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KEY PRIORITIES FOR HIGH TECHNOLOGIES DEVELOPMENT IN LITHUANIA

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Abstract. Development of high technologies in Lithuania is lagging behind from most of the EU Member States. Current high technologies expansion indexes in Lithuania do not comply with the goals se by the EU. Thus, the article aims to set key priorities for a successful development of high technologies business in Lithuania and therefore analyzes the theory of high technologies development, including specifics of high technologies development that derives from exceptional high technologies features, the most effective models for high technologies development and the principles of its formation. After analyzing models, aimed at high technologies development, we can conclude that the Lithuania should expand high technologies on the basis of a "triple helix" model of overlapping elements.

Keywords: high technologies, development, characteristics of high technologies, triple helix model, Lithuania.

1. Introduction

The attention to competitiveness of a region has not decreased for recent decades furtheremore the aspects of competitiveness gradually become one of the main parts in regional development strategies. A lot of regions are looking for perspective niches where they should or could increase their competitiveness and develop themselves economically and socially contemporaneous (Snieška, Bruneckienė 2009). Therefore development of knowledge economy based industries has been stated as a priority for the purpose (Gerasymchuk, Sakalosh 2007)

Studies of such scientists as Agmon, Messica (2006), Rausch (1998), Melnikas (2004), Snitka (2002) and others as well as strategically significant documents of national and international organizations tend to focus on the importance of high technologies in the period of intensive economic globalization because high technologies development is a strategically essential area promoting efficiency of a regional and national economy and ensuring a competitive edge of a region and a country. This is quite relevant to the EU and particularly relevant to small countries like Lithuania which do not hold substantial natural, material or labour resources. Countries developing high technology products not only gain a technological advantage, create marketable products for export, but also promote a rapid growth of the Gross Domestic Product as they create the highest value added. Therefore it is very important to strive for the rapid high technology business development.

Various studies (Tvaronavičienė, Ginevičius, Grybaitė 2008) show that economics and high technologies develop at a different rate in all of the EU Member States. The difference might be caused, as noted by Tiago *et. al.* (2007) by differences in funding, management and technical expertise, exposure and awareness of available technologies, training, and other infrastructures.

In terms of the scope for production of high technologies and other indices of high technologies expansion in separate EU member states, we may note that the leaders of high technologies based on the recent data are Great Britain, Italy, France, Slovenia and Hungary. These countries create added value in high technologies area of over 30 % compared to general added value. The highest added value in the high technologies sector based on the absolute indexes is created in Great Britain, Italy, France and Germany since the value added created in the said countries in this sector is over 50 million euros. The above listed countries and Spain can also boast of the largest number of high technologies companies, the number of which exceeds 25 million companies operating in the area in each country.

In the last few years the development of high technologies in Lithuania considerably lags behind in comparison with the EU level. According to the data provided by the Department of Statistics to the Government of the Republic of Lithuania in 2007 in Lithuania 419 companies operated in this area, which is 0.3 % of the companies in total and the number of employees in those companies accounted for 0.8 % of all employees in Lithuania. The program for development of high technologies by 2013 indicates that currently a share of the GDP generated by production of high technologies in Lithuania is less than 6 percent which is half as much in comparison with the EU average: Lithuania exports about three times less than the EU average. Based

on the *Eurostat* data of 2006 Lithuania in terms of this indication is ranked twenty-third among the EU countries (4.65 %) and from Malta which is the leader in this respect (54.61 %) it lags behind almost twelve times, from Luxembourg which is the runner-up (40.66 %) it lags behind nine times and six times from Ireland (29.01 %). Meanwhile the export share of high technologies in the USA and Japan in the total export of the country constitutes 26.13 % and 20.04 % accordingly.

Moreover, Lithuania considerably falls behind in implementing the EU goal by 2010 to achieve that the R&D would constitute 3 % of Europe's GDP and investments into the R&D from the private sector would be two thirds of the overall investment into the R&D. According to the data provided by the Department of Statistics to the Government of the Republic of Lithuania in 2007 the funding allocated for the R&D constituted only 0.17 % of the Gross Domestic Product of Lithuania which is nearly eighteen times less than the target. The majority of the R&D (about 48 percent) was financed from the state funds. Meanwhile the financing share of business companies was merely 24 % of all expenses for the R&D. So far this indication is almost three times lower than the target to be reached by 2010.

All those numbers both indicate that Lithuania considerably lags behind the EU average and also the majority of countries in the area of development of high technologies. They also imply that the current significant gap between indications of Lithuania in the area of high technologies as well as the R&D and the EU aims will not be eliminated by 2010 and the EU targets for the area of high technologies in Lithuania will not be reached. However, as it is evidenced that the expansion of high technologies and high technologies business is not as fast as desired, therefore it is quite complicated.

Thus, the *objective* of the present research is to propose a high technologies expansion model and its formation guidelines after conducting a scientific literature analysis and a review of indexes that indicate the EU and Lithuania's high technologies development. In order to achieve this aim, at first it is necessary to define the concept and characteristics of high technologies, due to which the business in question is characterized by specific features directly affecting its expansion. Furthermore, we should distinguish the key elements in the system of the business expansion as well as identify priorities of their successful interface pursuing the expansion of high technologies business in Lithuania. To reach the set aim, an analysis of scientific literature has been conducted.

2. Background for high technologies development in the EU

The first step to prompt expansion of innovations and also high technologies in the EU was the Green Paper on Innovation of 1995 which according to Rossi (Rossi 2005) was followed by the First Action Plan for Innovation in Europe. The fundamental progress was made when implementing the aims of the Lisbon Strategy in 2002 the Council of Europe in Barcelona defined a target for 2010 for the scientific research and experimental development (R&D) to constitute 3 % of Europe's GDP and investments into the R&D from the private sector to account for two thirds of the overall investment into the R&D (Rossi 2005). Understanding the role of innovations for the development of economy, the EU both reforms its approach to an active and independent position of the Member States regarding innovations, and implements relevant mechanisms on the EU level oriented towards promotion of the innovation culture, creation of the framework conducive to innovations and orientation of science towards innovations in spheres of industry and services. Therefore various programs for high technologies development are implemented in the EU.

3. Understanding high technologies and specifics of high technoogies business development

The complexity of the problem of high technologies expansion is determined by characteristics of high technologies. Walsh (2003) notes that the notion of high technologies was changing in time, since it is not constant due to its content: what used to be understood as high technologies after a period of time can no longer be attributed to high technologies and some technologies cannot be regarded as high technologies because what yesterday was high technologies, today may be usual and widely spread technologies. This is to say that the basis for the characteristics defining high technologies should be dynamics.

Clarke, Stough (2001) maintain that objective and subjective definitions of high technologies are still possible. In their opinion with subjective definitions, the researcher develops a definition based on personal criteria, [...] objective definitions can be used for multiple regions and as more as more use the definition, it gains credibility. Thus, it may be concluded that upon defining high technologies by such features which would be meaningful in the global market, we could have objective characteristics of high technologies and on their basis identify products satisfying such characteristics. Therefore according to the scientists such characteristics should describe a developed product, therefore

Rexroad (1983), defines high technologies as the newest, most innovative and modern products at a given period. Furthermore according to Allen (1992), Riggs (1983), Shanklin, Ryans (1984) first of all it should be noted that the products in question (goods and services) are inseparable from *application of science and technologies*. Therefore, such products become obsolete in the face of developing technologies. Riggs (1983), Ryans, Shanklin (1984), Rosenau (1988), Davidow (1986) MacInnis, Helslop (1990), Goldman (1982) identifies *short life cycle in the market* as another specific characteristics of high technologies. Thus, such products typically go through the life-cycle stages in shorter periods of time compared to an ordinary product. Furthermore, in the opinion of McIntyre (1988) also supported by Sahadev, Jayachandran (2004), Meldrum (1995) the list of specific characteristics of high technologies should also be supplemented by *indispensability of associated infrastructure.* The nature of high technology implies that there is unlikely to be an established external infrastructure which will make easy to commercialize high technology products (Meldrum 1995).

Due to dependence on rapidly changing technologies, technological environment and a short product life cycle, the market of high technologies in the opinion of Riggs (1983), Meldrum (1995), Sahadev, Jayachandran (2004), Rosen, Schroeder, Purinton (1998), is particularly *risky*. The market is risky primarily because of a set of product attributes: innovativeness, complexity and a short life cycle. High technology products are innovative and complex, which is why it is often difficult for users to realize a service, its value and benefit. In other words, users are not certain about the product, so it is quite difficult to convince them to buy rather expensive high technology goods or services (Chlivickas, Petrauskaitė, Ambrusevič 2009). Furthermore, customers' risk is driven from a lack of experience in applying, maintaining and using the technology, which increase a chance of problems, such as further costs, interruptions to support continuity, unexpected side-effect or quality devices (Meldrum 1995).

Due to that a product may fail in the market and this is what increases the possibility of failure for the firm. Furthermore, high technology products may become technologically obsolete within a short period of time due to a greater possibility of discontinuous change occurring in the product technology domain (Sahadev, Jayachandran 2004). Moreover, the high technologies business is particularly risky because it is complicated to estimate a long-term value of the technology, product or service being developed. A diversified company model theory, analysed by Ginevičius, Petraškevičius (2008) and Kutut, Ginevičius, Kutut (2008) could be one of the instruments for lowering of the business risk which would mean that companies should engage not only in creation of high technology products but also in manufacturing of other, less risky products. The other business risk management models and methods discussed by Kaleinininkaitė, Trumpaitė (2007) are also applicable for the purpose.

One more significant particularity of the high technologies business is that it is *investment consuming.* Large investments in the sector of high technologies are necessary in case a new technology or a product is being developed and investments are made into expensive research, technologies, their application, support and training of employees.

Another important characteristic of the high technologies business is *a rapidly changing market:* technological, economical, social environment and legal regulation, competition in the market as well as consumer needs and expectations and other circumstances.

Etzkowitz *et al*. (2000) and Wessner (1999) analyzing expansion of high technologies in different regions of the world distinguished three main configurations of the "triple helix" model (Fig. 1), all of them have advantages and disadvantages.

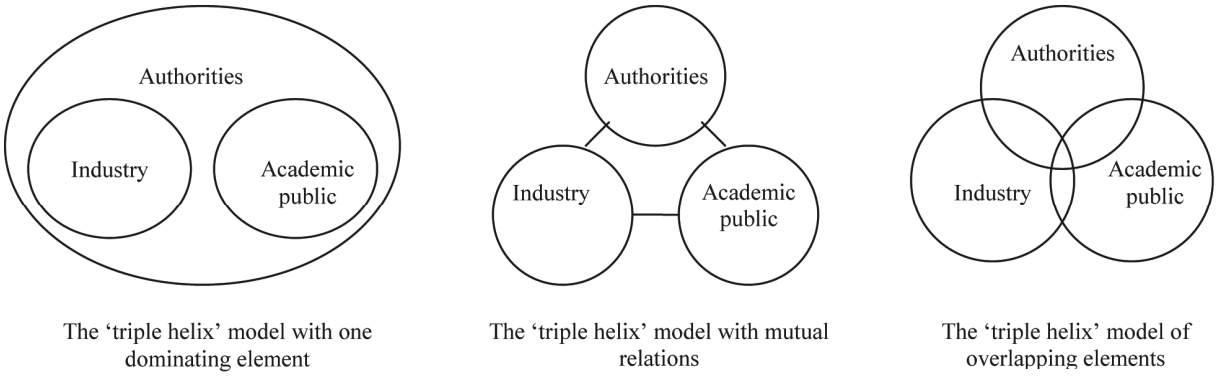

Fig. 1. The "triple helix" models (Etzkowitz, Gulbrandsen, Levitt 2000)

4. Triple helix for high technologies development

Due to exceptional characteristics of high technologies development of this business is rather complicated because processes of business promotion, innovation spread and fostering of the technological progress are highly intricate and it is important to know that expansion of high technologies business first of all strongly depends on the development of high technologies (Chlivickas, Petrauskaitė, Ambrusevič 2009). According to Melnikas (2004) it means that promotion of such processes and purposeful management of operations of their participants requires a complex approach.

The foundation for expansion of high technologies is innovation policy and it is reached by invoking innovations expansion systems. During the last three decades four innovations expansion theories have evolved: systems based on models of comparison of national innovation system, the first and second model of production of scientific knowledge and the model of the "triple helix". The latter is considered the most advanced.

The "triple helix" model indicates a relationship among the university, industry and authorities as an entirety of overlapping areas reflecting an impact of each element to other spheres. The model based on cooperation of science institutions, industrial enterprises and authorities was introduced almost a hundred years ago and such model promoting expansion of the high technologies sector was first suggested in the 1920s in the United States of America. It became the basis in developing programs promoting expansion of high technologies from the 1930s to mid-80s when the specialised Massachusetts Institute of Technology was established mainly working in the area of developing and implementing innovations. The "triple helix" model which states that the boundaries of a knowledge economy between the public and private sector in the society, science and technologies, universities and industry are vanishing giving a way for a system of interactive relationship to emerge, was formulated in the 1980s by Etzkowitz and Leydesdorff. The model was advocated as a useful method for stimulating enterprise and economic development as well as innovations, on national or international level. The "triple helix" model of high technologies reflects the entirety of multi-faceted relations affecting stages of creation and capitalisation of innovations. The model displays interrelatedness of academic public which is more often referred by authors as university, industry and government as entirety of separate overlapping areas, where influence of one element onto another is well reflected.

Etzkowitz *et al*. (2000) and Wessner (1999) analyzing expansion of high technologies in different regions of the world distinguished three main configurations of the "triple helix" model.

The first model reflects a situation, where the areas indicating elements of the industry and academic public exist independently without interacting. The dominant role of an intermediary is played by the authorities being the only element ensuring relations among the sectors. It may take initiative without consulting others and it may subsume the other institutional spheres and direct their activities. The main isavantage of the model is that the ideas are coming from only one source – the central government, therefore the model generates only a limited source of ideas and initiatives. The second model shows mutual relations of different elements but does not reflect their advantages and influence to generation of new ideas, creation of innovations and expansion of high technologies (Chlivickas, Petrauskaitė, Ambrusevič 2009). The model allows to establish relations between different spheres, when each of them plays an independent role in the own area only, but does not express the nature of those relations however the model does not express the nature of relations between institutions, therefore each of them plays an independent role in the own area only.

The third model of "triple helix" which shows the highest degree of cooperation among authorities, industry and academic public as the configuration of "triple helix" model and as noted by Chlivickas, Petrauskaitė, Ambrusevič (2009) allows solving all problems in implementation of innovations. However it can be successfully implemented only in developed countries and the implementation process is quite difficult as it requires high cooperation between institutions.

The aim is to reach the third helix, which implies that the parties jointly realize that university spin-off firms, trilateral initiatives for knowledge-based economic development, strategic alliances between different types of firms, governmental laboratories, and academic research groups together contribute an innovative environment (Brundin, Wigren, Isaacs, Friedrich, Visser 2008).

4.1. The role of the academic public, industry and authorities in a triple helix model

Academic public, industry and authorities in the triple helix in addition to their usual functions perform some functions taken over from other elements of the triple helix (Table 1.)

Table 1. The role of authorities, industry and the academic public in the "triple helix" model of overlapping elements for high technologies development

	Traditional functions in economical and business development	*New functions in the "triple helix"*
Authorities	Assurance of stable collaboration, coordination and regulation; Financial support for scientific research and expansion;	Academic aspect elaboration in daily activities;
Industry	Innovative products and services production; Economic trade;	High technologies expansion promotion; High technologies expansion financing; Developing training and research;
Academic public	Economic knowledge production and transfer; Research and academic activity;	Initiating high technologies development process; Firm formation;

The role of the academic public. The main role of universities, which are often referred to as the main academic public institutions operating in the process, in expansion of high technologies based on "triple helix" model next to its main functions is to transform their knowledge and technology to industry (enterprises) which actually means that universities have to transform themselves to entrepreneurial universities. An entrepreneurial university is one that extends its mission in higher education and academic research to assume the role of stimulating economic innovation in the environment (Leydesdorff, Meyer 2007). While mastering the knowledge, the business sector generates new ideas and a need of new scientific knowledge emerges which stimulates further collaboration. The university is also responsible for forming new firms in incubator facilities.

The role of industry. Industry, in this case, is responsible for economic production and trade. Its main goal in expansion of high technologies is to absorb university-generated knowledge for improvement of technological productivity. Technological productivity is associated with the science-intensity of patents (Leydesdorff, Meyer 2007). A firm can enhance its absorptive capacity by training its personnel, by carrying out R&D, and by using advanced manufacturing equipment (Schiller, Diez 2007).

The role of authorities. Importance of authorities for high technologies and innovation development in general is significantly important (Tvaronavičienė, Korsakienė 2007). The main task for government in high technologies expansion is encouragement of this expansion on the basis of the "triple helix" model. Etzkowitz concludes that this encouragement can be manifested in the following means: (Etzkowitz 2008):

1. establishment of a legitimate authority within a territory is extended from the public sphere to the private sector, promoting stability and reducing uncertainty in interaction (e.g. government guarantees are given to private capital so that with such insurance it may take greater risks in investing in new ventures);
2. levying of taxes to support protection of the nation and promotion of the general welfare is extended by using the tax system in a targeted fashion to provide special incentives and benefits;
3. establishment of rules to support the economic life including laws to charter firms and foundations and to regulate the conduct of markets and currency systems (e.g. new (hybrid public-private) agencies are established to promote innovation);
4. use of a legal system to establish special rights such as patents or temporary monopolies to promote innovation;
5. Provision of basic research funding to establish a linear model of innovation (e.g. provision of public venture capital to create an assisted linear model of innovation).

To summarise, the government supports development of high technologies through funding programs and changes in the regulatory environment.

4.2. Formation of the "triple helix"

In order to create an effective "triple helix" based a knowledge-based organisation on purpose, at first it is necessary to ensure human capital and material resources as well as availability of cooperation between the institutions and circulation of people, ideas and innovations. Etzkowitz (2008) calls it human, material and organizational factors. Among human capital factors he mentions the critical mass of scientists and engineers linked through social networks, research groups and a pool of scientists and engineers interested in formation of their own firms. In this opinion the essential material resources are the capital from private or government sources, inexpensive and appropriate space for new firms and equipment. To maximize likelihood to realize a strategy of knowledge-based economic

developments and at the same time high technologies, organisational factors are needed. The factors include (Etzkowitz 2008):

1. Opportunities for scientists and engineers to learn business skills or gain access to persons with these skills. A graduate school of business with consulting services or courses on entrepreneurship in which students develop business plans can be helpful.
2. University policies designed to (a) encourage faculty members and students to interact with industry, (b) give academic credit for promotion and award degrees for this work, and (c) provide clear guidelines delineating appropriate activities.
3. Applied research institutes, centres, and incubator facilities to assist firms with development problems and to provide mediating linkages between academic scientists and engineers and industry.
4. A residential community with cultural, scenic, and/or recreational resources that can attract and hold a population whose skills make them potentially highly mobile.

The evolutionary path, that "triple helix" model takes in axes acting interchanging on the circumstances, time and opportunities, creates a dynamic environment of acting parties, whose acting must be concerted in order to reach a common goal. This requires creation of a knowledge-based organization model which would aim to integrate each party interested in the whole system. For the above reasons, the "triple helix" model of interchanging elements is formed in four stages (Etzkowitz 2001):

1. Internal transformation in each of the helices.
2. Influence of one helix upon another.
3. Creation of a new overlay of tri-lateral networks and organizations from the interaction among the three helices.
4. Recursive effect of these triple helix networks.

5. Conclusions

Development of high technologies in Lithuania is lagging behind from most of the EU Member States. Current high technologies expansion indexes in Lithuania do not comply with the goals set by the EU.

Many reasons for that are associated with the specific characteristics of high technologies: short life cycle, inseparability from science and technologies, as well as the existing infrastructure. Therefore, the high technology business is highly risky and investment consuming. It is also characterized by the constantly changing environment and intense competition in the market.

In solving the said problems of development of the high technologies market, the top priority is development of high technologies. The high technologies development is implementation of the "triple helix" model covering integration of the public and private sector as well as science, where the public sector is trusted with strategic planning, organization and control of high technologies development, the science supported by the state and the private sector is responsible for creation of new high technologies and the business is provided with opportunities to implement new high technologies.

Particularity of high technologies requires a new, systematic approach to high technologies development. There are three main configurations of the "triple helix" model for high technologies development.

In the first model the areas indicating elements of the industry and academic public exist independently, without any interaction, and the dominant role of an intermediary is played by the authorities being the only element ensuring relations among the sectors. The second model shows interactive relations of different elements. The most effective theory is considered the "triple helix" model of overlapping elements as it presents trilateral initiative and solves all problems in innovations implementation in a form of negotiations and transactions. Therefore the priority for Lithuania for high technologies development should be turning to the "triple helix" model, which guarantees the highest degree of cooperation among authorities, industry and academic public in order to have efficient strategic planning, organization and control of high technologies development, support by the state and the private sector for creation of new high technologies and creating opportunities for its implementation.

To reach effective expansion of high technologies in Lithuania it is essential to provide opportunities for scientists and engineers to learn business skills, opportunity for academic public to interact, create and develop new forms of organizations that provide mediating linkages between academic scientists and engineers and industry. Only under these conditions the internal transformation in each of the helices, then influence of one helix upon another and creation of a new overlay of tri-lateral networks will be available and will constitute an effective high technologies expansion system.

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