

## HIGH TECHNOLOGY SECTOR'S DEVELOPMENT: THE NEEDS OF EFFECTIVE INNOVATION SUPPORT

*AUKŠTUJŲ TECHNOLOGIJŲ SEKTORIAUS PLĖTRA: EFEKTYVIOS INOVACIJŲ PARAMOS POREIKIAI*

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### Introduction

Modern global economy is strongly focused towards transnational knowledge and technology transfer networks and its functional models. Systemic technology management processes and new open innovation challenges in high technology sector are main priorities in regional and national levels for public support system developers. Open innovation paradigm, which influences formation of the global research and development value networks, plays important role in the development of high technology sector and should be adequately reflected in public support instruments. Firstly this impact is realised through significantly increased realisation of scientific potential and transnational dissemination of research results. Globalisation processes strongly influence rapid knowledge transfer between different stakeholders and open collaborative alliances. This situation creates demand for the new modern approaches for public support institutions to understand and influence those processes. Public support systems plays important role in innovation creation and dissemination processes in rapidly changing environment. Traditional view on public support systems should be expanded and reviewed in the context of new socio technological challenges and knowledge economy. Open innovation paradigm creates theoretical framework, which could be analysed as instrumental approach for the design of contemporary public support systems. The core understanding of open innovations requires extensive research in knowledge flow management, particularly in exchange systems based on modern global and regional networks. Development and support of high technology sector and other knowledge intensive sectors require new understanding and approaches based on open innovation developments. Open flow of innovation knowledge creates regional talent and knowledge hubs, which should be addressed and influenced by adequate public support frameworks.

Recent studies (OECD 2011) indicate global and regional science and research policy challenges related with regional knowledge clusterization and collaborative platforms. The rapid virtualization of knowledge exchange foster new ways of the public support instruments and approaches. Open innovation creates new possibilities for science and research policy internationalization, which is a strong factor for the new knowledge creation at global and regional contexts. This is important problem area for formation of adequate public support measures and instruments.

The main objective of this article is to analyse contemporary theoretical views for open innovation development and impact on the high technology sector development in international and regional contexts and to provide provisional public support directions and measures for main innovation policy stakeholders.

### Open Innovation Paradigm and the High Technology Sector's Development

High-tech companies are considered to be principal drivers of economic and employment growth in developed countries. In European countries, high-tech activity is considered to be crucial to achieving the desired structural transformation of economies (European Commission 2008). Development of innovations at global level is mainly related with high technology sector. Pharmaceutical and biotechnology industries, technology equipment and automotive sector investments accounts for 50,2 % of all global R&D investments. (Hernández 2013). Classification of high technology sector is multidimensional and based on regional contexts. Scientific understanding often is based on OECD classification, which is focused towards industry (sectorial approach) and produced goods (product approach) (Hatzich-

ronoglou, 1997). This classification includes only direct and indirect scientific research and technological development, but other factors like scientific personnel, intellectual property of technology, licenses and know how, strategic technological partnership among companies, internationalisation level strongly influences high technology sector. This study also based on outdated situation and not reflects today's reality. In 2010 European Commission implemented new sectorial study, with revised evaluation (Loschky 2010). Evaluation is based on scientific research and development intensity, which could be described as ratio between investment into research and development (R&D), production output and value added. Authors (Glasson *et al.* 2006) provides high technology classification and concept definitions .

R&D intensity, e.g. investment level into scientific research is fundamental decision for technological strategy. Competitive advantage based on product and process innovations is crucial for success of technology-based companies. Investments in R&D could create barriers for existing companies through patents and enable new companies to overcome it by using of innovative technologies.

R&D investment increases absorptive capacity, i.e., the capacity to absorb knowledge created from the relationships formed with agents outside the firm, as well as the capacity to use that knowledge to increase firm performance The greater strategic and organisational flexibility of companies, associated with the possibility of diversifying activities as a consequence of R&D investment, may encourage high-tech companies to form strategic cooperation

networks with other firms and scientific institutions (Nunes *et al.* 2012).

In 2010, the European Commission established a High-Level Expert Group on Key Enabling Technologies (KET). This was set up to develop a shared long-term strategy for key enabling technologies. Key Enabling Technologies are one of the key factors to realise the overall policy objectives of Europe 2020, due to the importance of these technologies for the competitiveness and innovation of European enterprises as well as for the development of sustainable products and processes (Larsen *et al.* 2011). This new strategy indicates transformation of traditional understanding about high technology sector and opens new opportunities for industrial development in European Union (table 1). It also leads to new theoretical and methodological research directions aimed at effective technology management and transfer processes among industry players, especially targeted to evaluation instruments (Vilys *et al.* 2015).

The European Commission defines KETs as 'knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and highly skilled employment. They enable process, goods and service innovation throughout the economy and are of systemic relevance. They are multidisciplinary, cutting across many technology areas with a trend towards convergence and integration. KETs can assist technology leaders in other fields to capitalise on their research efforts (SEC 2009)

New focus on KET requires allocation of critical mass in knowledge and funding through increased

**Table 1. Paradigm changes in high technology sector**

| OECD high- tech classification (1997)   | Eurostat high tech classification  | European Commission (2010), Key enabling technologies  | Lithuania (2011), Key enabling technologies   |
|---|--|--|---|
| Aerospace<br>Computers, office machinery<br>Electronics-communications<br>Pharmaceuticals | Aerospace (35.3);<br>Pharmaceuticals (24.4);<br>Computers, office machinery (30);<br>Electronics-communications (32);<br>Scientific instruments (33) | Nanotechnology<br>Micro- and Nano electronics<br>Industrial biotechnology<br>Photonics<br>Advanced materials<br>Advanced manufacturing systems | Biotechnology<br>Mechatronics<br>Laser technology<br>Information technology<br>Nanotechnology and Electronics |

synergy effects. Lack of market focus for R&D activities (European Commission 2012; Larsen 2011) creates challenges for search of effective technology transfer models. New policy directions are in line with global open innovation and networking trends. Understanding of open innovation processes and alignment with KET development issues is important contemporary research direction for public support institutions.

For analysis of newest technological models is important to understand system of factors which influence high tech sector activities (fig 1.). Important aspect of high tech sector development from public support perspective is to increase input parameters. External policy measures and public research directions has direct influence on input parameters, also new networking opportunities and flexible collaboration structures allows to achieve greater input results. New KET concept by EU has impact on input parameters by creating new opportunities and cross-sectorial collaboration possibilities (fig. 1).

The initial open innovation concept was vague and lacked concrete adoption frameworks for business context, especially in high technology sector. The new findings and theoretical analysis fill this gap (Eelko 2011; Dahlander and Gann, 2010). The open innovation idea is based on the new evolutionary collaboration model, which encompasses opening of organisational innovation process to the external environment actors. In other words it discusses purposive inflows and outflows of the knowledge to accelerate the internal innovations, and to expand the markets for the external use of the innovation Chesbrough (2011). This broad description of open innovation points towards effective transfer of knowledge to both directions (inward and outward). Open innovation processes combine internal and

external ideas into architectures and systems Chesbrough (2008). Main studies on open innovation are focused on externalization of R&D activities (Enkel *et al.* 2009).

Outbound open innovation points to actively pursuing external technology exploitation, which refers to the commercialization of technological knowledge using licensing and other transfer means Lichtenthaler (2009). Open innovation concept is mostly used for enhancing of the R&D input and output and important for public support systems.

Open innovation stresses the abundant landscape of external knowledge outside organisation waiting to be captured by them and converted into profitable innovating products and services Chesbrough (2008). Open innovation paradigm describes direction of possible knowledge flow and organization research and development partnership degree. Although knowledge is available and partnership networks create value, effective knowledge management frameworks are needed to enhance knowledge absorption and dissemination capacities.

Bertrand-Cloodt *et al.* (2011) studies the effect of the tie strength of inter-firm R&D partnerships on the innovation. Authors find that inter-firm R&D network ties that are stronger in terms of their extent (measured by the length and multitude of R&D partnerships) and weaker in terms of their depth (the degree of cooperation and the similarity of ties of companies) improve the innovation performance of companies. Newest research directions on networking structures are focused on effectiveness of new product development process, knowledge transfer modes, development of specific research and development networks. Innovation strategies and directions (Ettlie 2006), are very important creation

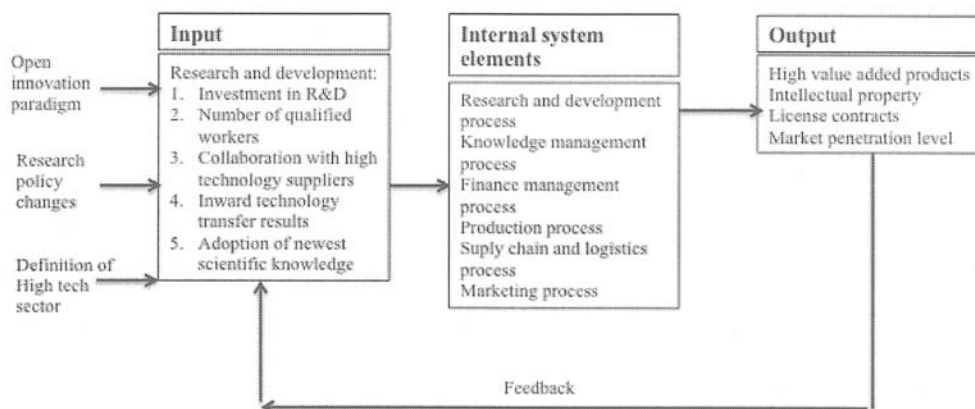


Figure 1. System framework of high technology sector activities

of effective public support measures for high technology sector (table 2).

Support of internationalisation activities of high technology sector are underpinned with above mentioned open innovation paradigm. Internationalisation processes for high technology sector encompasses holistic view (Spence, Crick 2006). Initial catalysts for pursuing and maintaining an international strategy plus the subsequent triggers for international development could be classified into three categories: (1) existence and utilization of existing contacts; this supports the networking view, (2) utilisation of resources, defined in a general sense to include financial and managerial resources (experience), enabling firms to become prepared for international development, e.g. targeting growth markets, supporting the resource based view of the firm (3) Reaction to environmental, including serendipitous, events that is consistent with the contingency view (Spence, Crick 2006).

Fast development of new ICT technologies influence internationalisation processes (Sedoglavich 2012). Author demonstrates that firms tend to be influenced by the entry decisions made by other firms in the same/similar industry targeting the same market; and that a firm's technological capabilities and the advantages of specialized knowledge act as the constraints in the development of the firm's future international strategy.

New business models could be strong catalyst for internationalization of high tech results (Onetti, et al., 2012), as well knowledge intensity and models for accumulation of innovation and scientific knowledge (Brennan 2009). Bridging together two broad areas, commercialization of university-developed technology and international entrepreneurship, could be realised through the stages of internationalization (Styles, Genua 2008). Growth of high tech companies could be analysed by using dynamic capabilities models, expressed by opportunity search, resource acquisition and resource reconfiguration (Kuuluvainen 2012).

Many companies have realised benefits of transnational networks, and in the global markets new trends of integrated R&D networks are observed. It's related with networked R&D model.

Company level research in innovation management is dominated by internal company knowledge transfer factors, scope of innovation activities in high technology sector, networking for new product development activities, knowledge transfer.

**Innovation Support and the High Technology Sector's Development: a Context of the Processes of European Integration**

Development of regional R&D structures is closely related with regional innovation policy. It could be realized through public support measures,

**Table 2. Innovation policies and trends for public support in high technology sector**

| Politics          | Main features   | Trends   |
|-------------------|---|--|
| Science policy    | Scientific education<br>Research in universities and government laboratories<br>Basic research<br>Focus on big issues, e.g., space, nuclear power | Selectivity (foresight)<br>Internationalization  |
| Technology policy | Support for creation of strategic Or generic technologies, e.g., IT, biotechnology, and encouragement of new technology-based firms               | Targeted research efforts<br>R&D collaboration<br>IPR protection<br>Regulation<br>Environmental issues<br>Favoured procurement       |
| Innovation policy | Facilitating diffusion of technology<br>Encouraging transfer sciences   | Network building<br>Intermediary development<br>Regionalization/ decentralization<br>Building firm capabilities as well as resources |

Source: Etlie 2006

which depends on regional context. Research on regional systems reveals that (OECD 2011):

- ◆ Regional innovation systems have different development trajectories.
- ◆ Heterogeneity is appropriate for internal situation inside countries not between.
- ◆ R&D activities and patents are concentrated in main OECD regions, but new knowledge hubs emerge
- ◆ Regional collaboration and networks are important for innovation activities at global level.

Importance of regional development is related with 3 main trends:

- ◆ Increased globalisation. Globalisation processes have dual influence for regions. Those processes require political, economical measures for securing of competitive advantage and talents, but also provide opportunities for transnational R&D activities and technology transfer.
- ◆ Social and environmental issues. New social challenges require innovative solutions and initiatives, by connecting private and public institutions into effective network structures.
- ◆ Importance of network innovations. Information technologies, biotechnologies and green technologies rely on incremental innovation and have demand for connection different knowledge sources. Integrative view on new organization models for technological innovations is needed.

Competitiveness challenges requires new measures and policies from regional perspective. European initiative by promoting Key Enabling Technologies (KET) is very important. KETs are knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and highly skilled employment. They enable process, goods and service innovation throughout the economy and are of systemic relevance. They are multidisciplinary, cutting across many technology areas with a trend towards convergence and integration (COM 2012).

Main innovation challenge for Europe in KET is to overcome the various barriers to commercial deployment of R&D base, the “Valley of Death” by linking together the various parts of the valuechain using for instance technology transfer mechanisms, supporting demonstration projects, and creating favourable market conditions for innovative (yet often relatively expensive) products (Larsen *et al.* 2011). This gap between basic knowledge generation and its subsequent commercialisation into goods and services could be bridge by innovative public support services and mechanisms.

The definition of the main characteristics of high-tech firms could include activity, human and technological parameters Glasson *et al.* (2006): involvement in innovative activity, R&D intensity, R&D employment, qualified personnel, intensive use of technologies, intellectual property.

Many high-tech firms are relatively new high growth businesses, but they can also include more established businesses in mature sectors, and indeed such firms appear to account for a disproportionate share of high-tech employment. Those characteristics are very important for knowledge management inside those companies.

The innovation activities and expenditures of Lithuanian companies in the innovation field indicate low involvement in external knowledge acquisitions. Also systematic R&D activities are low, which points out to weak internal knowledge creation systems. This shows lack of effective knowledge acquisition practices and systematic procedures. Public support measures could be directed towards enhancement of internal knowledge creation systems. Statistical information (Innovation union scoreboard 2013) shows decreasing collaboration activity of innovative companies by 3.9 %. This indicates the slowing rate of open innovation practice. It is important to stress that innovation activities decreased by 3 %. Those figures represent the slowing innovation activity rate among innovative companies. From the statistics it is not clear how companies adopt knowledge for the development of innovation. The main sources for the innovation activity are the companies from the same enterprise group, suppliers of equipment, materials, components and also clients and customers. This indicates only moderate knowledge networking space by the limited microenvironment actors. The universities and research institutions are moderately involved in the knowledge acquisition process. Public research institutions shows low level for innovation development. The use of competitors or other enterprises in the same sector is interesting new trend for the information search. But this can be related with the “understandable” knowledge acquisition, since scientific or interdisciplinary knowledge is more diverse. These findings show very weak connections between the science and business, which is common problem for the countries with the weak innovation support infrastructure and culture. The lack of the multidisciplinary absorption systems inside the organizations could be perspective public support direction.

Paradigm shift of high technology definition at European context and focus on Key Enabling

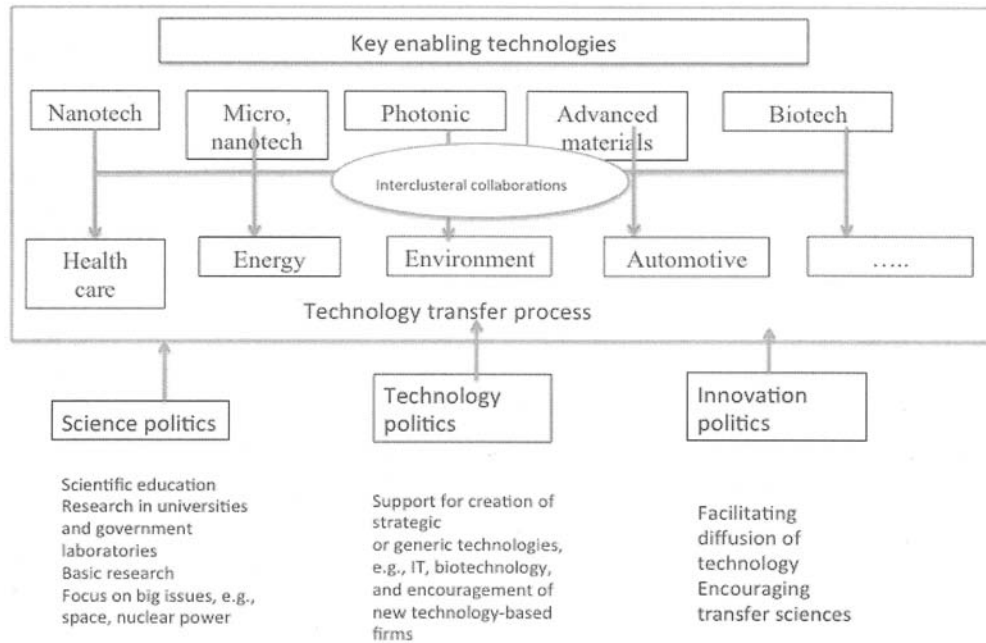


Figure 2. Theoretical framework for KET support system

Technologies is very important innovation support direction. This new regional challenge requires new methods and tools for technology transfer processes, integrative multidisciplinary R&D, especially by enhancement of cross-sectorial collaboration (Melnikas et al., 2011). Broad range of support activities should be added for fostering of R&D activities among KET sector companies (fig. 2).

New framework integrates 3 political directions, which is very important in open innovation paradigm and could be addressed in public support systems.

Contemporary collaboration trends influence various partnership forms. Open innovation paradigm stresses the importance of flexible and multidimensional networks (formal and informal) for development of radical innovation. This concept could be adopted for key enabling technology transfer processes.

Public sector activities for fostering of global scientific research should be directed towards stimulation of networking processes and improvement of regional industrial potential and innovative collaboration frameworks for tacit knowledge exchange practices (Zemaitis 2014).

Further research directions should be focused in developing of policy measures supporting open innovation paradigm changes.

## Conclusions

Global developments of new open research and science policy systems are important factor and element for today public support institutions. Open innovation and knowledge transfer creates new possibilities to systematically exchange best practice among public institutions and to design best possible policy frameworks. It is also important to understand high technology sector impact on socio economical developments, which should be adequately reflected in modern public support institution activities. Recent understanding of science and technology policy in European Union slightly changes by formation of new understanding of high technology and forming key enabling technology practice. This change is one of the main directions, which is influenced by open innovation paradigm on business sectors and opens new possibilities for contemporary public support instruments. Inderdisciplinary nature of key enabling technologies creates challenges for European public support institutions, specifically for the transfer of the public research results. Growing needs for rapid knowledge transfer mechanisms are reflected in new clusterisation forms and integrative policy instruments. Main objective of public support institutions is to understand global changes and to prepare adequate policy instruments,

which consists of the open and transparent mechanisms. Public support institutions should view high technology sector as main catalyst for development of knowledge based society and enabler for the high quality life standards. Public support institutions should develop synergy of innovation and internationalisation frameworks for high technology sector as important development measure. High technology sector has many challenges, related with uneven developments on regional and sub-sectoral levels. It should be addressed by effective public support systems, which integrated regional policy instruments and sustainable economical policy frameworks. Holistic view (based on talent, regional, innovation, internationalisation issues) on high technology sector should be applied by designing effective public support systems.

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## Summary

*Internationalisation of the research and development (R&D) and innovation activities are important contemporary management thematic directions. Rapid developments in creative economy and democratisation of networking systems, requires new approaches of public support systems for the development of knowledge intensive sectors.. Fast development of high technology requires non-linear thinking and disruptive creative solutions. Innovation activities in knowledge intensive sector require broad level of collaborative, creative efforts and effective support systems for companies. Main aim of this article is to identify main challenges and aspects for innovation development, based on open innovation paradigm and evaluate essential aspects of innovation networks and*

*possible public innovation support framework. Public support institutions should view high technology sector as main catalyst for development of knowledge based society and enabler for the high quality life standards. Holistic view (based on talent, regional, innovation, internationalisation issues) on high technology sector should be applied by designing effective public support systems.*

**Keywords:** High Technology, Innovation, Support, European Union

*Article reviewed*

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## AUKŠTŪJŲ TECHNOLOGIJŲ SEKTORIAUS PLĖTRA: EFEKTYVIOS INOVACIJŲ PARAMOS POREIKIAI

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## Santrauka

Mokslinių tyrimų ir eksperimentinės plėtros bei inovacinės veiklos internacionalizavimas yra aktuali šiuolaikinio vadybos mokslo tematinė nagrinėjimo krypti. Itin sparti kūrybinės ekonomikos plėtra ir tinklaveikos sistemų demokratizacijos procesai, reikalauja naujų viešosios paramos sistemų metodų, kryptingam žinioms imlių verslo sektorių plėtrai. Itin greita aukštųjų technologijų plėtra reikalauja naujo mąstymo ir inovatyvių sprendimų. Inovacinė veikla žinioms imliuose verslo sektoriuose sąlygoja plataus masto bendradarystės ir efektyvių paramos sistemų poreikį. Pagrindinis šio straipsnio tikslas yra identifikuoti pagrindinius inovacijų plėtros iššūkius bei aspektus, atvirų inovacijų paradigmos kontekste bei identifikuoti inovacijų politikos teorines kryptis. Viešosios paramos institucijos turėtų vertinti aukštųjų technologijų sektorių, kaip vieną iš svarbiausių žiniomis grįstos ekonomikos bei aukštų gyvenimo standartų katalizatorių. Efektyvios viešosios paramos instrumentai turi apimti holistinį požiūrį (internacionalizavimo, inovacijų, talentų, regioninį kontekstą) į aukštųjų technologijų sektoriaus plėtrą. Atvirų inovacijų sistemų iškelti iššūkiai turi būti adekvačiai atspindėti naujo pobūžio viešosios paramos instrumentuose.

**Raktiniai žodžiai:** aukštosios technologijos, inovacijos, parama, Europos Sąjunga



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