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Summary of PhD Thesis

RESEARCH ON THE CORRELATIONS BETWEEN THE INNOVATIVE CLUSTERS PERFORMANCES AND THE NATIONAL STRATEGY OF RESEARCH-DEVELOPMENT-INNOVATION ON SMART SPECIALIZATION COMPONENTS

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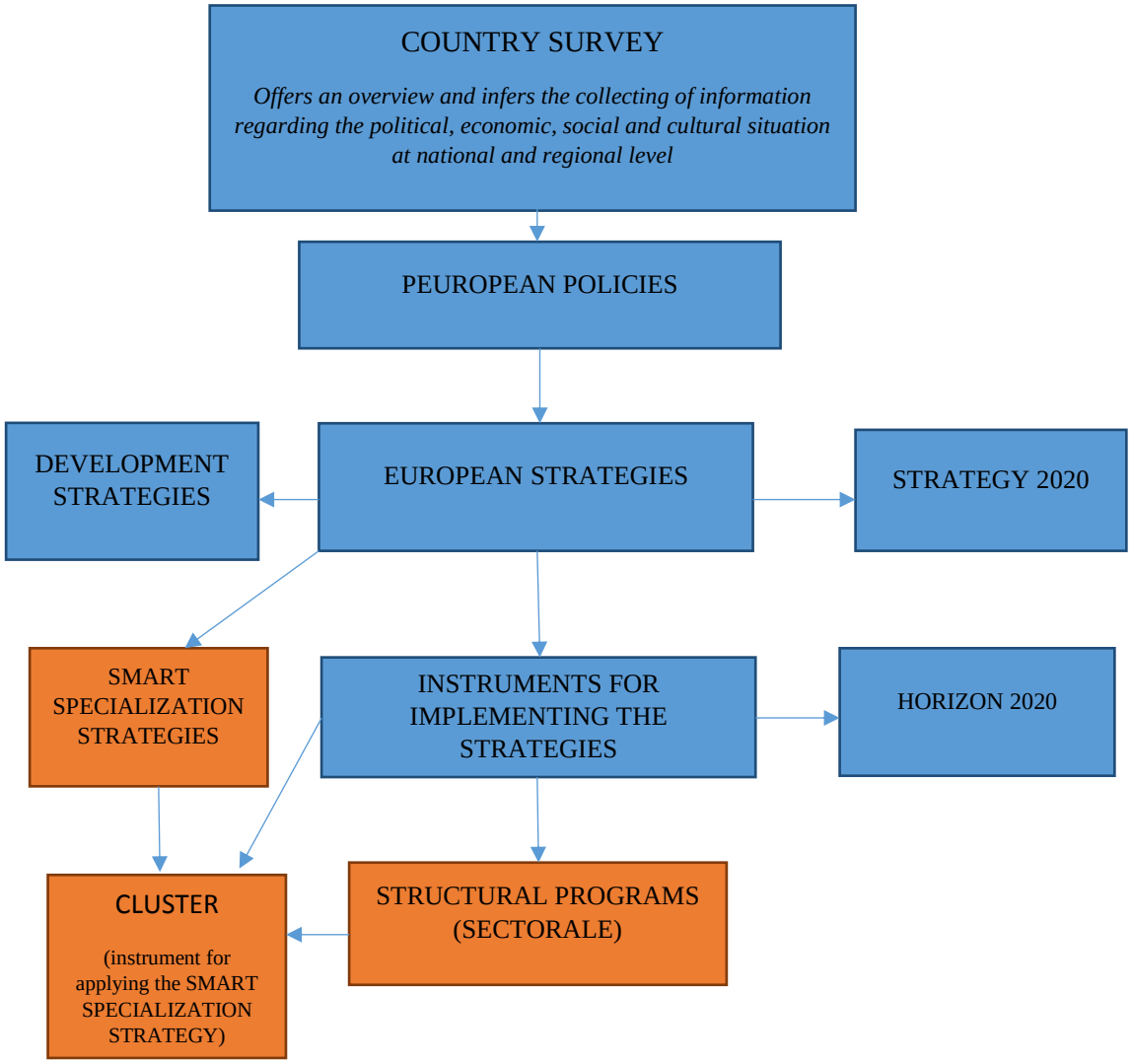
INTRODUCTION

Paradoxically, the sustainable competitive advantages in a global economy are increasingly found in the local elements: knowledge, relationship and strong motivation which the external competitors can not equalize. This has been stated by Michael E. Porter even since 1998, in his work "*Clusters and a new economy of competition*" published by Harvard Business Review. In a permanently changing world, the European economy aims to become smarter and smarter, more and more durable and inclusive. These three priorities, which mutually sustain should help EU and the member states to offer a higher level of workplaces, productivity and social cohesion.

This work highlights, from another perspective, the fact that the research – development and innovation activity constitutes a strategic component, decisive for the economic development and for the social progress, and the following explanatory figure highlights the fact that the cluster type organization represents an instrument for the application of the smart specialization strategy.



The country survey offers a comprehensive overview of a country and involves the gathering of information regarding the political, economic, social and cultural situation at national/regional level of the said state, situations that influence the working environment of an organization.

PART I

Chapter 1: THE CURRENT STAGE OF RESEARCH REGARDING THE SMART SPECIALIZATION STRATEGIES AND THE CLUSTERS

1. COUNTRY SURVEY AND THE EUROPEAN SEMESTER

1.1Results-based management

Such an analysis involves an exhaustive research and an assessment of the country/region profile that can lead to the drawing up of a *short list* with the existing major problems.

Thus are created the premises for the achievement of a national or regional strategy, the achievement of plans (national or regional, annual or multi-annual), programs/projects, principles and objectives on medium and long term, with the setting up of the priorities and of the necessary resources (human, material, financial, informational).

"***A country survey*** is carried out by the help of some country reports analyzed by the government of the said state or by independent companies or organizations such as the Economist Intelligence Unit, the World Bank and the Organization for Economic Cooperation and Development (OECD). In addition to the country survey, a special emphasis is put on a ***comparative analysis*** which an assessment of the own results of a country/region/organization with the cumulated results coming from other countries/regions/organizations operating in the same field/sector of activity and that allow the access to their database. This offers an added value and helps the country/region/organization to set up significant objectives, to obtain additional information about the tendencies in economy and about the needs of the economic agents and especially helps the country/organization to develop compared to the competition.

The strategy using the results-based management (RBM) has led to a better cooperation and collaboration among the states thus resulting a reform and a harmonization of the programs developed by the United Nations with the highlighting of the national priorities.

1.2 National strategy in the research-development field 2014 – 2020

In order to continue what was developed in the period 2007-2013 it was necessary to develop a new research-development strategy for the period 2014-2020.

"The National Strategy for Research, Development and Innovation 2014-2020"(NS-RDI 2020) sustains the strategic role and the capital position of the field, as an engine of the economic competitiveness increase and aims to connect to the new priorities of science and technology within the European Union reflected in Europe strategy 2020, especially in Europe initiative – An Union of innovation, and in the main implementation instrument – Horizon program 2020, as well as in the context of correlation with the cohesion European policies"[9].

1.3 The national strategy for competitiveness 2015-2020

Competitiveness means research-development and innovation. In 2015 the Romanian Government promoted the *National strategy for competitiveness*, a strategic document that was elaborated in cooperation with the economic environment and that aims to highlight the strategic priorities of Romania.

Based on the analyzes performed by experts in the economic and business environment, the Strategy determines "*10 economic sectors with competitive potential that correlates with the smart specialization fields identified in the national research, development and innovation strategy 2014-2020"*[10].

1.4 Competitiveness/clusters poles

Particular emphasis is put on clusters' formation (competitiveness poles) that plays an important role at national level. In order to achieve the necessary critical mass in a certain place or field, the connections that are established between economy and the institutions – from providers to the universities and governmental agencies – should provide an increase of competitiveness within the said field through several ways such as:

- increase of productivity in the associated companies,
- defining the development directions and rhythms,
- stimulation of developing new business within the cluster.

In March, 2016, "conform to the Ministry of Economy, Trade and Business Relations – *the Direction for Industrial Policies and Environment*, which coordinates the cluster policy as being a component of the industrial policy, there were 84 cluster initiatives, of which: 8 competitiveness poles were selected for being financed within O1.3.1 POSCCE «Competitiveness Poles», 27 clusters were selected for financing within the operation 1.3.3 POS CCE Clusters; 8 clusters accessed the call dedicated to innovation clusters within POC, AP1. «Research, technological development and innovation (RDI) in support of economic competitiveness and business development», Section B: Innovation clusters";

1.5 Strategies for smart specialization

Smart specialization at regional level (RIS3) [20] is a concept promoted by the European Commission together with the adoption of Europe Strategy 2020, to respond the need for a better substantiation of the investments in research, development and innovation through the cohesion policy of the European Union.

Smart specialization involves the identification of the unique characteristics and strengths of each region, highlighting the competitive advantages of each region, as well as the co-opting the interested parties and resources from the regional level around a vision focused on excellence on their future. The strategies regarding the smart specialization may constitute, in the same time, a powerful instrument for solving social, environmental, climate and energetic challenges, as well as the demographic changes, resources efficiency, energetic security and resistance to climate changes.

1.6 Europe 2020 Strategy

Considered the Growth Strategy for the decade 2010 – 2020, Europe 2020 Strategy, launched in the year 2010, sets up 5 main objectives the European Union aims to achieve until 2020, these being:

- "Jobs – at least75% of the people aged between 20-64 to be employed",
- "Research and development - 3% of GDP invested in research - development",
- Climate/Energy – "Reducing greenhouse effect gas emissions with at least 20%, increase of renewable energy share up to 20% and improvement of the energetic efficiency with 20%",
- Education – "Reducing the school dropout under 10% and increase of young people share with the third level of studies or diploma up to at least 40%",
- "Social inclusion and reduction of poverty –less than 20 million people at risk of poverty or social exclusion".

Chapter 2. PROJECTS – INSTRUMENTS FOR THE IMPLEMENTATION OF THE DEVELOPMENT STRATEGY OF A RESEARCH – DEVELOPMENT ENTITY

2.1 FORESIGHT Analysis

"Foresight means the art and science to anticipate the future" [21]**.**

In order to make a correct analysis with regard to the instruments for implementing the development strategies at national and sector level it is necessary "to define the relationship between prospective knowledge and the process of formulating public policies" in the field of research, development and innovation. It thus occurs the need to use a foresight exercise at national level. Foresight has been defined by Ian Miles and Michael Keenan as being "*the application of the systematic, participative processes, for collecting knowledge about the future and the construction of visions on medium and long term, in order to substantiate the decisions of the present and to mobilize joint actions*"[22].

Generally, a foresight analysis is based on five complementary stages, namely:

- Pre-foresight
- Recruitment
- Generation
- Action
- Renewal

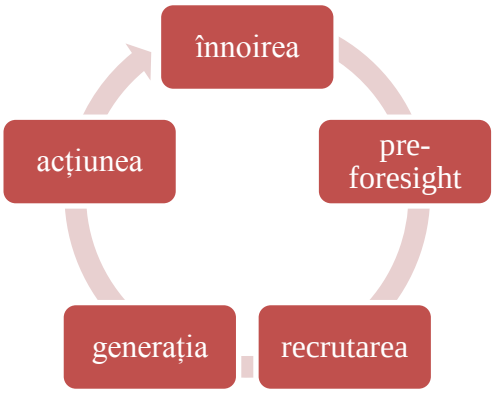


Fig.1.3 The five stages of foresight [26]

2.2 FORESIGHT within the context of formulating public strategies/policies

Foresight's relationship with public strategies/policies "is based on the fact that the former represents a common element of strategic planning and of the analysis of public policies"[27].

The process of implementing public policies and strategies is achieved by the analysis of fields, the identification of the interest areas and of the investigation directions, "setting up of the public agenda, formulating strategies and policies, making decisions, their implementation and, finally, their assessment".

2.3 Projects' life cycle – projects' design and planning

In their book "Principles of Management*: An Analysis of Managerial Functions", the fourth edition, published in 1968, by McGraw-Hill in New York, Harold Koontz* and Cyril O'Donnell, clearly highlight the principles that are to be used in performing different functions of management.

The manager must make himself/herself sure that these principles are also applied if exceptional situations occur and also in times of crisis. Such principles are:

- Increasing efficiency.

- Clear determination of management.
- Improvement of research.
- Achieving a goal.

Chapter 3: CLUSTERS

Silicon Valley is worldwide recognized, as being the birthplace of some of the most popular and representative today technologies. Many of its start-ups have a certain dynamic and have participated in the formation of clusters, groups of companies and organizations that have focused in a certain region and around a field of activity.

We also find a definition of the cluster "in the Romanian legislation – the *Impact Program*: a group of manufacturers, users and/or beneficiaries, in order to implement the good practices in the EU in order to increase the competitiveness of the economic operators" [39].

3.1 Presentation of the technological type cluster

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The technological clusters, also denominated, industrial clusters or innovation clusters, represent an important part of the organizing and understanding of the economic activity in a region.

A regional technological cluster represents a *geographical concentration of companies and institutions interconnected within a certain field* [2]. The common elements include a variety of small or start-up companies, a few companies of medium size, ore or two large companies, and often, the research universities and other governmental organizations. The technological clusters may form industries that range from food production and brewing to the development of computer games or biotechnologies.

3.2 Cluster's development strategy – General and specific objectives of the strategy (SMART)

The objectives of achieving a cluster should be correctly defined so that they become SMART objectives, and the strategy for developing a cluster should be such way defined it be a SMART strategy.

3.3 The conformity of the strategy with the national and European public policies framework

"The National Strategy for Research, Development and Innovation 2014-2020" is deemed to be a SMART strategy that "sustains the strategic role and the priority within the field of research, innovation, as an engine of the economic competitiveness increase and aims to connect to the new priorities of science and technology in the European Union reflected in Europe 2020 strategy, particularly in Europe initiative – A Union of innovation, and in the main instrument of implementation – Horizon 2020 program, as well as in the context of correlation with the European cohesion policies".

3.4 Consistency with the objectives of Structural Funds for research

The European Commission founded in 2006 the European Clusters Observatory [45], and this provided, "for the first time, both quantitative and qualitative statistical data, and comparative analyses with regard to clusters' situation in Europe. The Objective of the European Observatory of Clusters is to inform the decisional factors interested in the European clusters and in the policies in this field. The researches and studies achieved by this observatory in over 30 European states have led to the identification of over 130 national measures to support clusters, which could be classified as clusters policies".

Clusters' financing initiatives have been mainly represented by the structural funds and the European funds, among which the most representative is the Competitiveness Operational Program (COP) which was approved by the Decision no. 10233 for Implementation of the Commission on 19.12.2014.

3.5 Medium and long term sustainability plan of the cluster

Sustainability represents the element (criterion) that highlights the fact that a cluster is viable even after its financial sustainability from public funds is over; the criterion that brings credibility that, the cluster may generate the activities/services it has been created for. The regional, local and central public authorities must contribute to the development of clusters' vision and mission and to sustain the collective actions in order to consolidate the competitiveness of the SMEs.

3.6 Association and management structure of the cluster and the management entity of the cluster

The organization that provides the management of the cluster "may consist in all the members of the cluster or only part of them. In case of an innovative cluster, the management entity must also be able to carry out, conform to the statute, research-development-innovation activities".

3.7 Clusters and Smart specialization strategies – similarities and differences

However, there are differences between the clusters and the smart specialization strategy S3, RIS3 focusing more on certain sectors with innovative intensity, while clusters apply to a wider set of sectors within the economy [54].

3.8 Clusters' policies in Europe

3.8.1 Regional plans for clusters' support

Usually, the support plans of clusters focus on two elements:

- ✓ financial support for cluster's operation.
- ✓ existing personnel in the cluster.

In order to sustain the development of a cluster, the regional/national authorities develop different funding schemes and programs for the training of the existent personnel [57].

3.9 National programs for regional clusters

These types of programs are similar to the ones dedicated to the regional clusters, but more selective; it is decided through assessment and competition which cluster is to receive financial support. These types of programs are especially dedicated to the management of the clusters, in order to use these structures for channeling the support for activities that are specific for innovation or modernizing/improvement of the SME activity.

3.9.1 National efforts (financial) for regional clusters

These programs increase both the selectivity level, and the funding in relation to the largest national programs dedicated to clusters. Emphasis is also put on competitiveness; such way that clusters may "compete" with the most competitive European/international clusters. There are certain funding programs, dedicated to the management of clusters, but most funding is to support both the collaboration actions among the entities making up the cluster, and for the collaboration actions with the business environment.

3.9.2 Support for cluster programs

The European initiative for excellence within clusters' field – "*Among the objectives of the European Commission we also find the promotion of excellence in cluster's management, the internationalization of clusters and network construction. The central European instrument for the implementation of the projects for sustaining clusters' development is the European Excellence Clusters Initiative which brings together experts and organizations from the whole*

Europe, in order to identify and establish new sets of qualitative indicators and procedures based on some external assessments on cluster's management. The initiative firstly aims to create a methodology for the development and assessment of the clusters in order to improve the management of the internal processes and of the way they produce or offer services. Secondly, the program aims the development of the materials that are necessary to inform and train clusters' managers in order to develop their managerial capacity"[63].

3.9.3 Benefits of cluster programs

The cluster programs are intended to achieve some economic results, for ex. higher wages and employment, increase of the value added, increase of exports etc. The efforts for the development of clusters have a direct impact on these results, especially due to founding some companies or acceleration of the innovation activity. Clusters need the support of the regional/national governments to actively participate in their funding in order to improve the competitiveness of the companies in a certain location/region and they help the companies to better mobilize the assets available in the said location/region.

3.9.4 Contributions of clusters and cluster policies to smart specialization strategies

The policies regarding the clusters may offer a set of basic instruments necessary for the development of the economic sectors in a region they have a significant position.
Clusters have the capacity to guide the concentration and integration of the economic policies around some fields that are specific for economy. Clusters may help avoid the "traps" of the traditional industrial policies that often use instruments that limit competition and ultimately, competitiveness.

3.9.5 The role of cluster policy in smart specialization strategies

Both clusters and cluster policies represent, for many regions, the essential elements in the development and implementation of RIS3. The smart specialization strategies integrate cluster policies into a wider area of transformation of the whole regional economy, and supplement the cluster policies with other guidelines regarding the field of technology / knowledge. The cluster based analysis and the type of cluster policies implemented in RIS3 go beyond the current practice of policy in the clusters field; they should be adapted to the regional environment, at the maturity level of the cluster and should observe a list of rules of good practice, including the capacity to address new emergent fields.

Chapter 4. SMART SPECIALIZATION STRATEGIES AND THE CLUSTERS

The practical experience with smart specialization strategies is still limited at European Union level, due to the fact that the regions and the member states have started to work with them starting with the period 2011-2012. However, a series of problems are already visible from the existent initial efforts, and from the wider history of the regions with regard to the development policies in Europe. These highlight critical elements the cluster policies may contribute to in order to improve them.

4.1 Smart specialization strategies: practical challenges

The concept of Smart Specialization Strategy has been officially approved within the Cohesion Policy of the European Union, in regions and member states that want to have access to these EU funds. The RIS3 process is an iterative process: the development of the strategy is not an event happening "once forever", but a process over time that involves the interaction among partners and that constantly forms and changes the priorities and circumstances. RIS3 are evolution policies as they aim to develop new perspectives for the regional economies and

these ways continuously change due to the external requirements and internal changes that can occur at any time.

4.2 The elements of smart specialization strategy process (RIS3)

The functioning of "the smart policies" requires the setting up of some monitoring and assessment practices and of some instruments that are well connected to the making decisions process. The allotment of clear and measurable objectives to all the elements of the "policies mix", the measurement of results in relation to the expected benefits, reviewing the instruments in relation to the results of impact's assessment, all these are elements necessary to elaborate smart policies and which should be part of a smart specialization strategy.

4.3 Clusters and cluster policy: practical challenges

Cluster policies have increased in the last two decades from an experimental policy instrument used by few "innovators" to a popular instrument for economic development, especially at regional level. The concept of cluster [69] has been especially adopted within the multilateral policy of cooperation context.

Cluster policy is often used as if a generally accepted definition of this term existed, describing a homogeneous set of current public interventions. However, the empirical evidence is quite different, as there are different regions and countries that gave different answers with regard to these cluster policies and of what they would like to obtain from the cluster policy. The variety of policies regarding clusters is connected (at least) to the differences in the targets they have, what instruments they use and the governments launching them.

4.4. Situation from Romania in the field of clusters

Similar to the Scientific and Technological Parks, a cluster is coordinated by a management entity. The management entity is established in order to represent the cluster in its relationship with third parties and that may belong to any type of actors constituting the cluster. In Romania, due to the conditions imposed by the structural financing programs (operation O1.3.3 dedicated to the "integration of SMEs in suppliers and clusters' chains" – adherent to POS CCE 2007-2013 or the action "Innovation clusters" within POC 2014-2020), the management entities are of the type of associations that contain minimum 10 SMEs and a RDI organization.

4.5 Cluster vs. Competitiveness Pole

There is practically no difference between the two cluster entities and the competitiveness pole. The term cluster is used by the Anglo-Saxon channel and the term competitiveness pole is used by the French channel. However, in Romania there are conceptual differences that are imposed by the structural funds.

4.6 Regional clusters

The "regional cluster" approach based on similarity is an old one, in its principles about economy as Marshall has already mentioned in the "industrial districts" [74]. According to Marshall, the development of regional clusters has involved lately, because of the existence of the competitive advantages. "*The causes by which localized industries have been originated are various. But the chief of them have been physical conditions…Another chief cause has been the patronage of a court…Such natural advantages may themselves have stimulated free industry and enterprise: but it is the existence of these last, by whatever means they may have been promoted, which has been the supreme condition for the growth of noble forms of the arts of life.*"

4.7 Sector Mega-clusters

Porter's book from 1990 [72], represents the dynamic force behind the sector approach, which connects the sectors from Romania, the so-called mega-clusters. Analyzing Porter's "mega-cluster" it was found out that it incorporates 16 clusters or possible clusters that are divided into three major industrial groups (forerunners, with support role, for final consumption/ goods and services).

4.8 Innovative cluster

The "innovative cluster" concept has the following dimensions:

- Supplier-client relations, based on neo-classical economy theory.
- The influence of cities, as growth poles.
- The influence of the research institutions and universities, as excellence poles.
- The complex relations among different involved actors.

4.9 Horizon Europe & European Digital Innovation Hubs (EDIHs)

4.9.1 The cohesion policy of the European Union 2021-2027

In the new programming period of the **cohesion policies** there are **five policy objectives** for investments [80]:

- ✓ ***A more intelligent Europe,***
- ✓ ***An Europe with lower carbon emissions and more ecologic***,
- ✓ ***A more connected Europe***,
- ✓ ***A more social Europe***,
- ✓ ***A Europe closer to the citizens***

4.9.2 THE INSTRUMENT "EUROPEAN DIGITAL INNOVATION HUBS (EDIHS) – European digital innovation hubs"

The European Digital Innovation Hubs (EDIHs) will function as "unique working points" [81] which will help the entities to dynamically respond to digital challenges and become more competitive on the market, and the implementation of the *European Digital Innovation Hubs* (EDIHs) *Instrument* is to be achieved by the financing of some projects that is to be achieved in a percentage of 50%, through the European program "Digital Europe", and the financial difference should be covered by programs at national level, such as RDI IV National Program and the Operational Program of Smart Development, Digitization and Financial Instruments, the National Recovery and Resilience Plan and the Regional Operational Plan. Thus, the investments in the Digital Innovation Hubs are to be sustained and performed conform to the good practices elaborated by the Joint Research Centre of the European Commission (JRC 2021, European Digital Innovation Hubs in Digital Europe Program).

PART II

Chapter 5: RESEARCH REGARDING THE CORRELATIONS AMONG THE CLUSTERS' PERFORMANCES, THE SMART SPECIALIZATION STRATEGIES AND THE INNOVATION COMPONENT AT THE LEVEL OF THE DEVELOPMENT REGIONS IN ROMANIA – CASE SURVEY

5.1 The comparative analysis of the economic performance of the development regions in our country based on criteria-cumulating: innovation, smart specialization and clusters

5. 1.1 Methodological aspects

This chapter aims to achieve a ***comparative analysis of the economic performances of the development regions in our country, by cumulating some criteria aiming the smart specialization strategies, the innovation performance and the development of clusters/competitiveness poles.***

From the methodological point of view, it is started from the concept of ***composite indicators***, concept developed especially in connection with innovation performance analyzed at national and regional level, under the form of *European Innovation Scoreboard (EIS)* and *Regional Innovation Scoreboard* (RIS) annually achieved by the European Commission.

5.1.2 The European Innovation Scoreboard at national and regional level

The European innovation scoreboard at national level (EIS) uses a ***composite innovation index*** [103]**.** It is annually used to measure the innovation performance in the European countries. EIS, formerly denominated ***the Scoreboard of Innovation Union***, is used as an important instrument for the assessment of the relation between the strengths and weaknesses of the national innovation systems and helps the countries to identify the areas of interest. ***The Innovation Summary Index*** is calculated as a weighted average of the standardized innovation indicators.

5.1.3 Application of the smart specialization concept at regional level

The work "Regional foresight and dynamics of smart specialization" [108] analyzed the smart specialization concept and its development at regional level. Thus, the smart specialization concept has come to play a major role in supporting Europe 2020 agenda with regard to jobs and economic growth.

5.1.4 Structural similitude and composite indicator based on the concept of smart specialization at regional level

In the work "Regional benchmarking in the smart specialization process: Identification of reference regions based on structural similarity" there are analyzed the ways in which comparable regions can be determined based on the criteria specific for smart specialization strategies [119].

Analyzing different bibliographical references which tried to specify the context factors that make the territories more comparable among them, there were identified ***six dimensions:*** *geodemography, human resources, technological specialization, economy's and industry's specialization, the dimension of the companies and the international opening.*

5.1.5 Regional analysis methodology of clusters' performance

CLUSTERO Method

In the work "CLUSTER COMPETITVENESS PLATFORM" [127] and in the study elaborated in October 2016 by CLUSTERO [65], it is presented this method that considers ***the quantitative and qualitative analysis*** based on a set of vectors/indicators and on some specific instruments. The analysis was carried out on 2 levels: at the level of the national economy and at regional level, that of the clusters".

European Cluster Excellence Initiative (ECEI) Method

On the other hand, a set of quality analysis indicators to be the basis of labeling clusters have been developed by Working Group 2 of European Cluster Excellence [128].

5.2 CASE SURVEY. APPLICATION OF THE COMPARATIVE ANALYSIS METHODOLOGY TO THE LEVEL OF THE DEVELOPMENT REGIONS LEVEL IN OUR COUNTRY

5.2.1 Regional innovation index in Romania in the year 2017

For year 2017, the regional values of RIS for our country are presented in table 2.6 [131].

Table 2.6 – Regional values of RIS for our country

Region	**RO11**	**RO12**	**RO21**	**RO22**	**RO31**	**RO32**	**RO41**	**RO42**
Regional Innovation Index 2017	**0.129**	**0.139**	**0.105**	**0.12**	**0.122**	**0.214**	**0.106**	**0.159**

5.2.2 The composite performance index based on smart specialization concept at regional level in Romania in the year 2017

Table 2.7 shows the data regarding the indicators taken into account, with regard to the smart specialization concept for the 8 development regions in our country.

Table 2.7 – Values of the indicators regarding the smart specialization concept for the 8 development regions in our country

Indicator's code (UM)	**RO11**	**RO12**	**RO21**	**RO22**	**RO31**	**RO32**	**RO41**	**RO42**
dem.pop.avg (%)	13,08	11,88	16,49	12,46	15,29	11,64	10,04	9,12
dem.pop.ge65. le15.avg.sh(%)	12,68	11,88	17,45	12,77	15,97	10,35	10,22	8,68
emp.sh.a (%)	12,16	10,63	15,68	17,69	19,20	1,27	12,56	10,81
emp.sh.b_e (%)	16,88	14,78	12,29	11,20	11,73	16,07	7,27	9,78
emp.sh.f (%)	17,89	12,22	10,60	9,85	11,13	22,90	6,19	9,21
emp.sh.g_i (%)	14,56	11,44	11,34	12,59	12,10	20,80	8,41	8,76
emp.sh.j (%)	13,54	9,67	8,67	6,08	6,95	43,50	4,61	6,97
emp.sh.l (%)	12,52	10,20	8,34	8,42	6,56	38,52	5,54	11,90
emp.sh.m_n (%)	13,21	10,97	8,35	8,38	7,93	37,16	4,68	9,32
emp.ma.sh.01(%)	20,67	13,14	9,13	10,34	14,50	12,10	8,73	11,38
emp.ma.sh.02 (%)	16,09	13,61	12,39	14,22	12,10	13,43	8,74	9,42
emp.ma.sh.03 (%)	17,48	12,77	15,09	9,68	10,74	17,63	7,29	9,32
emp.ma.sh.04 (%)	16,87	20,13	18,04	7,85	10,28	12,59	5,90	8,36
emp.ma.sh.05 (%)	16,56	13,49	11,23	9,88	13,47	18,20	8,60	8,58
emp.ma.sh.06 (%)	19,90	14,80	11,22	11,06	12,38	11,38	8,04	11,22
emp.ma.sh.07 (%)	18,60	16,05	9,69	11,33	12,28	14,24	7,09	10,72
emp.ma.sh.08 (%)	15,13	10,94	9,77	5,43	9,97	28,89	6,12	13,76
emp.ma.sh.09 (%)	16,74	15,74	11,76	6,55	10,69	23,53	5,22	9,78
emp.ma.sh.10 (%)	9,15	14,16	4,90	28,54	13,40	11,22	5,45	13,18
emp.ma.sh.11 (%)	17,69	15,39	11,14	12,09	9,38	18,58	6,06	9,68
pat.pct.filed (normalized indicator*)	**0,083**	**0,053**	**0,052**	**0,025**	**0,035**	**0,111**	**0,027**	**0,114**
exports.m_htech (normalized indic.*)	**0,363**	**0,516**	**0,46**	**0,452**	**0,649**	**0,56**	**0,881**	**0,856**
firm.size.avg (normalized indic.*)	**0,376**	**0,509**	**0,165**	**0,265**	**0,419**	**0,645**	**0,251**	**0,828**
educ.isced3_6.sh (%)	12,73	12,17	14,86	11,61	15,33	13,36	10,32	9,62

Obs.: *normalization involves reporting to the maximum value in the database subject to analysis (maximum value normalized indicator = 1 and the minimum value normalized indicator = 0)

Table 2.9 presents the ***values of the composite indicators*** with regard to the smart specialization concept for the 8 development regions in our country.

Table 2.9 – Values of the composite indicators regarding the smart specialization concept for the 8 development regions in our country

Region	**RO11**	**RO12**	**RO21**	**RO22**	**RO31**	**RO32**	**RO41**	**RO42**
Composite Indicator	**14,16**	**12,15**	**10,83**	**10,32**	**11,07**	**17,52**	**7,05**	**9,91**

5.2.3 Clusters' performance at regional level in our country

CLUSTERO method at the level of year 2016[65]

Table 2.10 presents the values obtained in the survey performed by CLUSTERO, at the level of year 2016.

Table 2.10- Correlation of the quantitative analysis methods at national and regional level

		C	Stars	P*	
1	IndAgro-Pol (RO32)	8.48	-	0.14	Manufacture of machines and installations
2	ALT Brasov (RO12)	7.88	-	0.16	IT&C
3	CLUJ IT (RO11)	7.18	-	0.16	IT&C
4	iTech Transilvania (RO11)	7.16	-	0.16	IT&C
5	TREC (RO11)	5.67	-	0.04	Renewable energy
6	IT PLUS (RO12)	5.54	-	0.16	IT&C
7	IMAGO-MOL (RO21)	5.01	*	1	Research-development
8	ELINCLUS (RO32)	4.96	-	0.09	Electronics
9	AgroTransilvania Cluster (RO11)	3.87	**	0.23	Food industry
10	MECHATREC (RO32)	2.68	-	0.11	Mechatronics
11	ETREC (RO12)	2.63	-	0.14	Electric
12	Transylvanian Mechanical Engineering (RO12)	1.92	-	0.09	Electronic
13	ASTRICO NE (RO21)	1.66	***	0.24	Textile
14	Romanian Textile Concept (RO32)	1.60	***	0.24	Textile
15	Agrofood Covasna (RO12)	1.38	**	0.23	Food industry
16	Cluster Mobilier Transilvan (RO11)	1.28	**	0.22	Wood and furniture
17	ROSENC (RO42)	1.07	-	0.04	Renewable energy
18	Transylvania Textile & Fashion (RO12)	0.92	***	0.24	Textile
19	Traditii Manufactura Viitor (RO22)	0.51	***	0.24	Textile
20	Green Energy (RO12)	0.26	-	0.04	Renewable energy
21	PRO WOOD (RO12)	0.15	**	0.22	Wood and furniture
22	Regional Balneoturistic Transylvania (RO12)	0.13	-	0.07	Tourism

By grouping the results of the assessment presented in table 2.6, by multiplying the values presented in columns C and P* the following performance indicators are obtained (table 2.11):

Table 2.11 –Clusters' performance indicators, CLUSTERO method

Region	**RO11**	**RO12**	**RO21**	**RO22**	**RO31**	**RO32**	**RO41**	**RO42**
Performance Indicator	3,69	4,57	5,41	0,24	0	2,31	0	0,04

Table 2.11.1 presents the values of the performance indicators of clusters, CLUSTERO method, resulted following scaling the reported values, such way all values be within the range 0…100.

Table 2.11.1 – Clusters' performance indicators, CLUSTERO method

Region	**RO11**	**RO12**	**RO21**	**RO22**	**RO31**	**RO32**	**RO41**	**RO42**
Performance Indicator	68.21	84.47	100.00	4.44	0.00	42.70	0.00	0.74

European Cluster Excellence Initiative (ECEI) method at the level of year 2017

Following the grouping on regions, the following distribution of scores resulted, distribution presented in the table below:

Table 2.12 – Clusters' performance indicators, ECEI method

Region	**RO11**	**RO12**	**RO21**	**RO22**	**RO31**	**RO32**	**RO41**	**RO42**
Score	**18**	**9**	**3**	**9**	**1**	**14**	**6**	**7**

Table 2.12.1 presents the values of the performance indicators of clusters, ECEI method, resulted following scaling the reported values, such way all values be within the range 0…100.

Table 2.12.1 – Clusters' performance indicators, ECEI method

Region	**RO11**	**RO12**	**RO21**	**RO22**	**RO31**	**RO32**	**RO41**	**RO42**
Score	100.00	50.00	16.67	50.00	5.56	77.78	33.33	38.89

5.2.4 The composite performance index based on innovation, smart specialization and clusters at the level of the 8 development regions in our country

By cumulating all the results presented on point 5.2.1 ÷ 5.2.3 ș*and* by applying a reporting procedure of the results at the maximum values in each line, in order to express in percentages variables whose values are perfectly comparable, of normalized type values previously presented, **plus** a mediation of the clusters' performances values, assessed through CLUSTERO and ECEI methods, there are obtained the following ***composite regional performance indicators, by arithmetic mediation of the values of the analysis criteria with regard to innovation (RIS2017)***, Smart specialization and clusters' development (Clusters relatively level-headed at maximum) in table 2.13:

Table 2.13 – Regional performance indicators on innovation fields, S3, clusters and composite indicator

	RO11	**RO12**	**RO21**	**RO22**	**RO31**	**RO32**	**RO41**	**RO42**
RIS2017	60,28	64,95	49,07	56,07	57,01	100,00	49,53	74,30

Smart specialization (S3)	80,81	69,35	61,80	58,90	63,15	100,00	40,21	56,55
CLUSTERO Clusters	68,21	84,47	100,00	4,44	0,00	42,70	0,00	0,74
ECEI Clusters	100,00	50,00	16,67	50,00	5,56	77,78	33,33	38,89
Level-headed clusters	100,00	79,95	69,36	32,36	3,30	71,62	19,82	23,56
Composite Indicator	80,36	71,42	60,08	49,11	41,15	90,54	36,52	51,47

Chapter 6: THE USE OF NEURONAL NETWORK METHOD TO VALIDATE A CORRELATION BETWEEN THE INNOVATION CAPACITY OF CLUSTERS AND THEIR DEVELOPMENT STRATEGIES

6.1. Presentation of the method

The Artificial Neuronal Networks (ANN) represent an important component within the Artificial Intelligence field (AI) and are currently a research object not only in the field of neuroinformatics, as happened in the years 1940 (Warren McCulloch and Walter Pitts highlighted the first formal model of the neuron), 1950 (Frank Rosenblatt achieved a hardware implementation, called *perceptron*). The artificial neuronal networks characterize sets of elements of simple processing, strongly interconnected and operating in parallel, which aim to interact with the environment in a similar way to biological brains and that have the ability to learn.

6.*2 Synthetic analysis of the evolution of clusters surveyed during the period 2016-2020*

The questionnaire was applied for the 27 clusters, grouped in the following three categories:

- 4 clusters from Romanian top GOLD category (G) at international level;
- 10 clusters from the Romanian top within BRONZE_SILVER category (B_S) at international level;
- 13 active clusters in Romania (with no distinction).

The results obtained on **industrial sector** by the 14 top clusters:

	GOLD	SILVER	BRONZE
Minerit şi industria extractivă			
Industria alimentară de medicamente	1	2	2
Industria textilă şi de încălţăminte		2	2
Industria de prelucrare a lemnului	1	1	1
Industria chimică, farmaceutică, prelucrătoare a petrolului			
Industria prelucrătoare, extractivă			
Metalurgie			
Industria electrică, electronică, IT şi echipamente optice	1	4	4
Industria de maşini		2	2
Echipamente de transport		1	1
Alte sectoare industriale	1	4	5

From the analysis of the **quantitative indicators** presented in the table above, comparing 4-G & 10B_S vs 13 ACTIV_RO result the following data presented in the table:

Caz		4-G & 10B_S	13 ACTIV_RO
1	CA (din total CA)	63.49%	36.51%
2	Nr. Intreprinderi (din total Intreprinderi)	75.62%	24.38%
3	CDI (din total CDI)	95.10%	4.90%
4	Nr. Angajați (din total Angajați)	71.90%	28.10%
5	Nr. Salariaţi cu studii superioare (din total Salariaţi cu S.S.)	76.22%	23.78%
6	TOTAL INOVARE ŞI PATENTE (din total I_P)	78.55%	21.45%
7	CDI / CA	4.96%	0.44%
8	CDI / TOTAL INOVARE ŞI PATENTE (LEI/I&P)	552,885	104,240

6.3. The method of Osgood environments based on scaling

The method is based on the semantic differential and represents the most used scaling method and the most frequently used in marketing research. The foundation of this method has been laid by the psychologist Charles E. Osgood even since 1957 and subsequently, through the contribution of several specialists many variants were designed and achieved being adapted to the specific of the marketing research. The analyzed characteristics have a series of bipolar attributes. A scale has been inserted between the two poles of each characteristic, scale that is recommended to have between 5-7 levels.
The questionnaire applied to the clusters from Romania is interpreted by using 5 levels of appreciation for each analyzed characteristic.

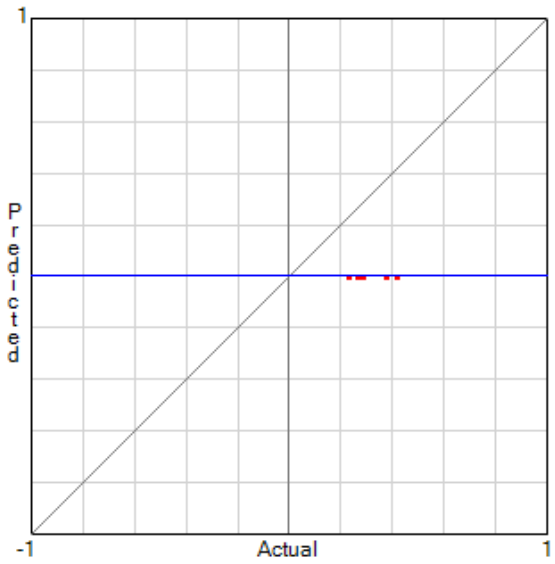
6.4 The validation of the artificial neuronal networks method ANN for establishing correlations between the innovation capacity and the development strategies

In order to achieve the set of data necessary for ANN training and validation with backward propagation the Osgood average calculated in the previous paragraph is used, resulting in the following table:

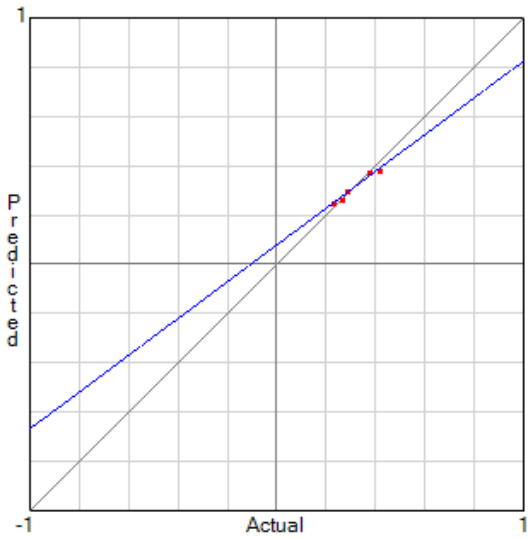
Nr. Q	4 - G	10 B_S	13 ACTIV_RO
2.1	2.93	2.92	2.30
2.2	3.11	2.96	2.66
2.4	3.50	3.20	2.82
2.5	4.17	4.05	4.16
2.6 a)	4.08	4.00	3.75
2.6 b)	3.42	3.38	3.49
2.7 b)	4.25	4.48	4.14
2.8	4.25	4.00	3.92
2.9	7.75	7.7	5.83
2.10 b)	4.75	7.63	4.83
2.11 b)	3.81	3.69	3.98

Visual Gene Developer software program, version 1.9 is used for modeling and simulation. This software (VGN) allows subunit input values. The set of data presented above is transposed in subunit values (by dividing by 10) and the following table has been obtained:

Nr. Q	4 - G	10 B_S	13 ACTIV_RO
2.1	0.293	0.292	0.230
2.2	0.311	0.296	0.266
2.4	0.350	0.320	0.282
2.5	0.417	0.405	0.416
2.6 a)	0.408	0.400	0.375
2.6 b)	0.342	0.338	0.349
2.7 b)	0.425	0.448	0.414
2.8	0.425	0.400	0.392
2.9	0.775	0.770	0.583
2.10 b)	0.475	0.763	0.483
2.11 b)	0.381	0.369	0.398

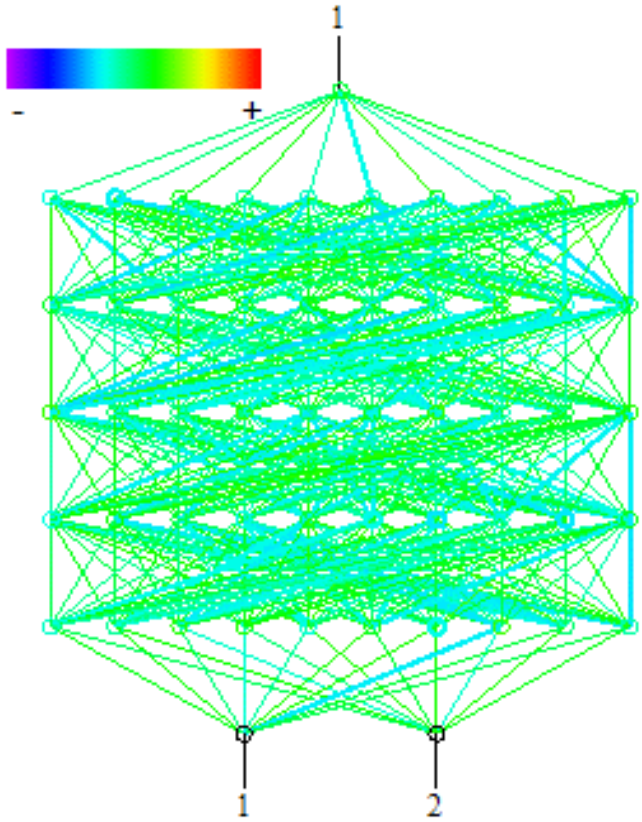


a) initial

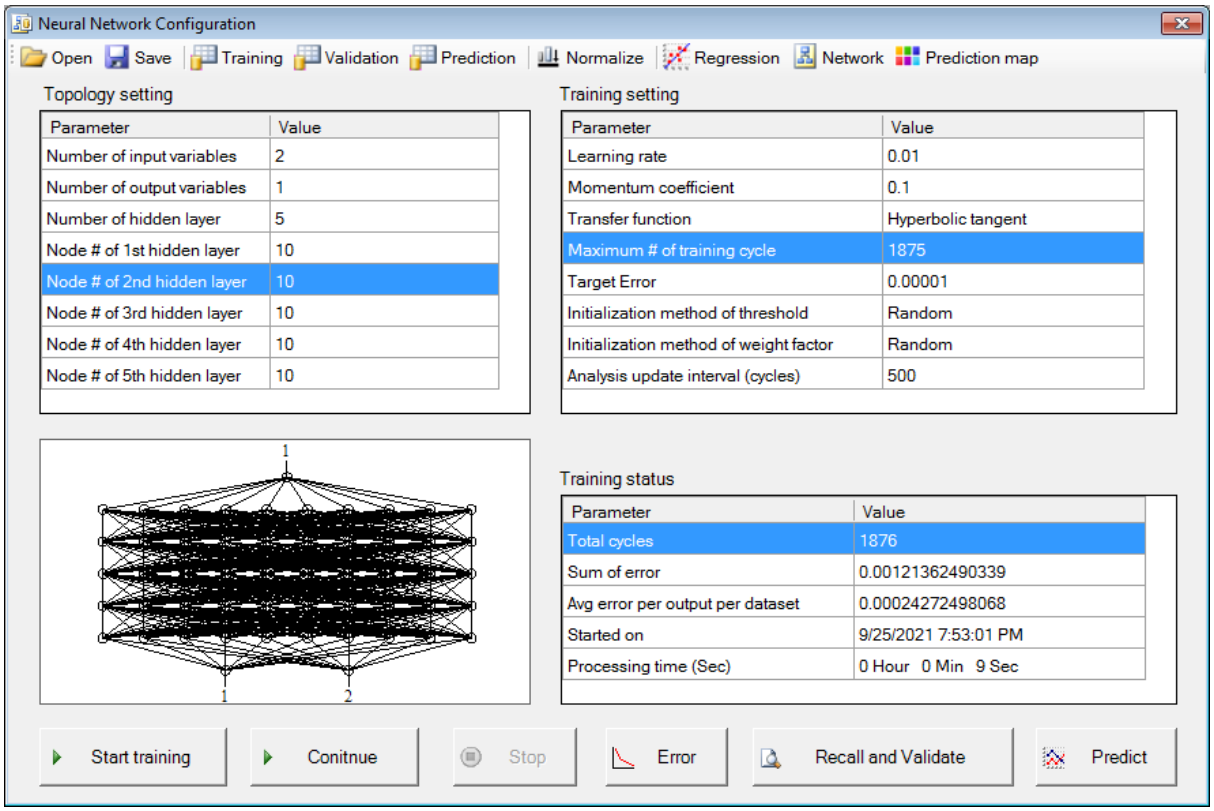


b) final

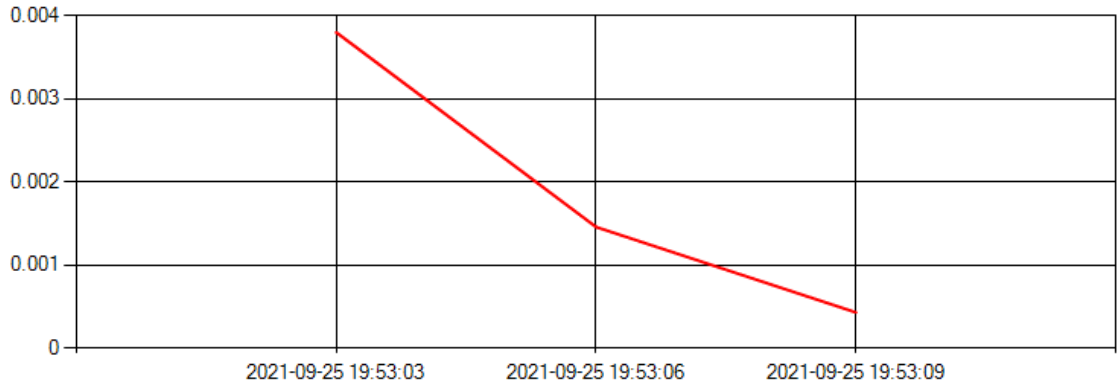
The slope of the regression coefficient r^2



ANN architecture and the informational flow



ANN architecture and settings



Evolution of error

Coef. de regresie	Panta	Intercepția axei Y
0.96	0.746	0.079

Regression coefficient - Slope Interception of Y axis

Validation Prediction

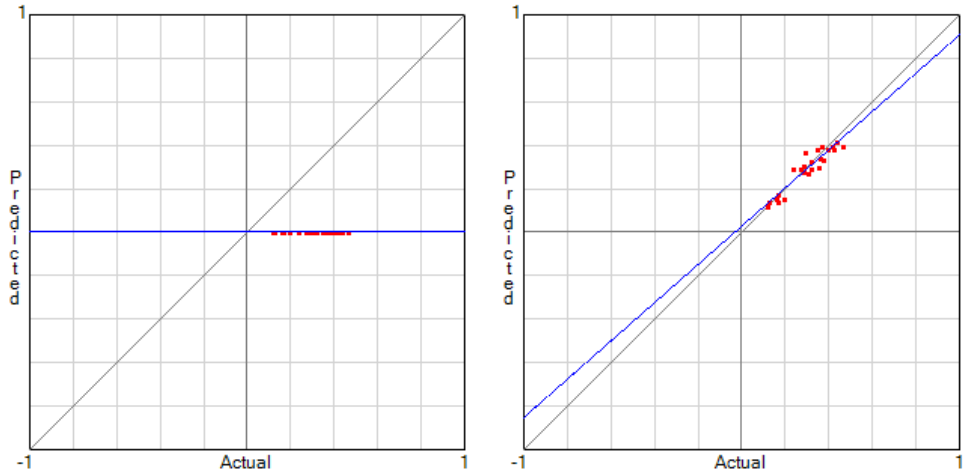
Validare	Predicție	%
0.349	0.305	87.27%
0.414	0.418	100.94%
0.392	0.391	99.76%
0.583	0.632	108.35%
0.483	0.563	116.51%
0.398	0.348	87.46%
Media %		**100%**

The architecture obtained for ANN leads to an accuracy of estimates close to 100%, for a regression coefficient of 0.96.

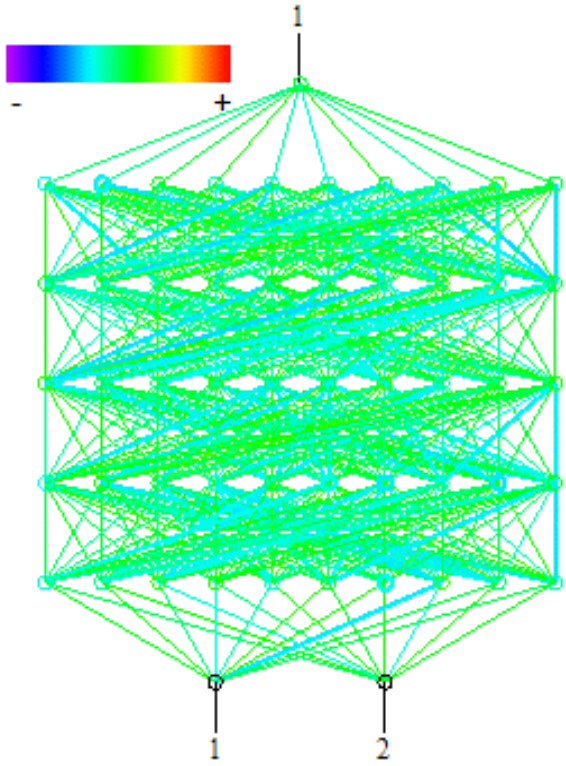
The ANN architecture, obtained by validation, is used to predict the individual components (presented in the following table) of each Osgood average. It goes from a 11x3 matrix (based on Osgood averages) to one of 33x3, three times larger, based on the individual components of the responses (without calculating Osgood averages).

INITIAL			SCALED		
INIȚIALE			DEMULTIPLICATE		
4 - G	**10 B_S**	**13 ACTIV_RO**	**4 - G**	**10 B_S**	**13 ACTIV_RO**
4.25	4.10	3.46	0.425	0.410	0.346
4.25	3.90	2.92	0.425	0.390	0.292
3.25	3.30	2.69	0.325	0.330	0.269
3.25	3.20	2.33	0.325	0.320	0.233
2.00	2.00	1.58	0.200	0.200	0.158
1.75	2.30	1.92	0.175	0.230	0.192
1.75	1.67	1.18	0.175	0.167	0.118
5.00	4.30	4.38	0.500	0.430	0.438
5.00	3.70	3.69	0.500	0.370	0.369
3.00	3.10	3.07	0.300	0.310	0.307
3.25	3.00	2.86	0.325	0.300	0.286
1.75	2.11	1.67	0.175	0.211	0.167
2.00	2.40	1.69	0.200	0.240	0.169
1.75	2.11	1.27	0.175	0.211	0.127
3.50	3.20	2.82	0.350	0.320	0.282
4.75	3.90	4.62	0.475	0.390	0.462
3.50	4.10	3.62	0.350	0.410	0.362
4.25	4.15	4.23	0.425	0.415	0.423
4.50	4.22	4.17	0.450	0.422	0.417
3.75	3.50	3.73	0.375	0.350	0.373
3.50	3.67	3.17	0.350	0.367	0.317
3.25	3.25	3.18	0.325	0.325	0.318
4.25	4.11	3.92	0.425	0.411	0.392
3.25	3.38	3.55	0.325	0.338	0.355
4.50	4.56	3.91	0.450	0.456	0.391
4.25	4.78	3.92	0.425	0.478	0.392
4.00	4.10	4.14	0.400	0.410	0.414
4.25	4.00	3.92	0.425	0.400	0.392
4.75	4.63	4.83	0.475	0.463	0.483
4.75	4.20	4.75	0.475	0.420	0.475
3.50	3.8	3.57	0.350	0.380	0.357
3.00	2.75	3.60	0.300	0.275	0.360
4.00	4.00	4.00	0.400	0.400	0.400

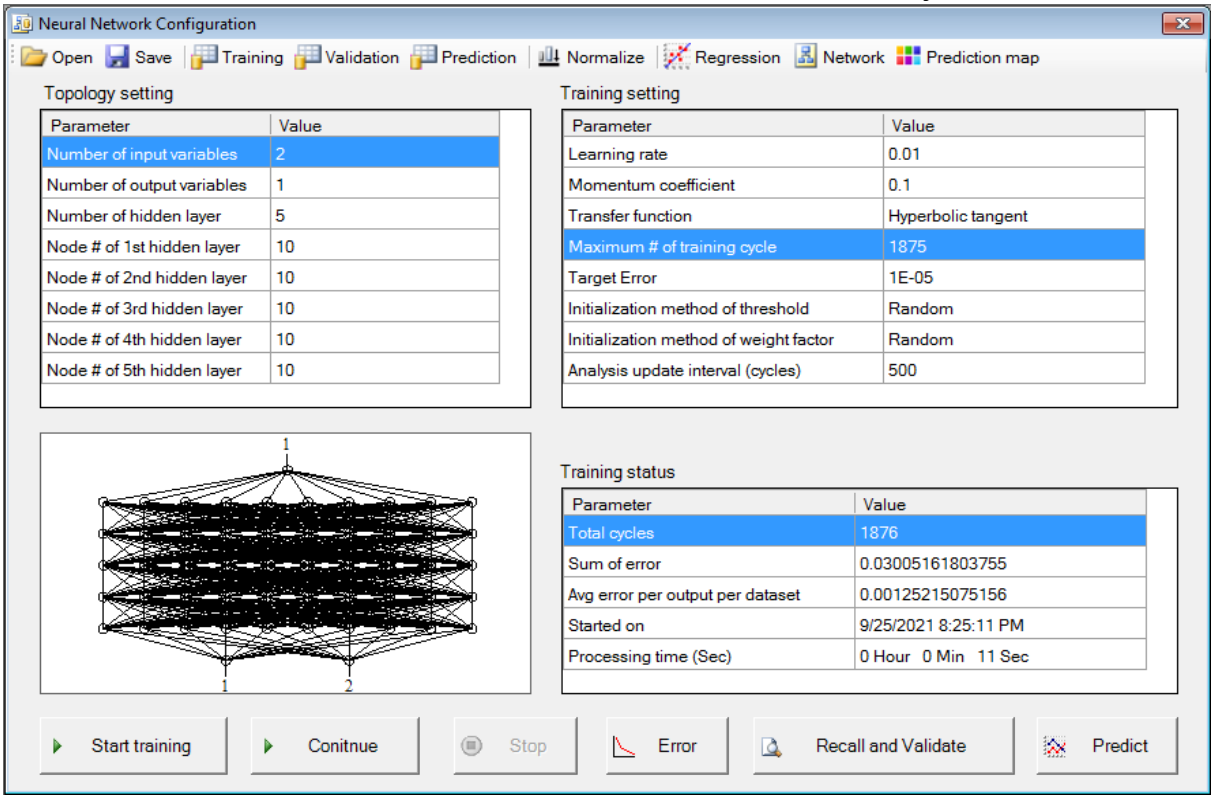
The used colors have the same significance as in case of 11x3 matrix.



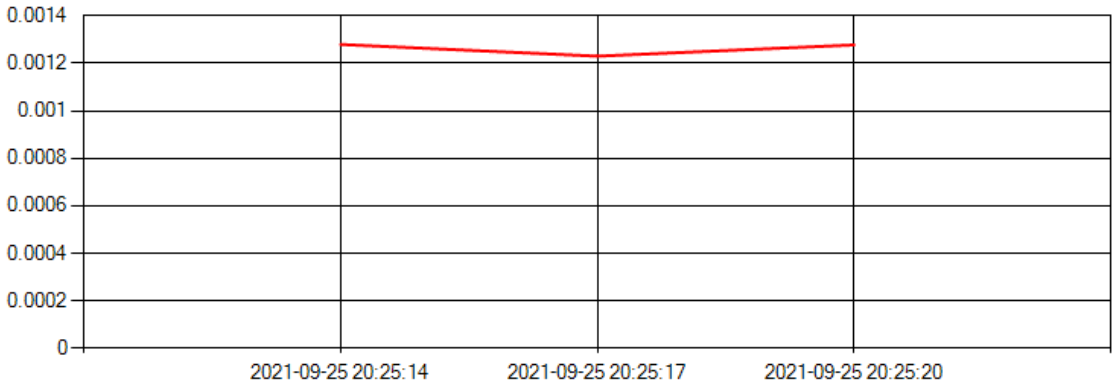
Slope of r^2 regression coefficient – instruction cycles 1875



ANN architecture and the informational flow – instruction cycles 1875



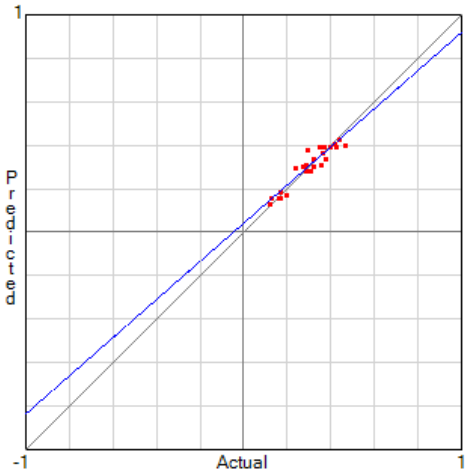
ANN architecture and settings – instruction cycles 1875



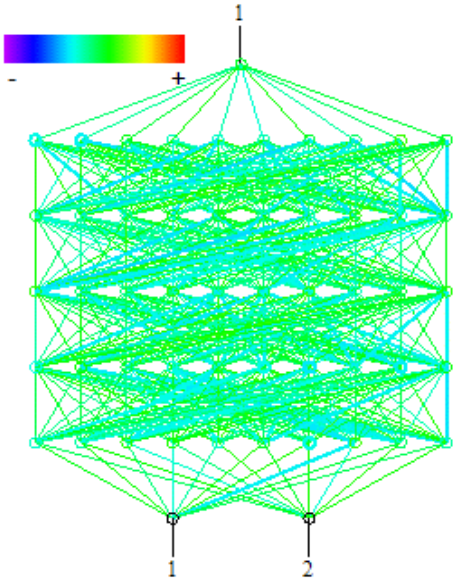
Error evolution – instruction cycles 1875

Regression coeff. Slope Interception of Y axis

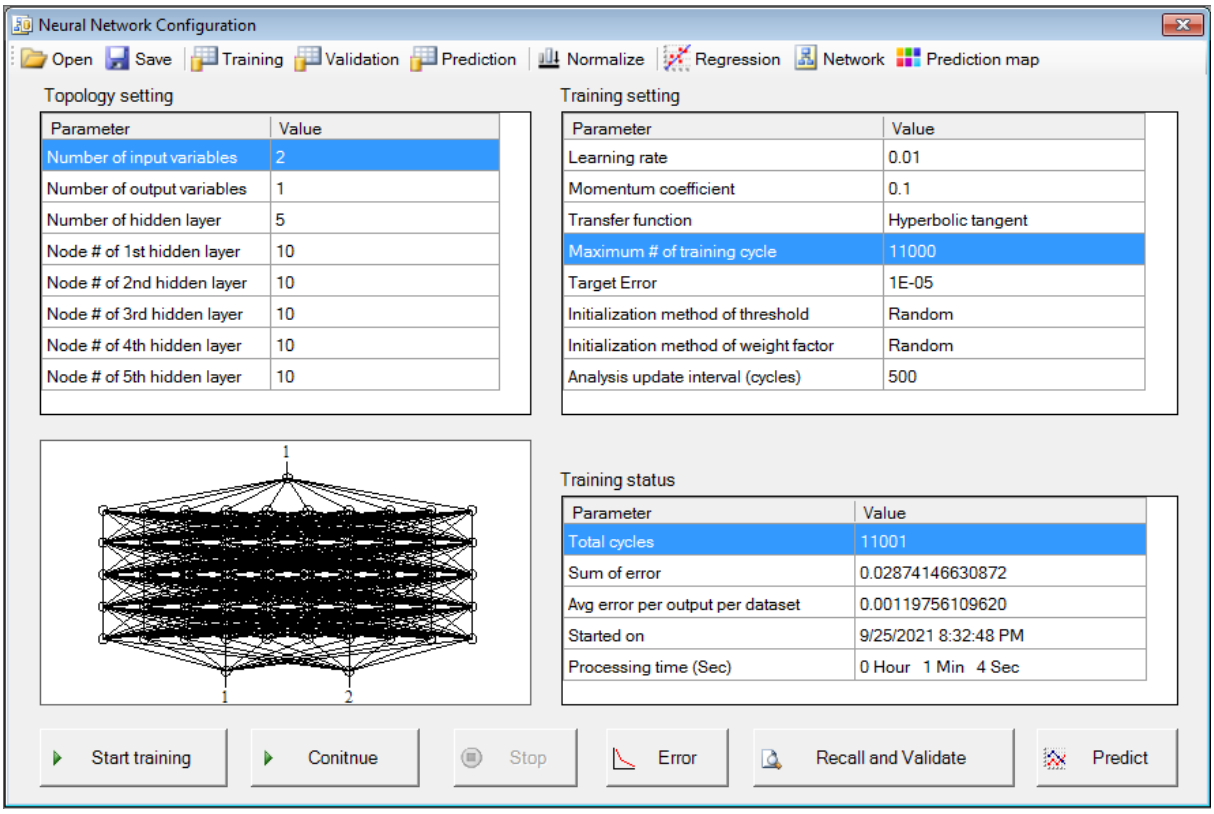
Coef. de regresie	Panta	Intercepția axei Y
0.88	0.880	0.028



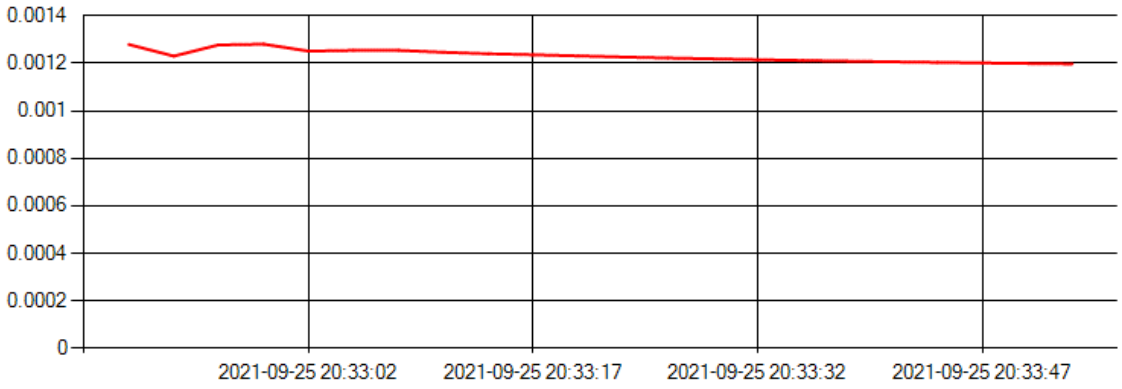
Slope of r^2 regression coefficient – instruction cycles 11.000



ANN Architecture and informational flow – instruction flows 11.000



ANN Architecture and settings – instruction flows 11.000



Error evolution – instruction flows 11.000

Regression coeff. Slope Interception of Y axis

Coef. de regresie	Panta	Intercepția axei Y
0.88	0.878	0.042

cicluri instruire	1875		11000	
0.391	0.407	104.22%	0.428	109.45%
0.392	0.405	103.35%	0.431	109.92%
0.414	0.368	88.84%	0.385	92.87%
0.392	0.375	95.73%	0.388	98.98%
0.483	0.420	86.93%	0.440	91.08%
0.475	0.404	85.10%	0.417	87.81%
0.357	0.330	92.49%	0.347	97.18%
0.360	0.253	70.27%	0.257	71.35%
0.400	0.364	90.92%	0.379	94.66%
		90.87%		94.81%

Data accuracy for an ANN architecture that uses the matrix for 11x3 is close to 90% and should be improved. If the number of the instruction cycles is increased from 1.875 to 11.000 (for 5.87 times) the accuracy increases with 4%, reaching 94,8%, close to an acceptable level.

There have been also identified other 3 types of architectures (the case of matrix 33x3) for which there were obtained accuracies estimated around the value of 94 %, conform to the following table.

Arhitectură RNA	2 s / 5 n		2 s / 15 n		1 s / 200 n	
Cicluri instruire	200,000		30,000		200,000	
0.391	0.429	109.60%	0.427	109.09%	0.426	109.05%
0.392	0.433	110.58%	0.429	109.53%	0.430	109.77%
0.414	0.381	92.13%	0.383	92.60%	0.381	91.92%
0.392	0.384	97.89%	0.387	98.60%	0.383	97.77%
0.483	0.441	91.34%	0.439	90.80%	0.439	90.90%
0.475	0.414	87.16%	0.415	87.46%	0.413	87.04%
0.357	0.343	95.95%	0.347	97.08%	0.343	95.96%
0.360	0.249	69.16%	0.256	71.02%	0.250	69.33%
0.400	0.375	93.69%	0.377	94.37%	0.374	93.55%
		94.17%		94.50%		93.92%
s - strat ascuns						
n - nod pe strat ascuns						

s – hidden layer
n – knob on hidden layer

6.5 Conclusions

By using ANN method, a model able to validate the input data from the analyzed clusters was obtained.

To validate the values analyzed as indicators of the clusters, it is recommended to use the same ANN architecture provided that the number of the instruction cycles be increased by, at least, 2 times for each increase with 100% in size of the matrix given the initial one.

The minimum regression coefficient r^2 for obtaining accurate valuations (errors below 5%) is at least of 0.9.

PART III

Chapter 7: GENERAL CONCLUSIONS, PERSONAL CONTRIBUTIONS AND THE DIRECTIONS FOR CONTINUING THE RESEARCH

7.1. GENERAL CONCLUSIONS

The following aspects result from the quantitative and qualitative analysis performed on a number of 27 clusters, CLUSTERO members:

a) the existence of a correlative relationship between the number of clusters in a region and the labour force (weight, specialization and qualification degree) existent at the level of the said region,

b) the existence of a correlative relationship between the number of clusters in a region and the volume of RD expenditure in that region,

c) the existence of a correlative relationship between the number of clusters in a region and competitiveness (the level of the regional GDP),

Therefore, Bucharest-Ilfov region significantly stands-out from the other development regions in terms of both competitiveness as level of the recorded GDP, and as impact of the research-development activity. Nevertheless, by observing Pareto's rule, South-Muntenia region that has the lowest number of clusters records the next level of GDP at the level of year 2017 compared to the other regions. Thus, the regional competitiveness is not determined by the number of clusters, but, by the competitiveness of each cluster, individually, the expenditure for research-development and the labour force significantly influencing the results of a cluster, and not their number.

Based on the comparative analysis of the economic performance of the development regions in our country, by cumulating some criteria aiming smart specialization strategies, the innovation performance and the development of clusters/competitiveness poles, the following can be concluded:

1. Region RO32 is the best performing both at composite level, and at the innovation level and smart specialization, the cluster component being less developed, in terms of lack of interest in using this modern instrument for performance increase, also correlated with the advantages obtained through economic and geo-political concentration around the capital city of our country (over 40% of the GDP being achieved in this geographical area of Romania);

2. On the 2nd place, at the level of the composite indicator, is placed region RO11, where the cluster component and the smart specialization represent a dynamic factor exploited at the highest level in our country, while the innovation component, based on research-development, does not reach the same level of performance, but has a significant potential of growth on medium and long term;

3. On the 3rd place, at the level of the composite indicator, is placed region RO12, which also benefits from the most balanced ratio among the three analysis components (innovation, smart specialization and clusters), which is due to a favorable geographical location (the centre of the country), to a significant industrial tradition, in spite of the changes that occurred in the last 30 years and to a favorable proximity to RO11, from the perspective of foreign investments of strong companies, in high technological fields;

4. A similar situation is also found in region RO21 (placed on the 4th place, at the level of the composite indicator), with the same balanced ratio among the three analysis components (innovation, smart specialization and clusters) and contradicting the idea used at public level of a weakly developed region. It is to be noted that in this region has been achieved through smart

specialization strategy in our country and that there existed a significant industrial tradition but, unfortunately, totally inadequately valorized

5. Regions RO22 and RO42 are placed on modest and comparable places, with the mention that they benefit from privileged geographical locations, RO22 comprising the gateway in the country on the Black Sea, and RO42 having the best Western proximity of Romania, with traditional economic connections with Serbia and the Western Europe, but inadequately valorized at the moment;

6. On the last places are regions RO31 and RO41, especially in the field of clusters' development, where the situation is very deficient, partially compensated by the existence of Dacia-Renault Group and Ford, and the innovation and smart specialization are placed at levels comparable to the averages existent at national level.

7.2 PERSONAL CONTRIBUTIONS OF THE AUTHOR

In this paper there was performed a detailed analysis the performance of clusters from Romania on the managerial component and the results obtained in their activity, in accordance with the smart specialization strategies.

7.2.1. Methods proposed for the elaboration of an assessment methodology of the performance

The analysis of the specialized literature has led to the identification of a portfolio of methods that can prove their utility in consulting the scientific community and of the responsibility factors with regard to the professional performance and of the satisfaction degree in the scientific research career.

Thus, four categories of methods can be identified:

- *quantitative methods*;
- *qualitative methods*;
- *foresight*;
- *innovative methods* (include research methods that, traditionally, have been associated to other research issues).

Thus, there was achieved a questionnaire template that has been sent to be filled in to a number of 27 clusters, and based on the received answers, there were performed both quantitative analyses, and qualitative vectors have been set up.

7.2.2. Quantitative indicators

A number of 14 quantitative indicators were proposed, these being framed within 3 different classes: market, internal factors, innovation and technology.

7.2.3. Analysis of the qualitative vectors

Another method used by the author is the method of ***qualitative vectors analysis*** achieved by selecting the indicators that are relevant for clusters' activity: concentration, labour force, R&D and innovation, cooperation, catalyst and internationalization.

In this paper the author identified the main qualitative vectors and elaborated their qualitative analysis, analysis consisting in identifying the connections or dependences among the indicators **with relevance for clusters' activity** and the way they influence the activity of a cluster. The identification of the connections among the components of the vectors requires a qualitative research of the connections among these components and as well as their classification according to their intensity and influence on the development and operation of a cluster, the modeling of the created dependences and the possibility to quantify the influence of the vector components.

Starting from the SPECIFIC OBJECTIVES of the doctoral thesis, THE MOST IMPORTANT OWN CONTRIBUTIONS are the following:

O1 – Carrying out a country analysis, respectively Romania, from the perspective of smart specialization strategies, of the implementation instruments, in correlation with the national strategy for research – development – innovation and with the policies for sustaining the increase of innovative clusters' performance and of the competitiveness poles.

1. There have been defined **general concepts regarding the notions operating with, such as: country analysis, governmental strategies for development at national/sector/regional level, research and innovation strategies for a smart specialization, the European Concept notion and its implementation stages**;
2. There has been described **the Results-based Management process, seen as a life-cycle based approach of a program and as a planning instrument, in order to empower the United Nations member states, focused on the three main elements: responsibility, commitment and inclusion**;
3. There has been achieved **a detailed analysis of the National strategy in the field of research-development 2014 – 2020 and of the National strategy for competitiveness 2015-2020, underlying the significant aspects for different development regions in our country**;
4. There have been synthesized **the defining elements of the innovative clusters and of the competitiveness poles in Romania, including their way of association in a representative body at national, European / international level, respectively their participation in ESCA certification process**;
5. There have been analyzed the **main characteristics of Europe 2020 Strategy, with the 5 main objectives the European Union aimed to achieve until the year 2020, respectively the Strategies for smart specialization at national and regional level (RIS3 strategies), including integrated agendas and the five subsequent actions**.
6. There has been analyzed **the EU's cohesion policy for the period 2021-2027, within the context of Horizon Europe and of the development of the European Digital Innovation Hubs (EDIHs)**.

O2 – To study the specific mechanisms of organization and functioning, respectively the strategies for clusters' development, within the context of public policies at national and European level and to analyze the financing mechanisms and instruments based on the correlations among the policies specific for clusters' support and the smart specialization strategies.

1. There has been achieved an **analysis of the elements specific for the industrial clusters, including from the perspective of the interested parties, as expected involvement and benefits and of the specific strategies of development based on the implementation of SMART objectives and in accordance with the public policies framework at national and European level**;
2. There have been presented **the funding mechanisms and instruments and the compliance with the objectives of the structural funds for research in our country, within the context of providing medium and long-term sustainability**;
3. There have been principled analyzed the **conceptual similarities and differences between the innovative clusters and the smart specialization strategies, from the perspective of the objectives, essential characteristics and expected effects as result of clusters' operation / strategies implementation**;
4. There have been presented the **national programs for supporting the regional clusters, in correlation with the estimated benefits and from the perspective of the contributions of the cluster's specific policies for the implementation of the smart specialization strategies**;

5. There have been analyzed the **practical challenges regarding the implementation of the smart specialization strategies, respectively of the development of the clusters' ecosystem (regional, sector and innovative) and the improvement of the support policies regarding the objectives, instruments and the involved governmental actors, including the current situation of clusters in our country**.

O3 – To develop a quantitative and qualitative analysis template of clusters' performances in our country, in accordance with the smart specialization strategies adopted at the level of the development regions in Romania.

1. Following the analysis of the specialty literature there have been presented **the quantitative, qualitative methods, foresight and innovation, with emphasis on questionnaire-based survey, which included quantitative indicators, but also qualitative "vectors" and that has been transmitted to a number of clusters in our country**;
2. There have been made **centralizing graphs and tables with regard to the synthetic indicators used for the analysis, and the turnover, the number of enterprises within the cluster, the direct foreign investments, the number of employees, expenditures with the research – development - innovation etc., which characterize the quantitative performance of each analyzed cluster**;
3. There has been defined a number of **qualitative "vectors" such as: geographical and technological concentration within the cluster, the quality and quantity of the labour force within the cluster, research – development – innovation activities within the cluster, cooperation within the cluster, the existence of catalysts within the cluster, cluster's internationalization**;
4. There have been drawn out conclusions regarding **the connections between the quantitative indicators and the qualitative "vectors" for the analysis of the clusters and the smart specialization fields in the development regions in our country, where the clusters operate, including the correlations among the number of exiting clusters and the active labour force, the volume of expenditures for research – development – innovation and competitiveness at regional level**.

O4 – To achieve a comparative analysis of the economic performance of the development regions in our country, by cumulating some criteria that aim the smart specialization strategies, the innovation performance and the development of clusters/competitiveness poles.

1. There has been achieved **a quantitative research on the use of composite indicators for innovation, based on indicators and sub-indicators (single, multiple, composed), based on the scoreboard of the European innovation at national and regional level and, by similitude, of a composite indicator based on smart specialization concept at regional level**;
2. There has been elaborated a **combined methodology for regional analysis of clusters' performance, based on CLUSTERO methodology, respectively ECEI, by including the labeling system: bronze, silver, gold**;
3. There has been achieved **a comparative analysis of the economic performance of the development regions in our country, by using a composite indicator, made up by an original weighting algorithm, based on the regional innovation index from Romania, on the composite performance indicator based on the smart specialization concept at regional level in our country, and the questionnaire transmitted and on the responses received from the representatives of the clusters members of CLUSTERO, respectively of ECEI method, adapted with scores based on the above mentioned labeling**;
4. There have been drawn out quantitative and qualitative conclusions **with regard to the ranking on development regions, based on the composite indicator and of the**

individual indicators, specific for the smart specialization strategies, for the innovation performance and for the development of clusters/competitiveness poles.

5. There has been used the artificial neuronal networks (ANN), to assess and validate the responses of the analyzed clusters; the software used program was *Visual Gene Developer* version 1.9.

7.3 DIRECTIONS FOR CONTINUING THE RESEARCH

In order to achieve short and medium-term objectives, the future research directions will take into account the following:

1. The adequacy of the essential aspects of SNCDI 2014-2020, subsequent PNCDI 3, and the National strategy for competitiveness 2015-2020, subsequent POC, POR, POCU, PNDR, sector programs, to the future programming period 2021-2027, with its component elements, in order to adapt the proposed content of the research methodologies to the future European, national and regional context;

2. Filling in / modification / adaptation of the quantitative and qualitative analysis questionnaire for clusters' performance in our country, based on the deficiencies noticed in carrying out the previous survey with more CLUSTERO members and refining the analysis indicators based on ECEI labeling methodology;

3. Introduction in the calculation algorithm of the composite analysis indicator of the economic performance of the development regions in our country, of the new European instruments / orientations based on EU's cohesion policy for the period 2021-2027, within the context of Horizon Europe program and of the development of the European Digital Innovation Hubs (EDIHs);

4. Based on the gained experience and by consulting a wide group of experts, at national and international level, the model suggested for being developed within objective O4 will be perfected, in order to adapt it to the economic, social and environmental sustainability principles - "A Sustainable Europe by 2030" and from the perspective "A European Green Deal", respectively "Digital Europe Program".

5. We estimate the existence of an interest for the application of this model of comparative analysis of the economic performance of the development regions in our country, by cumulating some criteria aiming smart specialization strategies, the innovation performance and the development of clusters / digital hubs and innovation in a wider European or regional Danube context, a premise of the internationalization and expanded cooperation in the field of research – innovation and integral part of the *"European industrial strategy*".

Translator's note – Table on page 19

Minerit si industria extractiva	Mining and extractive industry
Industria alimentara si medicamente	Food and drugs industry
Industria textila si de incaltaminte	Textile and footwear industry
Industria de prelucrare a lemnului	Wood processing industry
Industria chimica, farmaceutica, prelucratoare a petrolului	Chemical, pharmaceutical, oil processing industry
Industria prelucratoare, extractiva	Manufacturing, extractive industry
Metalurgie	Metallurgy
Industria electrica, electronica, IT si echipamente optice	Electrical, electronics, IT and optical equipments industry
Industria de masini	Car industry
Echipamente de transport	Transport equipments
Alte sectoare industriale	Other industrial sectors

Table 2 on page 19

CA (din total CA)	CA (of total CA)
Nr. intreprinderi (din total intreprinderi)	No. of enterprises (out of total of enterprises)
CDI (din total CDI)	RDI (ouit total employees with HE)of total RDI)
Nr. angajati (din total angajati)	No. of employees (out of total of employees)
Nr. salariati cu studii superioare (din total salariati cu SS)	No. of employees with higher education (out of total employees with HE)
TOTAL INOVARE SI PATENTE (din total I_P)	TOTAL INNOVATION AND PATENTS (out of total I_P)
CDI / CA	RDI / CA
CDI / TOTAL INOVARE SI PATENTE (LEI/I&P)	RDI / TOTAL INNOVATION AND PATENTS (LEI/I&P)

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