THE REGIONAL TECHNOLOGY DEVELOPMENT STRUCTURES AS ESSENTIAL PARTS OF REGIONAL INNOVATIVE SYSTEMS: THE OUTCOMES OF COMPARATIVE STUDY IN SILESIA REGION

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Abstract

The author analyzes cluster oriented regional technology development processes as the important determinants of regional development. Knowledge management approach is described as an essential methodology for management of regional nodes of technology development. Three dimensional model of knowledge management of regional technology nodes is presented. The model consists of: structural dimension, process dimension and knowledge assets dimension. Multidimensional category of trust is presented as a crucial concept in the presented knowledge model. The hypertext structure create the basic form of inter-organizational cooperation among different organizations creating the given technology development structures (i.e., R&D, firms and regional government). Silesia region, located in Southern Poland is presented as an example of territory on which cluster oriented regional technology development strategy - as the crucial part of innovative strategy - is now implemented. Two Silesian Technology Nodes are presented comparatively in the article: (a) network of coal mining machineries manufacturers, (b) network of medical instruments manufacturers. The first represents traditional regional technological competence, while the second represents new one.

Key words: *regional knowledge economy, technology development, regional technology nodes, knowledge management.*

1.Knowledge based regional economy

To describe the issue of knowledge based regional economy two terms are crucial, regional economy and knowledge economy. We can define regional economy as conceptual and open system with meaning for governance relations. Regional economy is the complex of human activities concerned with the

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production, distribution and consumption of goods and services in a particular geographic region (Cook 2004).

The growing importance of regions as important parts of global economy is the phenomenon of agglomeration. The agglomeration issue is the part of geographic economy and is based on spatial concentration of people (i.e., urbanization) and economic activities (i.e., industrialization). In the literature the most popular sources of agglomeration are (Rosenthal and Strange 2004: 2119-2171): (a) natural advantage of the given territory which is explained by the degree to which natural advantage (e.g. natural resources) explains economic activity location, (b) input sharing which depends on the existence of scale economies in input production, (c) knowledge spillovers effect which regards the trend that knowledge oriented industries have more spatially concentrated innovative activity, (d) labor market pooling which concerns that issue of spatial concentration of skilled labor, (d) home market effects, increasing returns lead to the concentration of employment into a large factory, this in turn creates a large market, which, in the presence of transportation costs induces other firms to choose the same location, (e) higher consumption, connected with the way of living in agglomerations.

Knowledge economy means that productivity and performance of various organizations depends crucially on knowledge generation and utilization processes. Knowledge seems to be the most important resource of contemporary advanced economies. Knowledge economies are characterized by following characteristics (Cook et al. 2002): (a) knowledge as an input is becoming more and more important which is reflected in an increase of investments based on knowledge (e.g., R&D, education, software and information technologies); (b) knowledge as a product is getting more important than in the past (e.g., the growing meaning of knowledge intensive business services, high-tech industries according to OECD[1]); (c) codified knowledge as an outcome of knowledge management system has become more significant (e.g., in industries based on knowledge, such as biotechnology and nanotechnology); (d) the development of knowledge economy is strongly connected with technological development in

[1] According to OECD practical classification one can define the knowledge economy on the examples of two "macro-sectors": high technology manufacturing and knowledge intensive services. The first sector includes industries such as: manufacture of pharmaceuticals, medicinal chemicals and botanical products; manufacture of office machinery and computers; manufacture of radio, television and communication equipment and apparatus; manufacture of medical, precision and optical instruments, watches and clocks; manufacture of aircraft and spacecraft. The second sector includes services, such as: communications, research and development, software, financial services, welfare and public administration services. So, from industrial sectors point of view knowledge based regional economies are those which are dominated by high technology manufacturing and knowledge intensive services.

ICT (e.g., e-platforms, knowledge data bases, electronic knowledge management systems). The most important determinant of increasing significance of knowledge based economies are knowledge dynamism and knowledge creation processes which are occurring within social context - social capital (Bojar and Stachowicz 2007).

Within the context of knowledge economy, the most important source of agglomeration economies is the category of knowledge spillovers. Location and geographic space have become the key factors in explaining the determinants of innovation and technological change. The empirical evidence based on analysis of spatial distribution of innovative activities suggests that location and proximity clearly matter in exploiting knowledge spillovers (Audretsch and Feldman 2004: 2713-2739). Innovative and knowledge adopting capacities of a firm are determined by its surroundings: its partners, competitors, customers, the available human capital, the regional knowledge infrastructure, institutions, regulations and legislation, untraded interdependencies and host of other actors that influence innovation directly or non directly. Enterprises which implement their research and development strategies tend towards using external knowledge resources including those resources which are rooted in a given territory (e.g., universities, research and development institutions, technology transfer centers, venture capital institutions, etc.). Firms link the innovative output of product categories within a region to the extent to which the economic activity of that region is concentrated on their industry and especially R&D activities which are relevant. Regions appears to be the most useful unit of analyses of innovation processes because regional geographical proximity is connected very strongly with other kinds of proximity, such as: organizational, institutional oraz technological proximities (Menzel 2006)[2].

2. Cluster oriented technology development regional policy

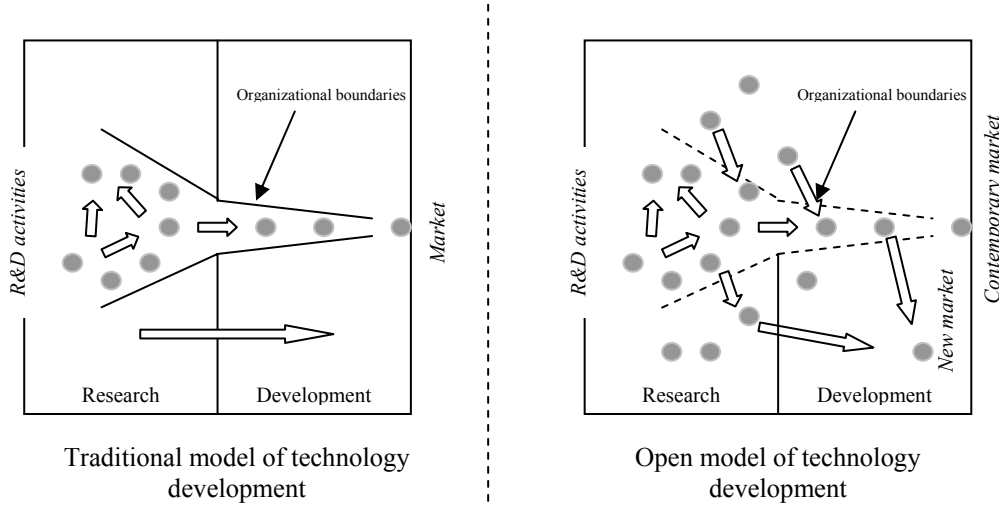
As it was noted above the proximity and geography are very important in knowledge management processes, especially knowledge generation processes. The global distribution of innovative technology processes illustrates the best that knowledge processes are unevenly located in the space and there are crucial differences between regions regarding the intensity of knowledge processes and the quality of life.

Within the conditions of knowledge economy the technology development processes – both on the phase of knowledge generation and knowledge utilization – has changed radically (see fig. no 1.). Technology development is no loneger a linear process based on knowledge creation processes occurred in

[2] The concept of proximity is a relational approach to explain localization.

the R&D institutions and adopted in the industry (Asheim 1996: 379-397). It is defined rather as an iterative process based on cooperation between industry and R&D on each phase of knowledge generation and knowledge utilization. New approach to technology development is connected with blurring of contemporary organization' boundaries, and is often called open innovation model (Chesbrough 2003). So, there two contradictory approaches to technology innovation: according to traditional approach organizations acquire, develop and commercialize technological knowledge separately; according to open approach organizations cooperate with other organizations during the whole process of technology development.

Fig. 1. Traditional and open model sof technology development.



Source: own study, based on: Ch.W. Chesbrough, The Era of Open Innovation, [in:] Strategic Management in the Innovation Economy (ed. T. Davenport, M. Leibold, S. Voelpel), Wiley, Erlangen 2006.

Among the most important drivers of open innovation are following mechanisms: (a) the growth of meaning of the cooperation networks and blurring of organization' boundaries, especially in the knowledge intensive industries where technology development create the chances for new "start ups"; (b) technology development is based on the knowledge originated from various scientific fields; (c) technology development investments are very often characterized by the long return periods and high risks; (d) market potential of the outcomes of technology development investments is often much wider than the market potential of single firm. The above described mechanisms lead to revealing of different technology development networks of cooperation. The

particular organizations are searching for the new possibilities and chances out of their boundaries very often (Kordel 2004: 61-68). The special role in the partnership for new technologies creation is played by public sector including programs and institutions such as: i.e. universities, R&D institutes and business-support sector, incl. technology transfer centers (Broers 2005).

According to the Enterprise and Industry Directorate of EU Commission the main fields of regional cluster oriented technology development policy are: increasing the level of human capital through trainings, attracting new enterprises to the existing regional networks, delivering the existing regional technology networks with business support service, strengthening the commercialization processes of research activities carried out within the regional technology specializations, enhancing the laboratory equipment of existing technology networks[3]. These directions of regional technology policy are implemented both by the regional programs and the regional institutions. The general aim of regional technology development policy is to create regional technology specializations as the important parts of the global technology development mechanisms. In other words the technological regional profile as the base of regional competitive advantage is constructed by the regional technology development networks - so called Regional Technology Development Nodes (RTDN). We can define the RTDN as the technologically separated cluster of regional set of innovative institutions and firms which are cooperating during the realization of technology development undertakings.

3. Knowledge management and regional technology clusters

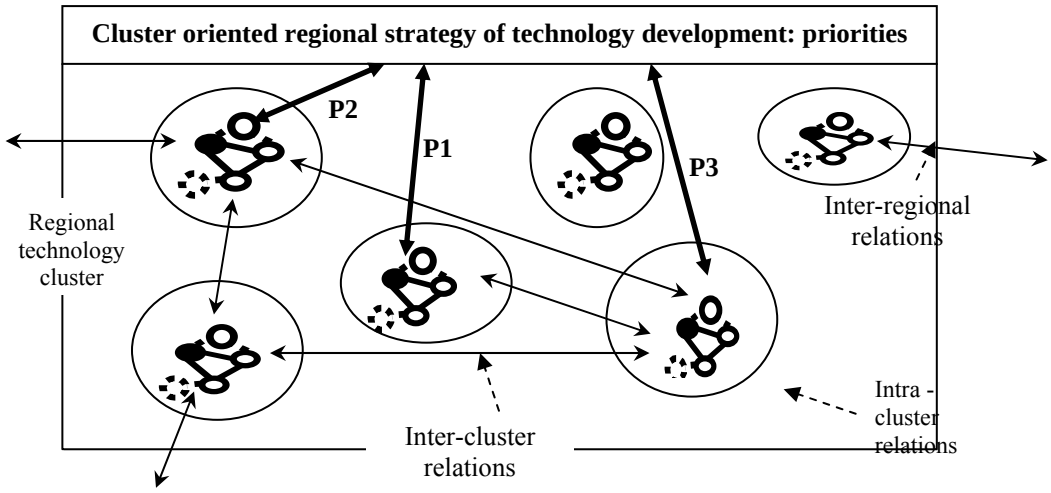
Regional ability of evaluating towards knowledge region can be perceived as the way in which different regional entities identify, create, appropriate and exploit knowledge by acting as a part of an innovation system[4]. This system includes knowledge generators (research and development institutions), knowledge users (enterprises) and knowledge regulators (regional government and its agendas). Contemporary regions as the separate entities within global knowledge economy and globally occurring technology development processes can be described as the sets of regional technology development nodes (see fig. no 2.).

[3] The regional cluster oriented technology development policy is strongly determined by the level of development of the region as the knowledge region.

[4] According the ECORYS - typology of high productivity/competitive regions knowledge hub regional economies are defined as regions that receive and transmit high levels of internationalized knowledge, both formalized and tacit, and are dependant on high tech enterprises and high value services.

There are two the most important approaches which can be used to construct the knowledge management dynamic concept of RTDN. First, the organizational capabilities approach (Eisenhardt and Martin 2000: 1105-1122), the second the theory of knowledge creation (Nonaka and Takeuchi 1995). The organizational capabilities theory describes learning processes as the most important base for building organizational competitive advantage. The theory of knowledge creation describes knowledge creation as a process which occurs in four social spaces (i.e., socialization, externalization, combination and internalization processes). The basic logic for knowledge creation is continuous process of transforming tacit knowledge into explicit knowledge.

Fig. 2. Region as the Set of Technology Development Nodes (RSTDN).

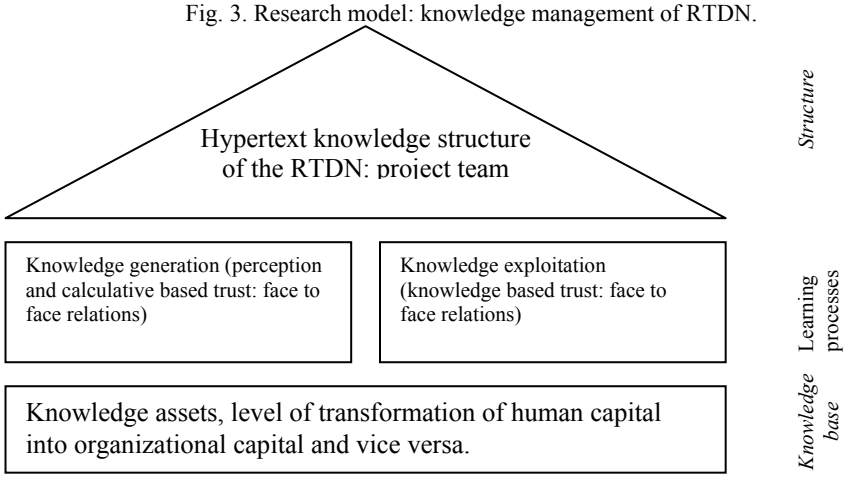


Source: own studv.

The above mentioned two theories were the bases for creation the research model of knowledge management in regional technology development nodes (see fig. no 3.). The model consists of three levels: first is the structural level, second is the process level and third is the knowledge assets level. Structure level is constructed on the basis of the concept of hypertext knowledge management structure. This kind of structure requires two structures which are existing simultaneously: task team structure and operational structure. In the case of RTDN the task team is the base for network strategies implementation and the operational structure reflects the business models of individual network participants. The process level concerns the dynamic part of research model (i.e., learning processes) and is divided in two separated learning processes: knowledge generation and knowledge exploitation. Knowledge generation is

described by perception and calculative based trust and is oriented towards creation new technology ideas. Knowledge exploitation is described by knowledge based trust and is oriented towards implementation new technology ideas into existing business models. Trust plays the role of crucial social mechanism in the context of both knowledge generation and knowledge exploitation processes.

Fig. 3. Research model: knowledge management of RTDN.



Source: own study.

The participants of the project team are from both R&D institutes and enterprises. Taking into account strategic vision of a given regional technology node, they engage in different technology development initiatives. These initiatives are the bases for learning processes (both knowledge generation and knowledge exploitation) which are occurring within the node. After fulfilling the purposes of a given technology development initiative they go to the knowledge assets level where they archive and store acquired knowledge. After that, they come back to their routine tasks in their organizations. The above described circulation of people which are engaged in a given RTDN is the base for learning processes.

4. The outcomes of empirical research

The Silesia Voivodship is highly industrialized and urbanized region which is located on the southern part of Poland. The effect of agglomeration is very high based on both high level of urbanization and high level of industrialization (general numbers and characteristics of regional innovative

model in Silesia are presented in the table no 1.). The industry is traditionally dominated by heavy sectors like coal mining and steel. The empirical investigations were carried out directly by the author in the years 2005-2008[5]. The research population covered the technology development clusters located on the area of Silesia Voivodship. The main purpose of the conducted research was the analysis of innovative potential of technology industrial clusters located in the territory of Silesia Voivodship.

Tab. 1. General data: Silesia Voivodship.

Specification	**Poland, Region Silesia** (NUTS – 2, PL22)[6]	
Area (thous. km2)/population (mln.)	12.331/ 4.70	
GDP per inhab*.	5461.0	6909.4
GDP per inhab. % of the EU average	26.4	30.8
RIS*rank.	0,21/142	0,29/156
Gross Domestic Product at current prices (euro)/2003 and 2005* * Regional Innovation Scorebord Index/2003 and 2006 (incl. knowedge workers, med-hi tech manufacturing, public R&D, patents, lif-long learning, high-tech services, business R&D)*		

Source: Eurostat, ECORYS.

Regional cluster oriented technology development policy is implemented with the help of regional operational program of Silesia Voivodship 2007 - 2013 (the total budget 2 billion euro per 7 years, divided into 10 priorities). The first priority of the programe directly concerns regional technology cluster issue. The priority is titled "Technological research and development, innovation and

[5] The author of the paper were the regional technology animator within the Management Unit of Regional Innovative System of Silesia Voivodship and the member of regional advisory board within the project "INNOOBSERVATOR SILESIA I" in the years 2005-2007.

[6] According to the ECORYS typology Silesia Voivodship is classified as the **Production Side Regional Economies.**

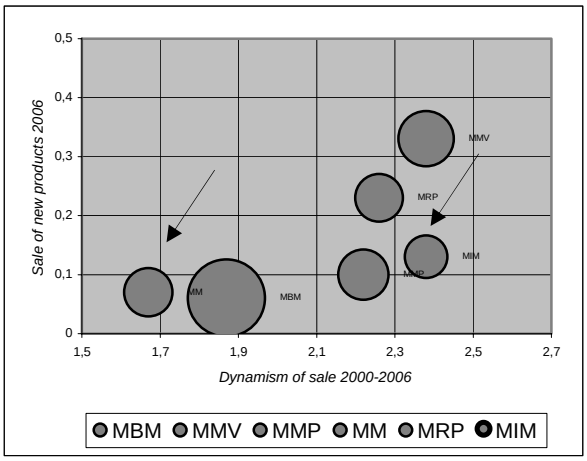
The most important features of the regional innovation model:

- formalized knowledge and innovation imported via FDI and international customer demand,
- innovation driven by technology transfer from parent FDI companies to local companies,
- innovation within region is primarly focused on production processes and supply chain to minimize costs and increase productivity,
- educational infrastructure orientated to re-skilling and applied technical disciplines (e.g. CAD, CAM, production and logistics).

entrepreneurship" (budget 348,5 mln euro per 7 years). This priority consists of three objectives:
- increase in the value of direct investments in the region;
- increased competitiveness of enterprises;
- increased R&D potential and network structures for innovation purposes.

The illustration of statistical analyses of manufacture industrial clusters is presented on the figure no 4.

Fig. 4. The industrial clusters in Silesia Voivodship



The explanation of abbreviations:

MBM	MMV	MMP
Manufacture of Basic Metals	Manufacture of Motor Vehicles and Trailers	Manufacture of Metal Products
MM	MRP	MIM
Manufacture of Machinery and Equipment	Manufacture of Rubber and Plastics Products	, Precision and Optical Instruments

Three variables:
- location quotient 2005,
- dynamism of sale 2000-2006,
- sale of new products 2006.

Source: own study on the base on data derived from Polish Main Statistic Office.

The general analysis of manufacturing regional clusters in Silesia shows that the majority of the industry is concentrated around the coal as a regional natural resource and they can be called traditional regional industrial clusters. The clusters which represent this traditional part of the regional economy are following: manufacturers of basic metals, manufacturers of metal products, manufacturers of machinery and equipment (they are about 60-70% of the regional economy). The cluster of manufacturers of motor vehicles and trailers is dominated by two foreign direct investments (i.e., GM and Fiat) and is located on the territory of special economic zone. The last two clusters (i.e. manufacturers of medical, precision and optical instruments; manufacturers of rubber and plastics products) represent more knowledge intensive part of regional economy with knowledge spillovers as an important source of agglomeration effect.

Continuing the above analyses, two regional clusters were selected to carry out the next investigations concentrated on knowledge management of RTDN. First, Manufactures of Coal Mining Machinery (MCMM) is the example

of traditional RTDN based on regional natural resource – coal. Second, the Manufacturers of Medical Instruments (MMI) is the example of a new regional technological specialization based on knowledge spillovers. Both MCMM and MMI are the regional technology nodes with strong regional R&D infrastructure. The investigations of two selected regional technology nodes were mainly qualitative and were based on theoretical considerations presented in the three first parts of this paper. The main research assumption was: "*the knowledge management processes which occurs within the regional technology development nodes as parts of global knowledge economy are the base for the analysis of their development potential"*

The outcomes of comparative analysis of two selected nodes is presented in the table no 2.

Tab. 2. The Comparative analysis of MCMM and MMI in Silesia Voivodship

	MCMM	MMI
Technological specialization	Complex coal mining technology consisted of: - wall combine harvester, - mechanized casings, - conveyors, - ventilation. High level of technological specialization, mature technologies, traditional regional competence.	Medical specializations in chosen fields: - products connected with rehabilitation, - surgical and orthopedic instruments, - diagnostic instruments, - software. Low level of technological specialization, young technologies, new regional technological competence.
Knowledge management Structure: 1. Project team 2. Business models 3. Knowledge base	1. Unformal relations without regional business support institutions 2. Capital integration of enterprises, formal integration of R&D centers 3. Formalized knowledge base	1. Formal relation with regional business support institutions 2. Low integration of enterprises, formal integration of R&D centers 3. During the creation stage
The type of knowledge and the structure of knowledge assets	Explicit, synthetic knowledge, high level of transformation of human capital into organizational capital. Strong relations with clients, strong foreign expansion, strong brand.	Explicit, analytic knowledge, medium level of transformation of human capital into organizational capital. Strong relations with regional clients, low export, poor brand.
Trust	Neutral level, competence profile, trust based on knowledge.	Medium level, competence profile, trust based on perception and calculation.

Learning process	Single loop learning, domination of knowledge exploitation processes weak relations between R&D and enterprises.	Double loop learning, domination of knowledge generation processes, weak relations between R&D and enterprises.
* double loop learning processes occur in the form of building the regional competence on clean coal technologies.		

Source: own study.

Summarizing the above presented analyses we can say that MCMM creates base regional technological competence while MMI creates future regional technological competence of Silesia Voivodship. The knowledge processes are crucially different in two presented cases. Knowledge structures, knowledge processes and knowledge assets have different characteristics (see tab. no 2.). The regional development technology policy should be oriented towards both regional technology nodes but it has to be tailored according to the specific characteristics of this two regional technology nodes. In the case of MCMM the regional efforts should be put especially on knowledge exploitation processes, and in the case of MMI the regional efforts should be especially put on knowledge generation processes.

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