University cluster evaluation by index method

Gleb Dvoryatkin
Tomsk state university of control systems and radioelectronics (TUSUR)

Gleb Dvoryatkin is a master of innovation management, in 2011 graduated from TUSUR (Institute of Innovation), master thesis topic: «Educational innovative complex of TUSUR as university cluster». In 2009 worked for Industrial Technology Research Institute (Taiwan) in the department of industrial economy as an intern, about 2,5 months. In 2010 participated in program "Development of Youth Incentive innovative entrepreneurship in Russian Federation". Also in 2010 became the founder and CEO of Altair Ltd., on the basis of which the project "Wireless monitoring system" is developing now. Participated in the IX Triple Helix Conference which was held in Madrid in 2010.

TUSUR cluster evaluation is analyzed in this science work. The index method as an instrument for evaluating qualitative and quantitative statistic data is considered.

Subtopics: interaction among universities, business and regional government, knowledge-based business, university clusters, index method of statistic evaluation.

Keywords: university clusters, university-based innovative companies, knowledge-based business, index method.

Introduction

Understanding the Triple Helix model, its ideas and evolution is extremely important for Russia because even the first issue of the theory still stays unclear: who are the leading players in the innovation process? Traditionally, in almost all countries there are three institutions, generating intellectual property:

• Public research centers, laboratories, public academies; for example, in Russia there is the Academy of Sciences with its fundamental focus and planning horizon for decades;
• Research centers; in Russia it is an industrial applied science which has good connections with production processes;
• Universities filled with young people. In the past the general feasibility of separation of youth from the research was justified by the fact that virtually all of any significant researches took place behind closed doors and were focused not on the consumer market, but on military industry.

Meanwhile, the Triple Helix model, based on long-term study of world experience goes beyond the recognition of the university as an equitable player in the innovative process along with

business and the government. The Triple Helix model suggests the thesis of the university's primacy in this trio (university, business, government). According to this theory the university becomes the main driving force of innovation development.

The majority of leading Russian universities are undertaking purposeful actions for improving their structure and management systems in order to meet the needs of the current economic situation in Russia. One of the methods to respond to these challenges is consolidation of educational organizations and innovative companies in clusters (groups of geographically concentrated interconnected companies and organizations related to them, which are mutually complimentary and specialize in a certain sphere).

This work is focused on evaluating the activity of the clusters, in particularly TUSUR cluster (UNIC).

State of the art about the topic

According to the strategic goal of the university, TUSUR has a lot of work to widen its "business surroundings" and strengthen its connections with knowledge-based business.
The work of UNIC (union of university and number high-tech companies around it) in the context of cluster theory is analyzed in this research work. The principles of interaction between the university structures and innovative companies included in UNIC are considered. The method of UNIC performance evaluation is provided.
Index method allows us decreasing several various parameters of UNIC performance into one clear number. Despite the fact that the large part of the data is not published, the available information allows us evaluating not only the dynamics of UNIC, but also the degree of development of the university. Also, the data reflects a clear influence of UNIC's innovative development on the Tomsk region in general.

Methodology

The main method of study was to implement the existing statistic methods for creating a model for UNIC performance evaluation and forecasting.
Primarily data search was based on open sources – the data from annual statements of UNIC companies and organizations, the university's statistics, articles and research papers in the field of clusters, in particular some of Michael Porter's works.

Findings and interpretation

TUSUR was created in 1962, as an R&D center for military purposes, particularly for developing rockets, missiles and radiolocation systems. After the Soviet Union fell the huge part of the government dotation was cut, so TUSUR as any other Russian university had to find new sources of financing. The most effective way to do that was consolidating of the university and innovative companies in cluster. So, in the beginning of the 90's the university undertook purposeful actions to create its own cluster. After 20 years of consistent efforts TUSUR has 125 high-tech companies around the university established by its alumni with 500$ of total turnover.

This system – the innovative complex based on a synthesis of the university and high-tech companies – was called UNIC (the name is actually a Russian acronym presented in Latin letters). It fully corresponds to the characteristics and definitions cluster provided by Michael Porter. UNIC is created on the basis of the university in order to develop mutually beneficial partnership and entrepreneurial processes between TUSUR and its business-environment, to create favorable conditions for innovative activity.

UNIC includes research institutes, design bureaus, student design bureaus, engineering centers, student business incubator, science laboratories, innovative companies created by TUSUR alumni. The main feature of UNIC is that every firm has its "own" unit inside the university (research institute, design department or science lab, creative team within the system of collective project training or in business incubator, etc.) and provides it with orders, financing, topics for students research work and final theses. There is a constant circulation of information about human resources inside UNIC. It means that information about a student or an employee spreads immediately within the cluster, which on one side creates awareness about personal and professional qualities of certain people inside the UNIC, and on the other stimulates competitiveness among these people.

Hence, UNIC is a net-shaped cluster located in a specific geographic region (Tomsk) where close location of firms allows them to enjoy the benefits of increased communal efficiency and improves the frequency and level of their interaction.

Educational process in TUSUR is designed in a special way, whereby a student develops in the innovation filled environment, studies and absorbs the basics of innovative thinking, and therefore gains capability to implement innovative projects in "real life". In fact if an innovative project lies in the field of control systems, information technologies and electronics, the order for R&D will most likely be given TUSUR, rather other university or research organization.

There are 4 basic principles of cooperation within the university cluster:

1. Partnership. It means that the university cooperates with companies created by the TUSUR alumni without paying attention to company size, its capitalization or whatever. The thing is that the condition of every separately taken element of this system may change, but the rules of partnership never change.
2. Double citizenship. It is critical that each of these companies has its own department inside the university, such as an R&D center, laboratory or design bureau, which provides the university with orders, financing, topics for students research works.
3. Sinergy. The university and the companies created by its alumni collaborate not for earning money from each other, but for attracting more resources from other sources.
4. Guarantees. When a company decides to quit the partnership, the university buys out all its property and uses it for its own purposes or resells it to other companies. So there is a reason for company to enter the cluster and a reason to stay there.

TUSUR creates the conditions and motivates students to start up their own companies, which are oriented towards knowledge-based business. It should be noted that 125 companies of Tomsk IT-sector were created by TUSUR alumni, which constitutes about 80% of the market.

The other numbers and facts are also quite impressive:

- The number of projects carried out by TUSUR alumni in existing companies – 130 projects.
- The number of companies and private entrepreneurs in high-tech industry, which are included in ESIC, and possess their own organization status in the university – 100 companies and private entrepreneurs.

- The innovative products, annual sales growth for companies of UNIC in 2008 – 30%.
- The total amount of companies created by TUSUR alumni – 176 companies.
- The volume of services provided by UNIC companies in 2009 – 15,2 billion rubles, which is about $500 million.
- The volume of private business investment in UNIC companies in 2009 – 400,5 million rubles, which is about $14 million.
- Capacity of student business-incubator - 3300 m^2, 300 work places.
- The number of companies which came out from the incubator – 15 companies.

The detailed investigation of UNIC as a cluster was provided in another research presented on a IX Triple Helix Conference which was held in Madrid in 2010; the advantages of this type of structures over isolated companies were outlined. The data from annual statements of UNIC companies and organizations served as an evidence of the aforementioned facts.

The UNIC's example has demonstrated us the following:

- Clusters will play the decisive key in modernization of Russian business and educational system.
- The advantages for innovations and increase of efficiency can be developed better in clusters than in isolated companies.
- The companies included in cluster are able to react faster and more appropriately to the customers' needs. The cluster's companies benefit from location in a place with a high concentration of other businesses which have already established strong customer relationships and thus know their needs.
- Clusters allow us to remove or decrease negative impact of organizational problems, which usually appear in more isolated territorial structures and in companies with a high vertical integration.
- Participation in cluster facilitates in access to new technologies, educational methods and good supply and demand opportunities. The companies included in a cluster can easily get new information about technological progress, availability of inventory and equipment, about new concepts in services and marketing, etc.
- The existence of cluster itself is an evidence of availability of certain opportunities. People who work within the cluster can easier detect the existing niches for certain products, services and supplies. All the required assets, skills, manufacturing factors and employees are easier for access inside the cluster.

All these facts taken together suggest that UNIC has great perspective and opportunities in bringing around new educational and entrepreneurial methods and mechanisms which will positively impact on Russian economy.

Further analysis of the TUSUR cluster (UNIC) revealed the lack of appropriate measuring instruments for qualitative and quantitative statistical data of the cluster.
This study is an attempt to answer such a question as how to measure the functioning of a university cluster? What methods of measurement and criteria should be used when dealing with a complex network of companies and organizations interacting with each other in accordance with special principles?

The first question that arises when trying to evaluate the performance of a cluster is "why do we actually need to evaluate clusters?" There are several compelling reasons for the need of this assessment.
First, evaluation is necessary not only to determine the best ways to stimulate the development of clusters, but also to determine the feasibility of using the cluster approach to economic policy in general.

Secondly, a clear system of indicators gives a formal framework (objective numerical data) for managerial decision making within the cluster and develop a common strategy.
Third, a set of indicators helps to justify the allocation of resources within the cluster system taking into account managerial ideas and innovative initiatives. Numeric forecasts allow us forming the expectations with regard to innovative potential of the cluster, and to compare planned performance with the performance during the reporting period which would help us see the weaknesses of the system that are reflected in certain numeric parameters and give us a clear image of what are problems inside the cluster.

How can we evaluate the performance of the cluster? As there is no single definition of a cluster, a single model of cluster policy, just as there is no universal approach to evaluation of the clusters. The lack of basic knowledge about the cluster processes, the lack of official statistics, the inability to identify the clusters, especially in the stage of their inception – all these factors taken together make the evaluation process even more complicated.
Analysis of works devoted to this issue suggests that the evaluation of clusters is not a one-time process, but a complex problem, which starts with the question - which methods and which criteria should be used to measure and evaluate activity of the cluster. The significance of this issue is extremely important, because the possible values (or at least part of them) remain important, and at the following stages of the evaluation process.

Anderson et. al outline such factors as, number of firms in the cluster (including the newly-created), employment, productivity, exports, profits, number of innovations produced in co-operation, changes in these indicators over time.
The reports of the Organization for Economic Co-operation and Development (OECD) provide extended indicators sets of the same type, among them: the number of linkages within the system, investments, specialization, the proportion of national product, qualification of personnel, cooperation between enterprises and research institutions, contacts with customers, etc.

However the criteria selection is not the only issue. The methods used for summing and generalizing these criteria are also very important to ensure the reliability of the assessment results. If we turn to the global practice of innovative development evaluation for countries and economies, it is impossible not to notice that almost all the approaches are based on the index method, i.e. reducing the number of various parameters into one overall index. European Innovation Scoreboard, an instrument of the European Commission developed in the framework of the Lisbon Strategy (a new strategic objective of the European Union aimed to increase its global competitiveness for economic renewal and improvement of social and ecologic environment) may be a really good example. The essence of this tool is to combine five basic parameters (each of them includes five more) into a single index that reflects the innovative activity of the EU on the basis of statistical information from various sources, first of all - on a EU innovations review. These parameters include the following: the conditions for innovations (Innovation Drivers), investment in knowledge (Knowledge Creation), Innovation and Entrepreneurship, applications and intellectual property. Another example is the Global Innovation Index, a generalized index for measuring the level of innovation in a country, developed by the Boston Consulting Group and the National Association of Manufacturers. National Association of Manufacturers considers this index as "the largest and most comprehensive global index among the others". Last index was published in March 2009. In order to rank the countries the researchers examined innovation costs and innovation output as well. In assessing the cost of innovation the government's fiscal policy, education policy and innovation infrastructure were taken into account. In order to assess the innovation output they estimated the following factors: account patents, technology transfer and other R & D results,

business efficiency, for example, labor productivity, total returns to shareholders, the impact of innovation on the migration of business and economic growth.

Despite the fact that these methods are focused on the evaluation of innovation policies of entire countries, in case of its application to cluster evaluation the essence stays the same - combining several parameters into a single indicator, i.e. an index that reflects not only the actual situation at any point of time, but also clearly demonstrates general development of the cluster. In practice indexes along with the averages are the most common statistical indicators. With the help of this method we can evaluate the development of national economy as a whole and its individual sectors, analyze the effects of industrial and economic activities of enterprises and organizations, exploring the role of individual factors in the formation of major economic indicators. Indexes are also used in international comparisons of economic indicators, determining the level of life, monitoring business activity in the economy, etc.

According to mathematical statistics index represents the relative value obtained by comparing the levels of complex socio-economic indicators in time, space or plan.
So, in order to introduce composite UNIC index, we have taken 5 basic parameters of its activities over the past 10 years:
1. Number of companies in the UNIC
2. The volume of funds brought in TUSUR by UNIC companies
3. The number of graduates working in UNIC companies.
4. The annual budget TUSUR
5. The total revenue volume of UNIC companies
Using the data available in annual reports of UNIC and reports of TUSUR Academic Council for 2000-2010 we formed a table which reflects the volume of each parameter for each year (table 1).

Table 1

Year	Number of Companies	Volume of funds (RUR)	Number of graduates	TUSUR budget (RUR)	Volume of revenue (RUR)
2000				105,590,000	
2001				173,424,000	
2002		73,989,000		334,864,000	
2003		91,734,000		439,816,000	
2004		93,620,000		519,097,000	
2005		100,105,000		600,012,000	
2006	60	113,698,000	317	1,065,803,000	7,800,400,000
2007	70	189,064,000	412	1,236,044,000	11,700,600,000
2008	83	185,538,000	509	1,147,273,000	15,200,000,000
2009	105	228,111,000	532	1,083,924,000	15,200,020,000
2010	125	418,909,000	589	1,251,320,000	15,360,300,000

As can be seen from the table there is no all the data necessary to monitor the evolution of indicators. So, the missing data were approximated by least squares method. This operation was carried out using the program Grapher (program from Apple for plotting equations with a visual representation of results).

In the end, we introduce the composite UNIC index by the following formula

$$I = \frac{\sum c_i \frac{q_i}{q_i^0}}{\sum c_i}$$

where q_i is a certain parameter of UNIC performance, q_i^0 - a certain parameter of UNIC performance in the base year (2010), c_i the weights (in the first approximation taken to be 1). So, it is possible to create a table showing the dynamics of the coefficients from 2000 to 2010 (table 2).

Table 2

Year	Number of Companies	Volume of funds (RUR)	Number of graduates	TUSUR budget (RUR)	Volume of revenue (RUR)	Index
2000	0,15285803	0,10588	0,236768431	0,08438	0,225902723	0,17059
2001	0,184352544	0,12862	0,274939061	0,13859	0,265547144	0,21754
2002	0,222336115	0,17662	0,319263369	0,26761	0,312148895	0,28713
2003	0,268145734	0,21898	0,370733423	0,35148	0,366928942	0,34963
2004	0,32339386	0,22349	0,430501222	0,41484	0,431322523	0,40403
2005	0,390025183	0,23897	0,499904489	0,4795	0,507016747	0,46508
2006	0,48	0,27141	0,53820034	0,85174	0,507828623	0,56984
2007	0,56	0,45132	0,699490662	0,98779	0,761742935	0,73207
2008	0,664	0,44291	0,86417657	0,91685	0,989564006	0,8107
2009	0,84	0,54454	0,903225806	0,86622	0,989565308	0,84471
2010	1	1	1	1	1	1

These data can be represented in absolute values by multiplying each coefficient by the value of 2010 to the corresponding parameter (table 3).

Table 3

Year	Number of Companies	Volume of funds (RUR)	Number of graduates	TUSUR budget (RUR)	Volume of revenue (RUR)
2000	19	44,355,606	139	105,590,000	3,469,933,602
2001	23	53,880,404	161	173,424,000	4,078,883,789
2002	27	73,989,000	188	334,863,999	4,794,700,669
2003	33	91,734,000	218	439,815,999	5,636,138,635
2004	40	93,620,000	253	519,096,999	6,625,243,347
2005	48	100,105,000	294	600,012,000	7,787,929,334
2006	60	113,698,000	317	1,065,802,999	7,800,400,000
2007	70	189,064,000	412	1,236,044,001	11,700,600,000
2008	83	185,538,000	509	1,147,273,000	15,200,000,000
2009	105	228,111,000	532	1,083,924,000	15,200,020,000
2010	125	418,909,000	589	1,251,320,000	15,360,300,000

Extrapolation of these data in the future can't provide any reliable prediction for a sufficiently large time span since most indicators for the previous period had exponential growth. However if we set the rate of expected growth of UNIC index, we can estimate the value of each parameter of UNIC performance which provides the required increase in the composite UNIC index.
In order to do this we have build a linear growth model for each of the indicators based on data for 2000-2010. In this case even a linear model for some of the indicators gives too optimistic forecast and as a consequence too large growth of the composite index. Therefore, we have introduced a correction factor to each of the models which provides the specified growth rate. The results of evaluations for a 4 types of growth rate are shown in table 4.

Table 4

Growth rate	Number of Companies	Volume of funds (RUR)	Number of graduates	TUSUR budget (RUR)	Volume of revenue (RUR)	Index
2%	144	387,490,825	728	1,809,408,720	20,429,199,000	1,219
4.6%	187	506,042,072	924	2,338,717,080	26,066,429,100	1,568
8%	258	706,699,483	1255	3,237,164,840	35,635,896,000	2,159
10%	311	854,574,360	1498	3,896,610,480	42,655,553,100	2,594

In the process of research, the author has faced with such problems as lack of information in available sources, the need for a qualitative assessment of UNIC using such tools as surveys and expert assessments, etc. The biggest problem was lack of information, fragmentary and not always accurate data in annual reports of UNIC. This was the reason for usage of approximation methods, so that we could get more data for retrospective analysis. In addition, documents and regulations describing the structure and functioning mechanisms of UNIC are either incomplete or do not exist. Many of these are secret or unpublished, such as information on intellectual property and export volumes of UNIC. Meanwhile, the information on patents would have a significant impact on the index UNIC and of course would reverberate on its dynamics.

Conclusions, policy implications and directions for further research

Clusters can be considered as a driving force of economic development, and can rightly be regarded as innovative systems of practical importance since scientific, technical and socio-economic development requires a concentration of national resources as well as the country's intellectual potential.
Clusters represent a new additional way of understanding the economy, the organization of economic development and public policy.
Unlike foreign countries, the analysis of participation of Russian enterprises in clusters leaves many questions unanswered. There is no universally accepted classification of clusters in Russia. There is not enough information describing the experience of interaction between enterprises and other actors of innovation processes within the clusters formed around the large companies, especially companies with foreign direct investment.
In addition, not only in Russia but also worldwide definitions of cluster remain the main source of ambiguity. Since the definition of Porter are somewhat unclear in terms of geographical scale and internal socio-economic dynamics, it has allowed various analysts use the idea of different ways to meet their own goals.

However, in general among researchers and within the existing regulations there is some commonality in the understanding of the term, which still allows some way to perceive this phenomenon.

In this paper we have undertaken an attempt not only to look at the TUSUR cluster at the angle of cluster theory, but also to evaluate it using several parameters as well as to simulate the development of UNIC in the future.
The study allows us to formulate the following recommendations for the development of the UNIC cluster.
Firstly, there is a need of further analysis of the UNIC structure, the principles of interaction among its participants, the definition of barriers and opportunities for the development of the cluster and of course we need to develop and improve methods of analyzing and assessing the performance of the cluster as well as modeling the processes occurring within the cluster.
Secondly, there is a need an appropriate development strategy for UNIC and a plan for its implementation, including development. The adoption of a coherent strategy for the cluster we have to take into account plans and projects of participants, their own strategies, so there should be an orientation on its compliance in a soft cluster management based on a set of formalized mechanisms for excluding the possibility of manipulation or pressure.
Third, cluster development policies should aim to establish effective information exchange between participants in the cluster. Publication of the quantitative data and expert assessments will simplify the process of studying the cluster and also will serve as a mechanism for attracting new participants.

References

1. Porter, M.E., On Competition, Boston: Harvard Business School, 1998.
2. Porter, M.E. What is Strategy, Harvard Business Review, Nov/Dec 1996.
3. UNIC TUSUR Annual Statement 2008-2009.
4. Enright, M. (1996) “Regional Clusters and Economic Development: A Research Agenda”, in Staber, U., Schaefer, N. and Sharma, B., (Eds.) “Business Networks: Prospects for Regional Development, Berlin”: Walter de Gruyter, pp. 190- 213.
5. Rosenfeld, S.A. (1997) “Bringing Business Clusters into the Mainstream of Economic Development”, European Planning Studies, 5,1, pp. 3-23.
6. Anderson T., Shwaa-Seger S., Sorvik J., Haanson E.W.. The Cluster Policies Whitebook, IKED. 2004.