Study and model on university-industry relations in cluster management within the North-West Region of Romania

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Abstract. In previous research on the N-W Region of Romania, it appeared that there are conditions conducive to the emergence of early-type clusters in this region. These conditions are manifested first and foremost from the bottom up, in the sense of the existence of material equipment with fixed means and human strength, both as professionals and as specialists. These conditions are also top-down in the sense of the authorities' preoccupation with developing strategies and a legislative framework to support and encourage the formation of these clusters and their further development. It has also been highlighted that in parallel with cluster structures, there are networks of innovation of IVth and Vth generation structures, including universities and research and design institutes, which are somehow superimposed on the structure clusters and which, by their interaction with all these elements of the clusters, have the effect of stimulating the technological transfer, for example, among others. In order to maximize the existence of these two networks, a model is proposed to be able to simulate different scenarios of evolution and interaction between all the components of the two structures, in order to highlight ways to deepen the integration of collaboration between these networks. The novelty of the model would be to introduce a negative feedback on actual and incidental external actions on the system and to introduce a particular property that takes into account the actions of the individuals involved, actions related to the free will of individuals, which cannot be restricted and cannot be assumed a priori that they are exercised only in the sense of amplifying some actions, even if these actions are positive.

1. Introduction

Starting with Romania's accession to the EC, a complex of studies and researches were carried out by accessing European funds, regarding the determination of natural evolving cluster conditions emergence in the north-western area of Romania and the economic areas of their emergence. On the other hand, studies have been carried out on the impact and importance of technological transfer on the development of economic activities in the area as well as on its importance in integrating the economy into the European economic circuit [1].

During these investigations, there was a downstream development system through governmental and legal governmental rules to allow clusters to develop in the geographic area of existence, depending on the results of their economic operation system. At the same time, there was a bottom-up development system that allows clusters to increase business competitiveness and efficiency by concentrating occupational human resources and specialists from university and research and design.
institutes. This facilitates all participating companies through a so-called "triple helix" [2] relationship to help increase the level of industrial development of their region.

This type of relationship integrates into the economic tendency of the countries of the European Union where relations already exist that lead to interactions between the economic agents within the cluster groups and the IV and V innovation networks, including the cadres of the universities and research institutes and industrial engineering.

On the other hand, in parallel with all these economic phenomena, there are the innovation systems of processes networks that in [3] was suggested that overlap the cluster networks, interfere and influences with each other.

Since, at present, networks of institutions involved in technological innovation and technology transfer, due to the complex and effective links between them and industrial companies, can be assimilated as belonging to the IV and Vth generations of innovation structures of processes, regional development must be tackled mainly by increasing the level of innovation and technological transfer.

This logical conclusion has been reached due to the similarities between the structures and modes of operation of cluster precursors and process innovation systems, which facilitate the expansion and complexity of links between universities, enterprises and research institutes, and through which it is possible to increase the efficiency of the development of the incipient clusters in the region.

Thus, it is desirable to study the links between the university structures, the specialists within them and those belonging to the industrial clusters in the incipient clusters of the N-W of Romania, based on the overlapping of the networks of the two structures, in order to construct a model simulating the interaction of the structure of the clusters with the structure of the process innovation system.

2. Methodologies

2.1. Preconditions and success factors for university/company relations in innovative clusters

It is obvious that intense correlations between a company efficient absorptive capacity of new developments in scientific and technological knowledge and its innovation outputs will increase the probability of generating a strong competitive advantage on the market [4].

The transfer of knowledge depends on a variety of conditions. For example, it depends on knowledge type, that is, explicit knowledge can be transferred easily by learning processes, while implicit knowledge depends on the individual work experience and his capability of giving or receiving information.

Also, the efficiency of the whole phenomenon of technology transfer depends on how people apply and engage themselves in the acquisition, processing, adaptation and application of new technologies or new products. These are actually the steps to implement an "autonomous management of strategic absorption capacity (such as: i-acquiring knowledge, ii-assimilation, iii-transformation, iv-application of new knowledge to a new product)" [4].

In order to achieve an efficient technology transfer process, companies can group into incipient clusters. The success of such a process lies also in intensifying collaborations with universities and research institutes to gain access and to implement cutting-edge technologies.

These collaborations involve the transfer of technologies, of know-how, and of specialists, specialized knowledge exchanges, technical consultancy and management of transfers of all kinds, mainly through joint projects in the field. Thus, the legislative and organizational work of the government to fund joint research projects and to encourage research programs in the field of development and the progress of both universities and companies becomes decisive.

In all these aspects, direct personal ties between academics and industry members are essential as they ensure an optimal deployment of technology transfer and knowledge transfer. This strengthens the possibility of solving technical problems, the emergence of innovative ideas and the emergence and development of new businesses.

This is all the more important as there are some differences between the way in which academic and industry communities behave, as the assigned time for solving problems, differences between the
corporate and academic social and technical characteristics, and also additional cultural national issues involves in cross-border collaborations.

These considerations lead us to the idea that there are a multitude of factors, favourable or disturbing, which positively or negatively influence the assimilation of new technologies, university-industry collaboration and cluster development.

But economic processes have to be analysed in their real aspect and taken into account by all events that may occur incidentally and/or accidentally, including the decisions taken by the participants as stand-alone units whose actions are related to their will and whose free will cannot be restricted, anticipated or directed only to a small extent.

2.2. Approaches to cluster/innovation systems of processes modelling

In order to develop development plans for the North-West region of Romania, it can be considered that economic activities take place according to those economic models in which interactions between clusters and process innovation systems take place.

They have been theorized that there are five generations of innovation process models. In the EU area, the last two generations are of interest at the moment. In Figure 1 a generic synthesis model for these two generations of innovation processes is proposed.

**Functional Integrated Model - IVth Generation**

- Marketing, research and development and distribution departments of innovation-producing companies;
- Similar departments of other supply companies;
- Internal departments in the innovation process;
- Developing networks of suppliers, customers and partners;

**Functional Integrated Model - IVth Generation** basic processes are:

- Functional integration of different activities and the simultaneous development of all levels of product innovation, instead of a sequential evolution;
- Complex business processes, feedback and reciprocal relationships.

**Integrated System Model - Vth Generation**

- A deepening of integration into complex networks in the design of systems and organizations of innovative networks, customer units, universities, suppliers and other industrial companies and local communities, including by addressing state-of-the-art technologies dedicated to complex issues within these networks team of system specialists interconnected in R&D-design, CAD/CAM software, models for simulations, rapid-expert prototypes.

**Integrated System Model - Vth Generation** basic processes are: information flows and actions occur simultaneously and closely with the activities and interests of the communities in which businesses operate.

The types of clusters that may occur in areas where universities and research and design institutes are involved in regional development are [4]:

i. Regional partnerships: interconnection of a group of companies in a region which in industrial production and services to obtain beneficial economic benefits, following the specific conditions of the region;

ii. Innovative clusters: cooperation between companies focused on the development of innovative companies' activities;

iii. University clusters: organization of co-operation between industrial enterprise groups, scientific and university institutions, concentrated especially in university research parks.

According to their level of development, there may be the following clusters:

a) Strong clusters: with high internal integration in cluster activities;

b) Stable clusters: with positive dynamics in interactions between their elements, but without consolidation;

c) Potential clusters: with poor development;
d) Latent clusters: organizations and companies with beneficial work together, but without an integrated structure.

On the other hand, there are three stages of cluster-based development:

a) The initial stage: a number of economic agents, having the necessary specialists and know-how, initiate an industrial activity;

b) The quantity expansion stage: the best innovative techniques are implemented from leading, innovative companies;

c) The quality improvement stage: trends to increase the performance of companies through technology transfer and the introduction of innovations.

![Diagram of Cluster Emergence](image.png)

**Figure 1.** A generic minimal structural model proposed for generation IV and V of innovation systems of processes

As can be seen from the above-mentioned classifications, the work carried out in the two networks - those of clusters and innovation process models - is based on component entities and in stages of evolution.

Components evolve from incipient forms to complex organizational forms in order to increase efficiency. This translates from products of low quality and complexity to high quality products that embody intelligence and innovation, as their technical capacity increases.

The efficiency of clusters also depends on inputs and outputs of material and financial resources, as well as access to specialized human resources.
Access to human resources also depends as well, on the regional concentration of institutions with innovative potential and resources in communication and research and design, through which to build the organizational structures characteristic of IVth and Vth generations of the innovation process models in the area.

At the same time, the way in which clusters evolve depends also on the pace of their occurrence and their life span, in order to have the necessary time to cluster them. Also, the percentage in this number of innovative cluster enterprises should be considered [5].

All these possible structures, processes and evolutions justify us to consider an archetype of evolution in stages, involving: i) transformations, ii) integrations, iii) inputs and outputs of human, financial, and material resources.

This must lead, for example, to the integration of a company into a cluster: i) in the first stage, to the structuring of these companies towards a technology, ii) intensive structure in a second stage, iii) and finally to companies that launch new technically evolved products on the market, in a third stage.

These stages involve also other entities that appear, interact and evolve from one stage to the next.

3. Results

The elements and their interaction must be the fundaments for all attempts to build an evolution model of cluster-innovation systems of processes networks simulation.

For example, scientific research requires the development of technological innovations and this influence can be considered as a two-way flow of information and influences, an interaction that intervenes decisively between the elements of innovation processes and cluster networks. This influence can be considered as a negative feed-back, in the sense that as the pressure of innovative ideas increases in quantity and quality, the cluster enterprises and innovation networks must restrict their material and human resources to deal with more opportunities.

Most clusters include:

- Companies produce products or services of interest;
- External suppliers of raw materials, production materials and energy;
- Financial institutions and service companies.

There are also government organizations, and often other consumer organizations, in collaborative networks.

The main collaborative structures within the innovation networks are universities and research structures, whose economic role to support clusters are [1]: a) consolidating the knowledge base of clusters; b) creating workforce through education and training; c) supporting scientific and technological infrastructure; d) testing to meet the cluster's technological needs to provide opportunities for new industrial opportunities [4].

Therefore, for a model that can be used in the case of considering also incidental events, the main components are: a) industrial productive companies which are grouped in regional clusters; b) external suppliers of raw materials, production materials and energy; c) specialists from universities and design and research institutes; d) new created workforce through education and training; e) financial institutions which provides financial resources, services; f) companies in horizontal industries which provides by-products, external suppliers of raw materials, production materials and energy; g) universities, and research structures; h) consumers organizations.

In such a model, the main actions to consider are: a) the transformation from a company with low quality products to a company with the production of high-quality products; b) inputs and outputs of staff employed; c) inputs and outputs of financial resources, materials, by-products etc.

Also, the model should contain a network component which inputs and outputs are knowledge, intellectual resources, and information. By this component the staff of universities for example can work and influence the structure of clusters and they can really superpose the innovation systems of processes networks over the clusters networks.
4. Conclusions
The analysis suggests that superposition of innovation systems of processes networks over cluster formation is not only probable but even mandatory given since technological progress is vital to maintaining the competitiveness of cluster companies.

Also, scientific and technological research is itself a force that produces the premises for the development of local communities present in geographic clustering areas.

From this point of view, the innovation systems of processes networks of IVth and Vth generations are mostly complementary, which ensures an increase in the speed of assimilation of technological progress, which in turn ensures the safety and stability of the companies present in the clusters.

On the other hand, the literature on the development of regional clusters, results in a three to four cluster development stages. So the model structure must respect this type of evolution [6].

The components of such a model are those involved in the creation of clusters and innovation systems of processes networks, the actions being taken are the inputs and outputs of products, personnel and financial resources, and the coordination between all these elements is made by negative feedback in order to provide the technological transfer.

5. Implications
One must take into account as implications for future research works the following considerations about the construction of the economic model:

- There are a multitude of factors, favourable or disturbing, which positively or negatively influence the assimilation of new technologies, university-industry collaboration and cluster development;
- The events according to the real, incidental aspect must be considered, as the presence of hazard on the markets regarding a multitude of aspects such as the prices of materials and raw materials, and bank and financial fluctuations.
- The personal decisions and actions of the people involved cannot be restricted and assumed a priori that they are exercised only in the sense of amplifying some actions, even if these actions are positive.

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