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THE FUTURE IS TODAY

Case study

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Abstract

In 2010 the European Competitiveness Report showed some insights about the importance of the five key enabling technologies which are nanotechnology, biotechnology, micro-systems, advanced materials and photonics, emphasising the role of these technologies for a country's competitiveness. European reports mentioned later six key enabling technologies, the number increased by adding a new one: advanced manufacturing systems. In a short time, the advances of technology generate faster growing and open new industrial directions that are difficult to predict.

This paper focuses on a summary case study about the advanced manufacturing systems enabled by key enabling technologies trying to point out their importance for the value chain. Some experiences showed by European reports could inspire beginner countries like Romania. Even if the Romanian reality reflected by some statistical data is not optimistic, there is a very ambitious plan for next years to implement politics for setting key enabling technologies.

1. Introduction

The most important goal of an economic activity is to organize the transformation of raw materials into products that change the life of people in a better way and keep the environment healthy.

As raw materials are an important part of the environment, they have to be used wisely. The main actor of this process is the human being, the only one responsible for organizing the economic activities and also of his own life. These both could run through creativity which can give the right direction of any effort.

Sometimes the creativity becomes complex where qualified people manifest ideas giving a strong contribution to the humanity by advances that influence the map of the industrial businesses.

Industry is organized around technologies that are the result of creativity through research and development (R&D) activity.

Changing the technologies is the most important step to be taken in order to achieve better results and to incorporate innovation into economic activity.

The focus is on those technologies that use few raw materials, obtain products with better characteristics that will be the leaders on the market.

The new technologies are the result of intense R&D activity and are far from traditional ones. They are the result of a multidisciplinary approach and operate at microscopic levels. They demand new forms of organization at the level of researchers, entrepreneurs and the state, in order to achieve new levels of cooperation to enhance innovation and creativity.

The European Union looks at these new technologies with hope and draft measures and programs to implement them into the European industrial landscape until 2020.

In 2010 the European Competitiveness Report showed some insights about the importance of the five key enabling technologies, the so called KET's, which are nanotechnology, biotechnology, micro-systems, advanced materials and fotonics, emphasising the role of KET's for a country's competitiveness. Later, European reports mentioned six KET's, that means the number of KET's increased by adding a new one: advanced manufacturing systems. In other words, the advances of technology generate faster growing, the industrial landscape becomes more and more complex and open new industrial directions that are difficult to predict.

In this context, Romania tries to overcome the gap between the national industrial landscape and the most advanced industries of the European Union, with the help of the National Strategy for Reasearch, Development and Innovation 2014-2020.

The research activity follows the developments of technologies applied to industries and gives the right answers to entrepreneurs, to researchers and government in order to change in a better way the economic activity by using innovation and creativity.

This paper is divided in three main parts: in the first part develops some theoretical concepts about industry, value chain, innovative chain, technologies and key enabling technologies; the second one focuses on some issues about advanced manufacturing systems in Europe and in Romania; the third part presents some conclusions with ideas to be followed.

2. New technologies create new business

From the theoretical point of view, the concept of industry met innumerable definitions. Most of them refer to the idea of different actors involved in production activity. Then the theory points the difference between the concept of industry and industrial sector. Some theories (Langager, 2009) say that even if there is a difference between these two concepts, they are used often with the same meaning. In reality the industrial sector concept comprises a larger number of actors while the concept of industry refers to the actors involved in similar activities. This means industry comprises companies that are a part in a sector, while in an industrial sector there are many industries (Langager, 2009).

Nowadays the new entrants in an industrial sector are creating own rules regarding the competition and business models. As Estall (1967:19) says all the industries and all the firms connected to these own their existence to individual decisions and the development depends on the experience of the people involved, on the advantages offered by their locations.

Every stage of the industrial development was characterized by activities analyzed in economic theories. For every new stage, the existing theory showed its limits and pushed to create a new one. Every industrial change rethink the entire system of institutions and rules that govern the entire field, because the industrial evolutions are not reflected at the micro level, but at the macro level too (Ghemawat, 2010). The existing industrial models create solutions for an existing demand. Through new technologies, new products are born for a future demand. Ghemawat (2010:31) shows every new strategic theory analysis new parts involved into the industrial process. This means, when new actors involved in the industrial system will create new rules for plying on the market new theories will be born.

Jolly (2012) says new attractive technologies create new business. The first actor in a new technology can impose own technical standards on the market, but in time, when new actors come and the business

become attractive only some of them can impose own standards, most of them will be only followers. Jolly (2012) shows that an existing strong technology design will be followed, but if it does not exist it will be created.

Jolly (2012) says the criteria for a technology selection takes into consideration financial aspects, investment return, but the main objective is income maximization for a potential unit venture. Generally the technological analyse follows two aspects: the future trend in terms of volume and life cycle, and power supplied to the company in terms of competition (Jolly, 2012).

Another criteria to select a technology refers to the life cycle of the product as a result of its use, and the effect of the company position regarding that product in comparison with the competition (Jolly, 2012). The selection of a technology refers to the choice of the patent from two points of view: it reflects the interest for that technology through a big demand of a certain patent or the patent reflects the company position on the market. The studies show a high attraction for a certain technology, but the products resulted failed on the market (Jolly, 2012). These idea emphasize the commercial aspect as very important too (Jolly, 2012), but for very new technologies it is difficult to estimate their market potential (Jolly, 2012).

Almidi et al. (2011) says that certain industries based on scientific discoveries become market leader by using some technological or commercial practices. These companies have an intensive research and development (R&D) activity and succeed to obtain better performance than competition and extend market share (Almidi et al., 2011).

New technologies impose new innovation standards for every actor involved in an industrial sector.

Morris (2002) says that globalization stressed on division of work and thus the cooperation is very important. Kramer et al. (2011) say that the core of the value creation process is the business network. Kaplinsky et al. (2000) defines value chain as all activities regarding the creation of the product describing the entire process starting with idea and finishing with the final user. The value of the network process is made by the quality and longevity of the relationships and by the ability to develop and innovate (Kramer et al., 2011).

Some studies show that market leader can design the value chains by adding or eliminating suppliers (Elg et al., 2011). Morris (2002) says there are key actors into the value chain and these assume their responsibility for their level regarding the connection of some other actors to the chain at the sector, national, regional or global level.

European Competitiveness Report (European Commission, 2010:133) shows that an innovation project takes into consideration the expenses for the R&D and the way to recuperate them through sales process, but they regard the entire chain of the business made of suppliers and customers.

Recently, the industrial landscape is reconfigured by the necessity to reduce the consuming of the raw material due to its existence in less and less quantities. In this direction the discoveries are technologies as result of interdisciplinary cooperation and they can be used in many industrial fields or generate new industries. As the Ghemawat shows (2010:30), the technology can be the border of an industry.

Due to large R&D effort, new industry is born and its core feature is defined by so called “key enabling technologies” or KET’s. These Ket’s means the creation of fundamental new products, supplying substantial economic advantages, satisfying a wide range of demands and involving industries with no connection to the past (European Council, 2010: 131). There are six types of KET’s: photonics, nanotechnology, biotechnology, advanced materials, micro-systems and advanced manufacturing systems (IDEA et al., 2012).

Nanotechnologies applications are used through magnetic, mechanical, electrical, biological and optical procedures at the molecular level and the dimensions are smaller than 100 nm (European Commission, 2010, p.77).

The micro-systems suppose miniaturization of the integrated components, combining semiconductor technologies with nanotechnologies applied to silicon structures smaller then 100nm (European Commission, 2010, p.77).

Biotechnology is based on the use of microorganisms in the industrial production of bio-materials, bio-fuels, textiles, paper, within an environmentally-friendly process by recycling the “wastes” as raw materials (European Commission, 2010, p.77).

Advanced materials enable better properties than traditional materials, are applied in all industries, affording low costs with high performance and a positive impact on environment in comparison with the traditional products (European Commission, 2010, p.77).

Photonics use photons replacing electronics by combining physics, nanotechnologies, material sciences, biotechnology, chemistry, electric engineering in the development of laser, electronics, optic fibres (European Commission, 2010, p.77).

Advanced manufacturing systems integrate production systems, equipments and processing controlled by complex communication systems (IDEA et al., 2012, p.26).

The main characteristics of KET’s are their location into the small and medium sized companies placed in clusters. As IDEA et al. (2012, p.33) says, KET’s need substantial investments and are supported by the state. Even it seems a paradox,

small or medium companies has their limits in creating complex networks, but it can cooperate efficiently at the international level and can offer flexibility, good communication and control of huge investments.
Qing (2012) shows many of the clusters have the state's support which created the proper institutional environment and policies. Through these measures the entire complex of cultural, business and geographical factors are efficiently used for creating new industries and specialized labour that will attract investors and foreign capital by intensifying the entrepreneurship.
Chiarvesio et al. (2008) says that districts can develop a specialization through an innovative strategy imposed by a leader company which create a commercial network or some essential resources. In this way, the companies inside the district could become important nodal point into the value chain.
Some studies show (Coccia, 2012) that R&D activity is not enough for an economical development, but the way to allocate the resources is very important. It refers to labour, infrastructure and raw materials, all these are important for industrial companies to be competitive (Boons et al., 2012).
Another idea which generates competitiveness regards cooperation (Tidstrom et.al, 2012) The cooperation aspect is not often mentioned in the practice, mostly the competition is predominant.
Davis et al. (2012) says that intelligent manufacturing process supposes new information based on testing the research issues. In this process the most important element for creating competitive advantage could be the qualified labour instead of the technology (Davis et al., 2012).

3. AMS in the European context

This paper tries to underline the importance of advanced manufacturing systems as a part of KET's which will close the value chain by new products. Since this concept is very young technologies, the approach is more theoretical, but there are already some examples as good practices to be followed. The general lines are offered by some European reports that present a clear picture of this new area. Experiences showed into these reports could be an inspiration for Romania as a beginner in KET's. Even if the reality reflected by some statistical data is not promising at all, there is a very ambitious plan for next seven years (2007-2014) to implement politics for setting KET's.

3.1.The AMS concept

Until now, the KET's have little value added and use to the society. Most of the discoveries remain still laboratory projects. The AMS are required to produce value through KET's and to implement the products for tomorrow.
As the effect of globalization, the most modern manufacturing systems were implemented in remote corners of the World (Thematic Report, 2010, p.1). Nowadays the technology trend will give answers to the pressure of small consumption of materials and this will be global implemented everywhere in the future through advanced manufacturing systems enabled by KET's. The future products will be a resource and energy-efficient with impact in commodity prices (Thematic Report, 2010, p.2). Who will be able to master AMS will keep the key related to the costs, quality, life cycle and performance of the products.
The Thematic Report (2010, p.3) defines AMS as a whole system involved in production like plants, equipments, information technology or robotics used in the manufacturing process. It is important to understand that AMS refers to processes and solutions. The difference between the traditional manufacturing processes and AMS consists in the speed of production, costs, material consumptions, precision, impact on environment and the materials used and it can be done using a high speed information and communication systems (Thematic Report, 2010, p.4).
As the Thematic Report (2010, p.4) says AMS is a mix of technologies, like "material engineering technologies (cutting, knitting, turning, forming, pressing, chipping), electronic and computing technologies … measuring technologies (including optical and chemical technologies), transportation" and logistic technologies.
The main purpose of AMS is to create new high tech-products through new inventions for the future of manufacturing (Thematic Report, 2010, p.3). AMS is applied in some activities like pharmaceuticals, biotechnology, micro-nano electronics, automotive, food sector and every process from the value chain (Thematic Report, 2010, p.5)
The value added obtained by traditional manufacturing systems came through "removing, reshaping, mixing or adding materials" (Thematic Report, 2010, p.4). Nowadays the manufacturing process creates value added through miniaturization, acting at smaller and smaller scales with the help of KET's.
Thematic Report (2010, p.5) shows that the structure of the AMS value chain is the same as in the traditional manufacturing starting from raw material to the production of the final products and services.
The characteristic of every value chain stage is that AMS changes every step of the manufacturing process.
AMS have a strong impact not only from the technical point of view regarding the industrial processes, but also on the business models consisting in lean production, supply chain, integration reflected into production efficiency, productivity and environment performance (Thematic Report, 2010, p.6).

The AMS enabled by KETs have as target to generate new products affordable in terms of economic feature as energy consume, low-cost transport, and energy saving manufacturing process. In terms of energy consume, they have to follow the trends of discoveries in the field of energy, using renewable, bio-fuels, reduction of waste production trying to be sustainable (Thematic Report, 2010, p.7). In terms of transport they refer to the reduction of the costs, increase of safety and efficiency all because the products are lighter (Thematic Report, 2010, p.7).

All the six KET's will change the entire economy making it energy and resource efficient. This will build a healthy life for the European consumer and a cleaner environment.

3.2. European examples of good practices in AMS

IDEA et al. (2012) published a study regarding the good practices of KET's. The main objectives of this study are to offer an European Union overview regarding the states policies in terms of KET's; second, the goal was to emphasize leading countries with relevant policies; third, to identify key factors for success (IDEA et al., 2012, p.7) in terms of transferability of policy practices (IDEA et al., 2012, p.2).

The selection of good practices was made by EU experts and they focused on success factors. In the study, some keywords were used to identify relevant policy measures and these regarded commercial activity, business models especially value chain, industrial map and public or private funding (IDEA et al., 2012, p.8).

The study (IDEA et al., 2012, p16) reveals 4 groups of countries involved in AMS activity. The first group is composed by countries with patent performance at the "production frontier"; these lieder countries are: Poland, Italy, Sweden, Germany, Czech Republic. The second group consists in only one country with patent performance, but situated below the "production frontier" and this is France. The third group of AMS countries is made by Nederland and Austria and represents countries with minim to low patent performance but on the "production frontier". The forth group is represented by Latvia and Greece as no patent activity, but on "production frontier".

At the first glance, most of the examples selected met the same issues to be improved through policies measures:

- Critical mass of the researchers
- Communication between universities and companies
- Taxation
- Cooperation with industry
- State aid framework
- Creating awareness for research activity
- Investment procurement
- Creating an existing demand

Germany seems by far a real leader, not only in AMS, but in all the KET's. Its slogan is "one euro from the Federal Government, five euro from businesses" (IDEA et al., 2012, p.73). Each country design own policies depending on cultural conditions, country's level of development and KET's objectives to be followed.

This study reveals some important lessons to be learned as the need to cover multiple stages of technologies development and deployment (IDEA et al., 2012, p.21). This will be a chance to pass over the valley of death that makes most of the projects to be stopped. As IDEA et al. (2012, p.27) say the second lesson is about creating a demand side support – it can be applied through public procurement that can boost technologies into the market and diffusion of innovation can be done through bidders, renewing public services, purchase innovative products and services. Following this idea, a good example could be Czech Republic where the national programme for innovation comprises a list of priority fields of industrial research (IDEA et al., 2012, p.12).

Another important lesson revealed by this study is the need to tap into a global value and innovation chains (IDEA et al., 2012, p. 33). Since SME are small and not powerful enough to act at international level, cooperation with large companies is needed. In this sense, Germany is again a good example regarding the policy of alliances between the state and the private sector in funding the industrial research (IDEEA et al., 2012, p.24). This could be also a good example for small countries that cannot afford the entire value chain of the KET.

Another important lesson to be learned regards a problem present everywhere in the research world: the cooperation between academies and business environment. This lesson is an invitation to find ways to enhance collaboration in these two sides. Again Germany could serve as an example of approaching this matter.

A private glance should be concentrated on Poland since it could be a good example to be followed.

As IDEA el al. (2012, pp 93-105) show Poland had two important projects: "Support for goals-oriented projects" and "Support for the implementation of results of R&D works". These were implemented by two state entities, one regarding the enterprises development and the other one concerning the high and research education. Poland did not target a certain KET to be implemented or developed. It was mentioned a general idea as "medium-high tech technology" but it was a clear list with fields to be found: electronic elements, production of optical instruments, production of pharmaceutical substances, production of equipment, production of irradiation devices. Through these projects the support was directed to discoveries that will guide to a knowledge based economy, with a societal

impact, particular need of a given entrepreneur, creation of a prototype, implementation of R&D discoveries. In this way companies were obliged to submit two applications, one for research and the second for results implementation. The success of these policy measures is in fact a consequence of the entire synchronized policy, industrial and educational. Over this basement made in years of efforts, it is easy to develop and adapt new evolutions.

The IDEA et al. (2012) study revealed that every country had some premises to implement AMS and these are connected to the policies implemented in industry, education and research. All the AMS countries have an intensive production activity which seems to be a key element for AMS and a developed infrastructure according to this technology.

3.3. Perspective of AMS in Romania

KET's require a very high qualified labour, huge activity of R&D and are capital intensive. They can be developed in small and medium sized companies organized in clusters. They receive state support consisting of founds and policies measures. In the following, these directions will be drowning through some statistical data or information supplied by authorized Romanian entities.

- The Research and Development activity

According to the National Strategy for Research, Development and Innovation 2014-2020 (2014, p. 6), there are some insights about the strategy 2007-2013 regarding the goals focused like the growth of the scientific production and the quantitative increase in the human research capital. Another success was a result of internationalization process by increasing the quantity and the quality of the scientific publications and the R&D projects evaluation become international. In comparison with international standards, Romania does not have enough numbers of researchers. A critical mass misses to implement and develop advances in the near future directions, especially regarding the multidisciplinary approach. The intra and inter sector mobility has little impact on knowledge propagation.

As EUROSTAT (2014) shows the R&D activity in Romania is the poorest in comparison with all the other European members arriving at 0.42% of GDP in 2012. Another statistics showed by EUROSTAT (2014) reveals that the research activity is almost isolated to the business environment and state: 0,12% in 2012 in business sector, 0,20% in government sector and 0,10% in higher education sector.

Due to this reality it's obvious the fact that the R&D sector in Romania is not seen as central point for the development.

- High level qualified labour in terms of present and the future

A statistical survey regarding the education in Romania (EDU-01, 2014) reflects that more than 40% of the total students study technical or industrial insights in 2012, which is a promising direction for the future. This could be a hope for implementing AMS in Romania.

IDEA et al. (2012, p.16) supplies a cruel Romanian reality regarding the KET's showing no sign of activityty, there is no important actor playing on the patent market, but there are some universities or projects founded by European Union with no significant impact.

- Small and medium sized companies organized in clusters

The Association of clusters from Romania (Clustero, 2011-2014) concentrates a number of 15 clusters in different areas where there is a national interest for competitiveness. Even if this kind of model of clusters is a pioneer activity in Romania, there is something important missing here: the activity of research. This pushes the limits between what is a Romanian cluster and how really works a modern cluster abroad, where KET's are on the every actor's list: state, research institute and private companies.

- Entrepreneurship

The small and medium sized enterprises cover a turnover about 57% of the total turnover existing on the market (IMM-01, 2014). Even if they seem so important for the economy, the entrepreneurship lives in difficult conditions, uses instable labour in terms of fidelity, seems poorly connected to policy makers, and suffers because of high level taxes.

All this information reflects vulnerability in terms of R&D activity, state support, poor critical mass of researchers and lake of important actor (research institute, private company or state) involved in KET's or patents with national impact. It seems the future labour could be specialized in the new direction, and real hope could appear from the entrepreneurship and maybe from some existing clusters.

The National Strategy regarding the R&D activity refers for the first time explicitly to the KET's (National Strategy 20014-2020, pp.17-18) following the European Union 2020 Strategy where the KET's will boost SME, innovation, technological innovation in every European country, even Romania.

At least the future seems more optimistic than the present. The National Strategy for the Research, Development and Innovation shows the intention for creating a private sector in the research field with through entrepreneurship for innovation (National Strategy 20014-2020, p.14). Government will implement policies in this direction.

In a situation where there is almost nothing, the good news is that there is enough space to do what is needed, but it takes time and vision. Even if it seems too late to recuperate the time, taking into

consideration that most of the KET's advances could not pass over the laboratory level, this can be a chance for Romania to look carefully at the others more experienced and to learn from their experience.
In this way, Poland could offer a good example for building policies in time and follow a vision.
A right way for Romania could be to find alliances to cooperate as a partner into a value and innovative chain.
Another way to implement KET's is to take part in research partnerships. This could avoid situation of not finding resources to finance a project a project or to meet the valley of death situation. As the Thematic Reports.(2010, p. 37) shows the infrastructure and competitive energy prices will play an important role to attract investments. Then the access to the raw materials will be important.
For the moment, Romania did not decide yet a clear direction for the so called "smart choice" of one or more KET's. The AMS should be on the list following the Latvia or Greece example of being at the "production frontiere" and having no patent activity, or it could concentrate on other KET. In any choice It has to follow the priorities established by the objectives of the European Union and to assume the direction chosen there.

4. Conclusions

Nowadays, the new entrants in an industrial sector create their own rules to play on the market, by designing new business models.
Technology is the core of the change and the predominant model implemented by actors will design the new landscape of any industry.
A technology become leader on the market only when it succeeds to pass over the laboratory borders and it is implemented into the existing products on the market.
The future trend of the industry will be designed by the need of small consumption of raw materials and small energy consume. These two parameters will be drivers for new discoveries that will be combined through KET's and will offer the right answer for these needs. Starting from now the production scales become more and more contracted and the miniaturization is the trend.
This paper tries to underline the importance of advances manufacturing systems as a KET which will close the value chain by new products. Since this concept is a very young technology, the approach is more theoretical, but there are already some examples existing as good practices to be followed. The general lines are offered by some European reports that present a clear picture of this new area. Some experiences showed into these reports could be an inspiration for Romania who has a very ambitious plan for next seven years (2007-2014) to implement politics for setting KET's.
In its own short history, AMS can already offer some good practice as examples to be followed by other countries. There are already some leaders existing on the market who decided to choose AMS as a KET to be implemented and developed. Poland could be a good example of an ex-communist country where KET's are implemented successfully, even AMS since proper policies were implemented years ago in research, education and industry and now it seems prepared for the future.
In this matter, Romania seems more vulnerable, since it does not have an infrastructure ready for KET's, but it has a very ambitious plan to be implemented in the next seven years through National Strategy for Research, Development and Innovation 20014-2020.
It is difficult to estimate the start since a regulation framework is needed to be settled.
There are some directions to be followed like to create conditions for entrepreneurship involved in research activity that could develop collaborations in an innovative value chain or to be inspired by Latvia or Greece that is already involved in the production activity without having own patents to be used.
It is the right moment to understand the importance of a synchronized vision in terms of infrastructure, education and research environment to offer proper conditions for the existing goals regarding the KET's.
The seven years between 2014- 2020 could be enough for some countries to get progress, but for Romania could not be enough to obtain the expected results. Besides to implement a plan, awareness is required and a vision is needed to correlate the steps to reach the goal creating an industry based on the best new technologies.
This study could be continued focusing on developing the drivers for implementing some KET's in Romania.

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