and

in circumstances in which some of them are discharged by washing device, exhausts pipes deposits may be created.

Recyclability: For the moment, there is no possibility of recycling after use. It is premature to put the problem of recycling, as it is not yet a finished product. For now, no information on waste recycling is available, but future research may provide.

The validity of resources: Organic components (polyvinyl acetate, polyurethane adhesive, and glycerol) are easy to provide and relatively inexpensive. The wire is made up of imported cotton, and barium hexaferrite is the only element that is relatively difficult to find, still found in the country, but the prospect looks that the supply is imported (China) not always on great value given the small quantities required.

Risk perception: There may be concerns about the possible particles inhalation during processing and subsequent handling, but with micro-sized particles, there is no danger of inhalation. No information is known about changes in the magnetic properties of the textile yarn in time; the effect should be carefully followed.

Considering all these indicators, sustainability of the patent can be achieved by means of a SWOT analysis as the one below (**Table 4**).

Table 4 presents a clear potential for sustainability of magnetic yarns, but that does not necessarily translate into a competitiveness potential, since it is not a question of selling an app yet, although there are good prerequisites for both an economic process and an environmental impact.

2.2.2.2. *Direction of orientation to integration into a value chain*

Current research for applications of magnetic materials is mainly in the direction of nanotechnology, although certain studies [20] demonstrate the interest of researchers since 90s for barium hexaferrite nanoparticles. Historical evolution started from magnetic fibers has evolved in a direction of magnetic yarns to align new trends and research programs for the looming default to the nano (**Figure 9**).

EU clusters [28] dedicated to nanotechnology have developed strategies for shaping the value chains, which are now in training and are to be configured as follows:

Strengths	Weaknesses
Carbon footprint	Societal and users benefits
Low power consumption	Environmental risk
Lack of incidents	Cotton import
Low consumption of raw material	
Low costs	
Opportunities	Threats
Recyclability	Barium hexaferrite
Risk perception	Risk perception

Table 4. SWOT analysis of sustainability indicators.

- Value chain 1 (VC1): multifunctional lightweight composite materials applicable for textile and sustainable sport, packaging, transport, energy, Information, Technology and Communication (IT&C), and construction;
- Value chain 2 (VC2): nanoenabled surfaces for multisectoral applications, such as humidity, water, plasma, and vacuum;
- Value chain 3 (VC3): structured surfaces in energy field, IT&C, textile, medicine, transport, and construction;
- Value chain 4 (VC4): functional ceramic and intermetallic alloys used in the field of energy accumulation and conversion, as well as IT&C;
- Value chain 5 (VC5): functional fluids for transport, construction, medicine and pharmaceuticals, consumer products, and IT&C;
- Value chain 6 (VC6): nano integrating for semi-finished and finished products, direct manufacturing, 3D structures for nano electronics and photonics, catalysis, and filtration;
- Value chain 7 (VC7): infrastructure for modeling and testing on full-scale, for complex adaptive systems for complete product design.

The variants mentioned above can be a source of inspiration to correctly identify future research orientation. Magnetic nanoscale wires would find utility in many of the areas targeted for funding of NANO futures cluster.

Research could continue alongside for the development of magnetic fiber value chain by developing applications that will find their purpose both in Romania and Europe, but the first step requires the engagement of a proactive behavior that involves promoting the idea, and resources finding to activate the said patent into an active form. The mere fact is that there is a patent in a latent form in a complex database, but it does not make it visible. Good ideas, in any business, require to be promoted and applied. It is true that success does not always reap effort, but it is worth trying.

In conclusion, the patent analysis shows that it could be sustainable in terms of environmental indicators and resources. What determines a product to be successful or not is how it

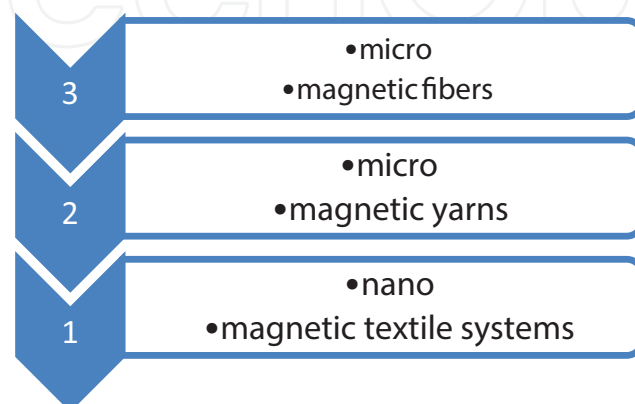


Figure 9. The innovative value chain of coated magnetic yarns.

manages to convince the user. Therefore, subsequent developments may be the key to success. Nanotechnology is the nowadays trend, and it coincides with development directions at European level and has the potential for integration into a value chain and likely financial support.

The message of this study is that any technical idea required to be pursued in relation to market conditions and access to resources for consumption and environmental impacts; otherwise, the effort may simply be an exercise in creativity, consuming time, and significant financial resources, which could be redirected to a more efficiently idea.

As it could be seen, in both case studies (Davo Star and patent analysis), the social and economic perspectives are taken in consideration. New technologies cannot be compared between them, and every step of the discovery is noticed carefully to control environment and health impact. Both require huge investments, and integration in international collaboration is *sine qua non*. When the discovery succeeds to cross the laboratory level, there are networks prepared and already configured at the European level to integrate these new ideas in planned value chains where specialists are available to develop later stages. Even if the success obtained in a laboratory is not a commercial one, there is the hope that every small step gets closer to the final process. As a conclusion, the best ideas could be implemented in the best way only inside the best variant of cooperation.

2.3. Final thoughts

Hopefully, this chapter revealed practical and theoretical examples of smart textiles from an economic perspective concerning their integration in different value chains, commercial or innovative. As it could be seen, even if it was an economic concept, an authentic interdisciplinary approach was required to get information from economic, textile, chemistry, physics, and business fields to have an impact in understanding the phenomenon of smart textiles.

This chapter covered a wide range of case studies focusing on equipment, a group of nanoproducts, a smart fabric, a solution to reinvent the activity, and a patent analysis. Three of these cases are from Romania, and they were luckier to be identified since smart textiles are quite nonexistent in this country, although it used to be one of the most famous textiles producer in the world. That is why these examples are welcome not only internationally, but even at the national level.

All these examples show that technology could help to reconfigure the international market, and the advantage seems invincible, but always for short time since new discoveries can undermine the entire company's effort. Also, even the investment required is huge, this is not covered always from the governmental or European funds (as in the case of Elmarco and Davo Star), and they can be supported from private sources (as in the case of Holmenkol and Siderma). The international context plays a very important role in every case, and the value chains represent a result of a very strong international cooperation. The integration in a commercial or innovative value chain confers a double opportunity for all the actors analyzed to be a supplier of a wide range of advantages due to their discoveries, and at the same time, they become opportunities users. This helps them to consolidate their position since they get reputation and trust, and thus they could open new doors for cost optimization or finding new ways of development.

The research activity is a specific feature for all of them, and this helps them to be in front of the others.

In these new markets, the technology diffusion is difficult to follow since they are not yet mass products or because the field where they act is not transparent at all.

The quality of raw materials supplied is very important. Investments are justified not only for great ideas or highly qualified workforce, but even for a healthy and economic sustainability.

If in Czech Republic or Germany smart textiles are well represented, Siderma seems an isolated and a surprising example from Romania.

All these approaches suppose specific niches, and they require an entrepreneurial culture [29] based on capabilities to create best environment for ideas, special equipment, unique applications, strategic partners, find ways of financing and sometimes special character to manage turbulent or geopolitical situations.

Finally, all these case studies demonstrate that smart textiles represent an alternative of what we live today, but surely, they will be the answer for the best future.

This research shows that success is a consequence of intensive and commercial-oriented company policy, an effect of updating to nowadays conditions, an inspired movement to the right business way. The chapter represents an invitation for creative people to focus on developing innovative value chains.

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