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Cluster infrastructure networking model for the knowledge economy development in Ukraine

INTRODUCTION

Economic growth in a global economy is driven by technological advances and innovations. This involves the employment of existing knowledge and human capital to create new knowledge and improved innovative products, technologies, organizational structures, services, market models. Thus we are on the verge of a new era of innovative systems associated with knowledge economy that relies on research networking, knowledge sharing and technology transfer, as well as on the diffusion of innovations, their internationalization, socialization and commercialization at the same time.

Transnational corporations (TNCs), including large, small and medium enterprises, have chosen networking models of R&D, cooperation in technology transfer for commercial purposes as a means of increasing the competitiveness and attractiveness of their products and services.

For Ukraine and other countries undergoing economic transformation, with abundance of many universities labs, centers, science & technology institutes, and parks with high potentials for research & development, as well as other institutions that create and seek ways of transferring innovation, the question that arises is: "how to create the best channels of knowledge transfer?" and "how to identify the best institutions for international transfer and commercialization?"

The main goal of this article is to justify the necessity of developing a Ukrainian innovative cluster and to define vectors of economic reorientation towards processes of intra- and inter-regional, and international integration, and networking in a globalized world of knowledge economy.

CONCEPTUAL BASIS OF A CLUSTER MODEL
FOR REGIONAL DEVELOPMENT IN A KNOWLEDGE ECONOMY

J. Chamara, in expressing agreement with other economists, notes that "technological generation makes appropriate changes of comparative advantage,

which will determine the mid-century geopolitical competition" and "requires a new approach to the economy, which would examine the information and knowledge as critical parameters of post-industrial society"[1]. World tendencies are oriented towards a cluster approach for the development of a new economy based on innovation and knowledge. For example, various networks (like innovative clusters) for knowledge and innovation transfer have been developed in EU countries. Intra- and trans-regional cluster collaborations have become the strategic goal in the euro-zone taking into account development possibilities in areas of information and production infrastructure, transport networks, scientific and educational, as well as social and cultural collaborations.

The fundamentals of cluster theory and economic models of networking had been developed by M. Porter, Ch. Ketels, L. Yang, T. Haris et al. In the Ukraine issues of scientific and methodological aspects of innovative clusters development, interregional and trans-regional co-operation for knowledge and innovation transfer have been investigated by many Ukrainian scientists (among them P. Belenkiy, N. Mikula, M. Voinarenko, S. Sokolenko, I. Studennikov, and others). Clusters are characterized by certain common features: mutual interest, the informational interconnection, cooperation, and critical mass of companies oriented towards innovation, which if appropriately implemented would allow them to quickly develop in regional and global markets. One of the basic tasks is converting these features into an effective practical networking policy which can be adapted in different spheres of Ukrainian economy.

There is the need to integrate theories of clustering with regional knowledge-based economy to find the best directions of regional cooperation and institutional channels for the improvement of knowledge transfer in Ukraine. Great attention is paid to studies in the possibility of using innovative clusters' model for institutional infrastructure development in a regional innovation system.

As M. Porter firstly observed (1998)[2], cluster is a "group of geographically closely linked companies and institutions in a certain industrial activity". Most Ukrainian researchers in diagnosing the "economic cluster" phenomenon have come to the conclusion that its main characteristics are those of innovations, geographical proximity and independence of the participants. Cluster development depends, at the micro level, on the economic environment, as well as on the economic developments at the macro level. According to Ch. Ketels[3] clusters may be classified by their levels of economic development, which depends on

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[1] I. Чамара, *Особливості сучасного етапу інтелектуалізації економіки під впливом НТП*, http://experts.in.ua; Чамара, *Інтелектуалізація праці як найважливіша умова економічного розвитку*, http://experts.in.ua.

[2] М.Э. Портер, *Конкуренция*, Издательский дом «Вильямс», Москва, 2001, 495 с.

[3] Ch. Ketels, G. Lindqvist, O. Solvell, *Cluster Initiatives in Developing and Transition Economies*, Center for Strategy and Competitiveness, Stockholm, First edition, May 2006, p. 38.

the founders, reasons of formation, purpose and industry strategies, as well as sources of financing and other reasons.

According to Porter[4] clusters present a new type of national, regional and local economic picture, and they require new roles of companies, government and other institutions. The establishment and formation of small businesses around a large strong company (e.g. TNCs) in a cluster can help them to reduce costs of information and new technology transfer through intraregional, interregional, and cross-border cooperation. This can be explained by the theory of transaction costs by R. Kouz[5]: if transaction costs are low and property rights are clearly defined and their entities maintained – the market can be regulated. It can be assumed that reduction of transaction costs in clusters is associated not only with common research and development (R & D), but also with the information on innovative products and information technology transfer based on common information virtual platform.

PRACTICE OF CLUSTER NETWORKING INITIATIVES IN UKRAINE

The practice of cluster networking development has considerable influence on urban economies in different Ukrainian regions. Despite the positive aspects of cluster initiatives development in Ukraine there are some problems such as:

▪ most important, the lack of confidence at all levels (city, region, country) of public and business administration, and in social life;

▪ lack of proper legal public and private partnership (PPP) support for potential cluster members. Despite the fact that Ukraine, in 2010, adopted a law on PPPs, which could have enabled the public authorities to participate in partnership, there is the need to expand the range of possible forms and strategies of PPPs for cluster interaction;

▪ disproportions between interests of local authorities and those of business partners, particularly in the modernization of the urban infrastructure for the initiation of cluster (the former are looking for partners rather for a „hard" infrastructure, whilst the latter are looking rather for „soft" infrastructure development)[6];

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[4] M.E. Porter, *Location, Competition and Economic Development: Local Clusters in a Global Economy* [in] Economic Development Quarterly 14, no.1, February, 2000, pp. 15–34.

[5] Р. Коуз, *Фирма, рынок и право* / Р.Коуз / Пер. с анг. – М.: Новое издательство, 2007. – 224 с.

[6] In modern cities infrastructure can be classified into "hard" and "soft" infrastructure. "Hard" infrastructure refers to the large physical networks necessary for the functioning of a modern industrial economies, whereas "soft" infrastructure refers to all the institutions which are required to maintain the economic, cultural, health and social standards of a city (region), such as the financial system, the education system, the health care system, the system of government and law enforcement, as well as emergency services: [http://www.theurbanvision.com/blogs/?p=761].

▪ lack of national and regional policies targeted at financing cluster initiatives.

Our research have shown that the most widespread sources for the funding of cluster initiatives and networking integration in Ukraine are the followings international projects and programs, supported by EU and other international funds:

– monitoring of private and public organizations' activity in innovative entrepreneurship development at local and international levels;

– an audit of business-education of the country's higher educational system for the international system of education; international forums, conferences and seminars – USAIDE, PAUCI, Open Society Institute, Soros Foundation;

– projects of international innovative entrepreneurship development and transborder cooperation support (including projects of public and governmental organizations cooperation) – World Bank, EU Funds, OECD and other.

The most frequently encountered form of "soft" infrastructure projects in cluster initiatives in Ukraine are those often funded by non-governmental organizations, and international donors (see table 1).

**Table 1. The characteristics of cluster initiatives' infrastructural support
in different regions of Ukraine**

Regions (cluster initiatives)	Funding and administrative cluster elements		Infrastructure development projects
	External	Internal	
Khmelnitsky (Dress, building materials, tourism)	International Foundation for Market Promotion, USAID, Fund «Eurasia»	NGO "Podillya the First" (founder)	Joint information activities, training, marketing, legal and audit service
Ivano-Frankivsk (Tourism, decorative textile production)	International Foundation for Market Promotion	Ivano-Frankivsk center for cooperation	Joint information activities, training, marketing
Odessa (Wine production)	Project of International Development of Great Britain "Private sector Development"		Joint information activities, marketing
Rivne (Wood processing)	Rivne Chamber of Commerce, project of TACIS, OSCE, Rivne Regional Organization «Ukrainian Marketing Association»		Joint information activities, training

Source: compiled on the bases of own studies and innovation activity survey in Ukraine 2008–2010.

Under "soft" infrastructure for cluster networking we means joint information activities, common training and research activities for technology transfer and innovative development of national cluster members and their integration into the European and global networked structures.

ROLE OF THE "SOFT" INFRASTRUCTURE IN THE CLUSTER NETWORKING INITIATIVES DEVELOPMENT IN UKRAINE

Majority of researches have confirmed the marketing communication and networking advantages of cluster initiatives for their members. For example, Ch. Ketels[7] indicated the growing influence of the "soft" infrastructure institutions that provide specialized framework for the interaction and to facilitate higher levels of integration among members of the cluster.

In examining the nine functioning Ukrainian clusters in different regions and areas of activity (construction and building materials, stone processing, clothing, green tourism, eco-tourism, wood processing, wine and decorative textiles production, transportation), it can be stated that (table 1):
▪ joint information activities is applied in all cases;
▪ joint marketing activities are carried out in 65% of cases;
▪ co-education – in 45% of cases;

The analysis shows that the current program of the cluster initiatives support within the regions of Ukraine is related primarily to the information infrastructure platform for the transfer of technologies. However, very often, friendly trusted environment, which is a prerequisite for the dissemination of knowledge and „networking competence" for the cluster infrastructure, attitudes of administrative staff remain unaffected in the cluster development projects.

The creation of common information platform provides an opportunity for improvements in cooperation in five key areas of cluster networking:
– information and communication (IC),
– training,
– IC innovative technologies development,
– standardization and internationalization,
– marketing and PR.

The implementation of the open virtual environment for successful cluster initiatives leads to significantly faster and more sustainable innovative development for all network participants. For example, in such countries like Germany, Canada, Britain, Norway about 79% of functioning clusters share information through common websites, while in countries with a lower level of cluster initiatives development, this figure stands at about 40%[8].

One of the successful examples of networking in the development of innovative initiatives in Ukraine, based on virtual information platform, is the National Technology Transfer Network (hereinafter referred to as NTTN)[9]. NTTN

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[7] *The Development of the Cluster Concept – Present Experiences and Further Developments* / by Ch.H.M. Ketels, 2003, p. 25.

[8] Ch. Ketels, G. Lindqvist, O. Solvell, *Cluster Initiatives in Developing and Transition Economies*, Centre for Strategy and Competitiveness, Stockholm, First edition, May 2006, p. 38.

[9] www.nttn.org.ua.

is developed in accordance with the methodology and models of European Innovation Relay Centers – IRC network (EEN – since 2008), Russian Technology Transfer Network RTTN and Ukrainian Technology Transfer Network UTTN[10]. NTTN consists of the state and non-state network segments which is a good example of the public-private partnership network in Ukraine and it includes 43 participants and 9 network partners, in particular:

- 4 scientific-research and design institutions and organizations working as innovation structures;
- 27 universities, educational institutions working as innovation structures or specializing on preparing and raising the level of innovation structure through specialists' skills;
- 11 organizations implementing innovation results and inventions;
- 2 innovation funds;
- 8 networking organizations providing legal services, services in the field of scientific and technical expertise, management, marketing, advertisement, publishing and information activity.

The peculiarity of this network is that many NTTN members and partners have initiated cluster structures in their regions, creating local clusters and networks. Furthermore, there exist other successful examples of networking initiatives among the potential cluster members for the knowledge and technology transfer by using a common Internet platform. For example, for the Zhytomyr Cluster of Stone Processing with the support of the "Private Sector Development", a joint website for promoting internal resources and the sharing of knowledge for education, and to share innovations[11] was set up.

Our investigation of the Ukrainian regional cluster initiatives reveals lack of cluster information networking infrastructural elements and interregional disproportions in relevant innovation supporting centers and the importance of creating an information platform for the transfer of innovations, which will provide sustainable development of a knowledge-based economy in Ukrainian regions.

MODELLING OF INFRASTRUCTURAL NETWORKING PROCESS IMPACT ON THE DEVELOPMENT OF REGIONAL CLUSTERS

Many scientists and economists, in analyzing the common features of a knowledge-based economy in different regions and countries, have noted that the main factors of its sustainable development are the level of science and research development, investments in the region's economy, innovative enterprises

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[10] V.S. Lusenko, S.O. Yegorov, *Reasons and methodological basis for creating and development of technology transfer network in Ukraine*, „Mathematical appliances and systems", 2008 #1.
[11] www.stones.com.ua.

charges. In many scientific papers, this has been confirmed as the primary tasks of clusters formation [1–4, 8–9]. and cluster initiatives networking development.

We assume that an effective development of cluster initiatives and using them to develop active innovation-oriented clusters is a direct result of their infrastructure components (institutional and financial) development and their networking ability. By developing an information network among potential cluster members, the operation of regional clusters will have positive impacts on gross regional product (GRP). To justify our assumptions the following hypotheses was tested:

- The existence of relationship between the volume of the GRP and the degree of innovation infrastructure activities in the region, expressed through the financing of innovation (total innovation expenses, research and development activities of enterprises).
- The existence of a positive impact of regional information infrastructure (information connections among enterprises) on the GRP;

The effect of integrated infrastructure-forming factors (e.g., volume of output of enterprises, the level of investment revenues from a variety of sources, innovation regional expenses, activities of scientific institutions in the regions and the cost of developing information infrastructure) on GRP which dynamically varies in different regions of Ukraine was investigated. In mathematical form this dependence is expressed as:

$$VRP_{t,r} = \alpha_0 + \beta_1 Inv\_p + \beta_2 Nauk\_vutr + \beta_3 Inv\_M +$$
$$+ \beta_4 Inn\_vutr + \beta_5 Vutr\_inform + \beta_6 MP + \beta_7 Inv\_B + \beta_8 Inv\_I \tag{1}$$

where:

VRP – volume of gross regional product, per enterprise (thd. UAH/ Unit);

α_0 – constant displacement along the vertical axis (the level of influence of other factors on the formation of cluster);

Inv_p – enterprises investment in their capital assets, per enterprise (thd. UAH/ Unit);

Nauk_vutr – the amount of internal regional expenditure on scientific and technology activities performed by scientific organizations, per academic institution in the region (thd. UAH/ Unit);

Inv_M – investment of the local budget in fixed assets, per enterprise (thd. UAH/ Unit);

Inn_vutr – costs of innovative activity, per enterprise (thd. UAH/ Unit);

Vutr_inform – expenditures for information technologies, per enterprise (thd. UAH/ Unit);

MP – volumes of small businesses goods (products, services), per enterprise (thd. UAH/ Unit);

Inv_B – state budgetary investment in fixed capital, per enterprise (thd. UAH/ Unit);

Inv_I – foreign investment in fixed assets, per enterprise (thd. UAH/ Unit);

r – sequence number of the region (r = 1…27);

t – time factor, year;

β – regression coefficient;

ε – standard error.

The survey was conducted by stepwise inclusion of variables in two separate years for 2005–2011 period in 24 regions of Ukraine based on official statistical data[12]. This method enables the selection of the optimal set of parameters for the dependent variable. Mathematical processing of data was carried out using SPSS Statistics 17.0. Table 2 is a presentation of the results obtained.

Five parameters for which changes in F-test were significant (i.e. in table 2 "Sig. F-Change" <0,05) were selected. These were companies and local governments' budget investment, spending on research and development, innovation and informatization. This set of parameters is optimal in terms of cumulative impact on infrastructural development in the regions.

The model characteristics which include all the above mentioned parameters are presented in model number 5. Linear correlation coefficient R is 0,844, which indicates the existence of a strong linear relationship between the parameters of the equation. Durbin-Watson autocorrelation test (2,063) shows no autocorrelation between indicators (autocorrelation is absent, if the coefficient is within 2). Standardized regression coefficients indicate the importance of the variables included in the regression. Displacement variance (R-squared) indicates that 71,1% of the studied fluctuations in volume are related linearly to the differences in terms of product innovation volume.

Sources of variance of the output:

1. factorial variance described by the regression equation – 1 558 496,767 (sum of squares);

2. variance, which is not considered when writing the equation (sum of squared residuals) – 631 950,492.

Factor F indicates the existence of non zero regression coefficients – 20 716. Tabulated values of $F_{0,05;(5;42)}$=2,44 means that with a significance level of 0,05, the existence of a linear relation can be affirmed. The value of the main significance criteria p <0,001 points to the probability of error, which corresponds with the F-test. As such, the significance can be estimated as global. Co-linearity checking shows no linear relationship between the independent variables (no values for which the Tolerance<0, 1 and VIF>10).

The calculations show that two infrastructural factors, i.e., level of investment from the local budget and the costs of computerization will have the most significant impact on spatial development of regional business networking activity.

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[12] http://ukrstat.org/en - State Statistics Service of Ukraine.

Table 2. Regression model of integrated infrastructure-forming factors affecting the GRP in 24 regions of Ukraine

Descriptive Statistics			
	Mean	Std Deviation	*N*
VRP	631,9086	215,88252	48
Mp	284,9311	83,78524	48
inn_vutr	8,4548	9,82554	48
Inv_B	10,3839	7,95968	48
Inv_M	5,4352	2,44819	48
Inv_p	91,9146	34,54696	48
Inv_I	5,4791	6,22471	48
Nauk_vutr	2802,4683	2329,73897	48
vutr_inform	2,2203	1,96259	48

Entered / Removed Variables			
Model	Entered Variables	Removed Variables	Method
1	Inv_p	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
2	Nauk_vutr	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
3	Inv_M	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
4	inn_vutr	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
5	vutr_inform	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).

Model Summary									
Model	R	R – square	Adjusted R - square	Std. Error of the Estimate	Change Statistics				Durbin-Watson test
					R –square change	F-change	df1	df2	Sig. F-Change	
1	,697a	,486	,475	156,47835	,486	43,459	1	46	,000	
2	,741b	,549	,529	148,23231	,063	6,260	1	45	,016	
3	,793c	,629	,604	135,84612	,081	9,580	1	44	,003	
4	,823d	,678	,648	128,09727	,049	6,484	1	43	,015	
5	,844e	,711	,677	122,66393	,034	4,894	1	42	,032	2,063

a. Predictors: (Constant), Inv_p
b. Predictors: (Constant), Inv_p, Nauk_vutr
c. Predictors :Constant), Inv_p, Nauk_vutr, Inv_M
d. Predictors: (Constant), Inv_p, Nauk_vutr, Inv_M, inn_vutr
e. Predictors: (Constant), Inv_p, Nauk_vutr, Inv_M, inn_vutr, vutr_inform
f. Dependent Variable: VRP

Source: own s statistical data.

Partial regression coefficients indicate:
- that by increasing funding from the local budget (*Inv_M*) by 1 (thd. UAH/ Unit) – gross regional product will grow (on average) by 27,266 (thd. UAH/ Unit);

- that by increasing enterprises capital assets (*Inv_p*) by 1 (thd. UAH/ Unit) – gross regional product will grow (on average) by 1,934 (thd. UAH/ Unit);
- that increase in scientific research funding (*Nauk_vutr*) by 1 (thd. UAH/ Unit will result in gross regional product growth (on average) of 0,033 (thd. UAH/ Unit);
- that increase in innovation expenditure (costs of innovative activity, *Inn_vutr*) by 1 (thd. UAH/ Unit) will result in gross regional product growth of 6,68 (thd. UAH/ Unit);
- that increase in expenditures for information technologies (*Vutr_inform*) by 1 (thd. UAH/ Unit) will result in gross regional product growth (on average) of 22,13 (thd. UAH/ Unit).

Thus, the regression model of networking for innovative cluster development in the regions of Ukraine could be represented by the equation:

$$VRP = 108,771 + 1,934 Inv\_p + 0,033 Nauk\_vutr +$$
$$27,266 Inv\_M + 6,68 Inn\_vutr + 22,135 Vutr\_inform \tag{2}$$

In analyzing processes of networking for the development of innovative clusters in various regions of Ukraine, it can be concluded that it is necessary to synchronize two directions in these clustering processes, i.e., education–science–technology networking and technology-industry transfer information platform development. The latter must be fixed as a distinct important constituent of innovative infrastructure with a strong institutional and financial policy support through private-public partnership projects.

Literature

Войнаренко М.П., *Кластери в інституційній економіці*, [монографія], Хмельницький: [Тріада-М], 2011. – 502 с.

Коуз, Р. *Фирма, рынок и право* / Р.Коуз / Пер. с анг. – М.: Новое издательство, 2007. – 224 с.

Портер М.Э., *Конкуренция*, Издательский дом «Вильямс», Москва, 2001, 495 с.

Соколенко С.І., *Кластери в глобальній економіці*. – Наукове видання. – К.: Логос, 2004. – 848 с.; 190 іл.

Ketels C., Lindqvist G., Solvell O., *Cluster Initiatives in Developing and Transition Economies*, Center for Strategy and Competitiveness, Stockholm, First edition, May 2006, 38 p.

Чамара І., *Особливості сучасного етапу інтелектуалізації економіки під впливом НТП*, http://experts.in.ua.

Чамара І., *Інтелектуалізація праці як найважливіша умова економічного розвитку*, http://experts.in.ua.

The Development of the Cluster Concept – Present Experiences and Further Developments / by Ch.H.M. Ketels, 2003, 25 p.

Porter M.E., *Location, Competition and Economic Development: Local Clusters in a Global Economy*, „Economic Development Quarterly" 14, no.1, February, 2000, pp. 15–34.

http://ukrstat.org/en.

www.stones.com.ua.ukr.

www.ppngo.org.

Summary

Ukraine's cluster development strategy provides prospects of regional and transnational collaboration. The analysis have shown that current cluster policies in Ukraine are based on the transfer of technologies. The potential advantages of regional clusters such as development of informational infrastructure, conduct of researches (both marketing and applied science), training programs and staff development are key issues of Ukraine – Poland mutual collaboration.

Thus, regional cluster developments could have maximum positive impacts on GRP in the regions of Ukraine. There is need to intensify investment in infrastructure component, in particular, increasing spending on research and development, and costs of innovative products. An important factor is also increasing the role of local and government investment in support of innovation activity, and in attracting investment resources. Assumptions about the importance of the impact of information infrastructure in the regional development process were also confirmed.

**Sieciowy model infrastruktury klastrów
w rozwoju gospodarki opartej na wiedzy na Ukrainie**

Streszczenie

Strategia rozwoju klastrów na Ukrainie stwarza perspektywy współpracy regionalnej i międzynarodowej. Przeprowadzone badania wykazały, że obecna polityka klastrów na Ukrainie opiera się przede wszystkim na transferze technologii. Klastry regionalne i potencjalne zalety ich działalności, takie jak rozwój infrastruktury informacyjnej, prowadzenie badań (zarówno marketingowych, jak i w dziedzinie nauk stosowanych), realizacja programów szkoleniowych i rozwoju pracowników, stanowią ważne zagadnienia we współpracy między Ukrainą a Polską.

Rozwój regionalnych klastrów może mieć pozytywny wpływ na wzrost PKB w regionach Ukrainy. Zachodzi więc potrzeba zintensyfikowania inwestycji w składniki infrastruktury, w szczególności zwiększenia wydatków na badania i rozwój oraz wydatków związanych z innowacyjnymi produktami. Istotnym czynnikiem jest również zwiększenie roli inwestycji lokalnych i rządowych wspierających działalność innowacyjną i przyciąganie środków inwestycyjnych. Wyniki przeprowadzonych badań potwierdziły również znaczącą rolę infrastruktury informacyjnej w procesie rozwoju regionalnego.