INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL
ISSN 1841-9836, 9(4):453-462, August, 2014.

Cloud Service Management System for Innovative Clusters. Application for North-West Region of Romania

D. Popescu, A. Dodescu, P. Filip

Daniela Popescu, Anca Dodescu*
University of Oradea
Economy Department
Romania, 410610 Oradea, University Street, 1
depopescu@uoradea.ro
*Corresponding author: adodescu@uoradea.ro

Petru Filip
1. Dimitrie Cantemir Christian University,
Romania, 040042 Bucharest, Splaiul Unirii, 176
2. Agora University of Oradea,
Romania, 410526 Oradea, Piata Tineretului, 8
3. University of Oradea
Romania, 410610 Oradea, University Street, 1
pfilip@uoradea.ro

Abstract: In order to stimulate and optimize the organization and management of innovative clusters from value chain perspective and guide their planning activities towards a differentiation strategy in which cluster members cooperate, we propose a Cloud Service Management System (CSMS) that provides IT services for these innovative clusters companies that can be customized for both enterprises with the associated clusters.
Within such a system, actors begin to depend one on another and to take advantage of the local knowledge base. Each cluster is designed to have a different profile which will integrate all the companies mapped with it, with the objective of keeping the profile and data for each company. For the existing companies the idea is to migrate their services into the related cluster for integration within CSMS. Thus, our proposed CSMS will consider and meet different quality of services (QoS) parameters of each individual enterprise and service which will be included in specific Service Level Agreements (SLAs), after the negotiation between the cloud service provider and the CSMS. Realizing that technological progress is at the heart of regional development and decision-makers could support the development of technology clusters towards transforming them into regional innovative clusters, the application of our proposal aims to overcome existing bottlenecks in terms of business strategies and regional development policies in the North-West region of Romania.
Keywords: cloud computing, service oriented architecture, open cloud architecture, IT services, innovative clusters, supply chain management

1 Introduction

The paper proposes a *Cloud Service Management System (CSMS)* that provides IT services for the innovative clusters companies in order to develop collaborative mechanisms specific for innovative clusters aimed to solving the problems identified in the economic development of the North-West region of Romania.
Although in the past 20 years numerous studies have been conducted regarding the importance of innovative clusters for the regional economic development, the number of innovative clusters in Romania, in general, and in the North-West region, in particular, is surprisingly small, many of the existing clusters not being functional, due to lack of experience in organizing and managing

collaborative mechanisms specific for innovative clusters and insufficient and ineffective interconnection of companies in the same sector of activity through services and related technologies which enable an efficient group management and fostering innovation. Surprisingly small is also the number of networks of firms in Romania, the explanation being related to the lack of confidence of economic actors in the collaborative mechanisms and the lack of investments in building confidence at regional level, the lack of good governance practices of networks of firms that lead to bottom-up clustering as well as the lack of patterns of structured planning and development of innovative clusters.
In this context, the practical relevance of the problem sought to be solved through the present paper is the proposal of applying a Cloud Service Management System (CSMS) that provides IT services for innovative clusters which produces an effective group management, able to stimulate cooperation between cluster members in terms of the value chain on high value added niches, increasing competitiveness and innovation within the cluster and hence diversified smart specialization and regional development in order to increase the number and ensure long-term sustainability of innovative clusters in the North-West Region of Romania.
Proposing a functional model for the management of innovative clusters to compensate for functional limits of collaborative mechanisms within networks of companies and existing regional clusters, research involves an interdisciplinary cooperation of specialists in information technology, management and economics, the solutions targeted being positioned in the interference areas of the information technology with knowledge management and regional development.

2 Cloud Service Management System for Innovative Clusters

Given the advantages of cloud which allows the delivery of scalable resources on demand, we propose a Cloud Service Management System (CSMS) that provides IT services for the innovative clusters companies that can be customized for both enterprises with the associated clusters. In this sense, CSMS will be built within a private cloud with multiple clusters. We are focused to deliver broad range of cloud services as the ones described by David Linthicum in [2] due to their spread across industry. These are: Storage-as-a-service, Database-as-a-service, Information-as-a-service, Process-as-a-service, Application-as-a-service, Platform-as-a-service, Integration-as-a-service, Security-as-a-service, Management / Governance-as-a-service, Testing-as-a-service, Infrastructure-as-a-service. These services can be rent by customers depending on their needs and used as computing utilities. The advantage is the decreasement of the initial investment and that billing changes accordingly with the computing requirements for an individual or an organization changes, without incurring any additional cost.
Regarding the security of the Cloud Service Management System, we must point out that besides the stages of a Service Level agreement (SLA) content [1] [4], our services provided within each cluster of the CSMS must enhance availability, confidentiality, data integrity, control and audit. Within such a system, actors begin to depend one on another and to take advantage of the local knowledge base, if this interdependence causes a continuous flow of product and process innovations, diffusion of knowledge and collective learning processes at local or regional level, public-private partnerships being the synergistic factors that lead to innovative clusters.

Each cluster is designed to have a different profile (e.g. IT, automotive, apparel, tourism, health services, green energy etc.) which will integrate all the companies mapped with it, with the objective of keeping the profile of each company (Figure 1). For the existing companies the idea is to migrate their services into the related cluster for integration within CSMS. Eventually, CSMS will bring together all the involved services provided by the enterprise applications.
Moreover, in order to make the cloud computing approach to work as an efficient Cloud Ser-

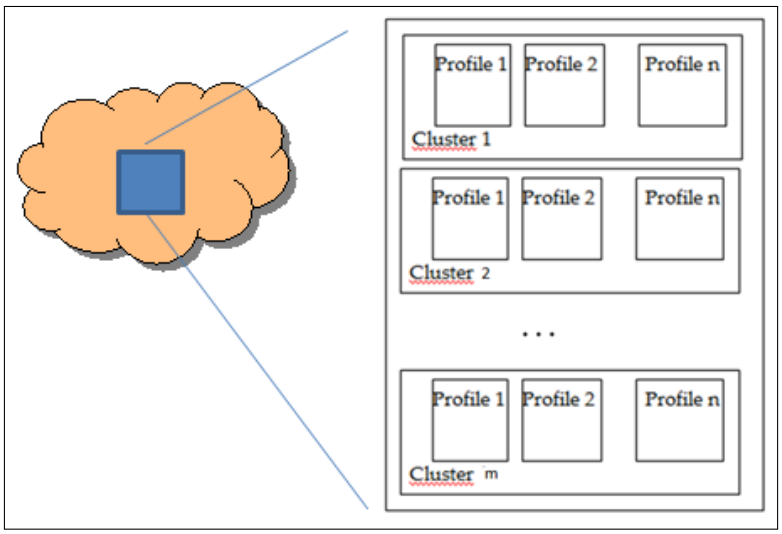

Figure 1: The CSMS/

vice Management for the innovative clusters, and to deliver the business agility and IT flexibility promised by Web Services, it is required the creation of a Service Oriented Environment (SOE) [3].Our approach is to deliver value to customers through the services provided using the SOE without implying any additional cost and risk from the customer perspective.
The services with CSMS are supposed to bring to customers: simplicity, flexibility maintainability, reusability and independence from technology. Services can be published, discovered and used in a technology neutral, standard form by using the web services protocols.
Thus, through a common interface, separate services for companies within each cluster are created and managed with the purpose of achieving the objectives of each company that has its own assets, employees, suppliers, partners (and information about them) or existing IT infrastructure [2] [6].
The huge increase in IT system interoperability that SOA can bring, not only at enterprise level, but also at the innovative cluster level is based on the use of smaller, modular services that have interface descriptions and contracts that ensure the business agility. These services are identified, defined and described in the context of the innovative cluster business activities and they are performed by the IT system and managed at the CSMS level. For each service is clearly set what it does and it is stipulated in a contract. The development of effective and flexible solutions is ensured by the use of SOA techniques like: service composition, discovery, message-based communication, and model-driven implementation [3].
SOA represents not only the architecture of services seen from a technology perspective, but also the policies, practices, and frameworks by which we ensure for the entire innovative cluster the right services are provided and consumed in order to ensure a best business outcome for the innovative cluster [2].
The software services used by the innovative cloud business operations are supported by a Cloud infrastructure that, together with the IT services, improves information flow within the companies and between the companies from the innovative cluster and all of them end the outside. The access to all of these services frequently involves a human-computer interface, often implemented as a web interface using portals (Figure 2), etc.

Thus, our proposed CSMS will consider and meet different quality of services (QoS) parameters of each individual enterprise and service which will be included in specific Service Level Agreements (SLAs), after the negotiation between the cloud service provider and the CSMS.

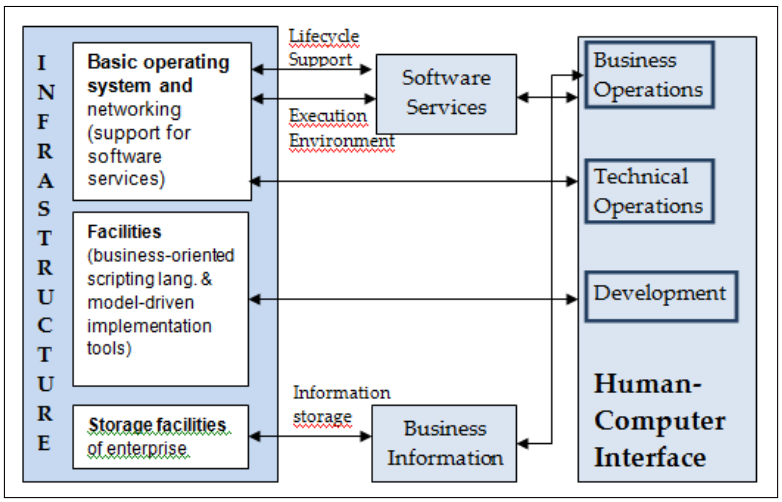

Figure 2: The Infrastructure (adapted from [3])/

Realizing that technological progress is at the heart of regional development and decision-makers could support the development of technology clusters towards transforming them into regional innovative clusters, the application of our proposal aims to overcome existing bottlenecks in terms of business strategies and regional development policies in the North-West region of Romania in order to stimulate and optimize the organization and management of innovative clusters from value chain perspective and guide their planning activities towards a differentiation strategy in which cluster members cooperate with high value added niches (smart diversified specialization) and, consequently, to create regional growth and development.
To get the ideal agile in collaborating environments (such as business) is needed that the IT infrastructure necessary to access the functionality by services be able to be configured by the user without the need to become experts in the field. A well suited solution can be the Cloud Computing Open Architecture (CCOA), proposed in [5].

Our CSMS solution for the management of services of the innovative cluster is developed based on the Cloud Computing Open Architecture, which we have to customize in order to ensure the services needed to migrate the companies services into the related cluster for integration within CSMS.
So, at the second level of the CCOA model [5] we develop the innovative clusters using an HPC infrastructure. Level 3, structured as SOA, will be used to define the profiles and the services for each company included in each cluster. Level 4 will be specific to each cluster, namely profile. Level 5 provides the granular services, while level 6 will have custom profile services for each cluster (Figure 3).

3 Innovative Clusters in North-West Region of Romania

There is currently a broad consensus to consider that economic agglomeration effects in a given location is the result of the balance of opposed agglomeration forces (centripetal and centrifugal), generally or in a particular field, branch of industry, assuming technological networking, mainly for efficiency and flexibility, or by propensity for innovation [7]. The identification of endogenous determinants of knowledge spillover and collective learning process within innovative clusters represent one of the most advanced theoretical perspectives on regional development [8]. Initially defined by Michael E. Porter as business strategy in a global economy context, as a source of competitive advantage for the participating companies [9], and later as "geographic

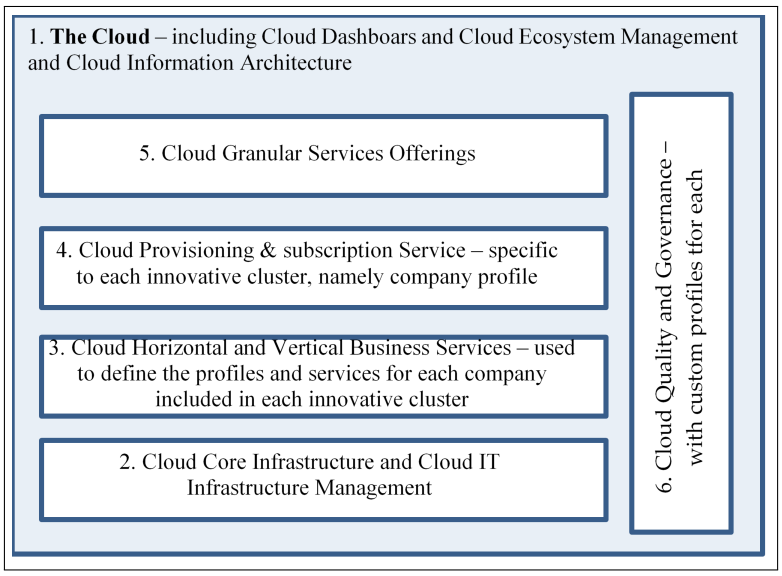

Figure 3: The CSMS Model/

concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries and associated institutions (eg universities, standardization agencies, professional associations) in a particular field that compete but also cooperate" [10], by encouraging the formation of some relational regional assets external to individual firms, but with major influence on the performance of their competitiveness [9], [12], the porterian cluster has turned from the most influential business strategy into the most popular regional development strategy. Innovation has become a critical factor for survival in a competitive spatial economy and also the factor that determines the direction and the rhythm of regional development. In this context, the propensity to form innovative clusters characterizes development policies at present, due to regional and local impact (providing a successful combination of infrastructure, highly skilled workforce and flexible corporations for development, offering well-paid and high quality jobs, have prospects for long-term growth and development, are dynamic and dominated by innovative SMEs because continuous research and development is vital for survival, it accelerates the technological and innovative process at local or regional level etc.) [13].

The linkages between firms and organizations that form an innovative clusters the institutional density at local level, the unsold interdependency network that go beyond market transactions, the mechanisms by which technological progress within the cluster turns into a collective learning system, have been the subject of numerous research based, especially, on case studies of successful technology clusters [14], the Cambridge technology cluster with the involvement of Cambridge University and science parks: Melbourne Science Park, Cambridge Science Park and St John's Innovation Park being frequently analyzed. Close working relationship between specialized SMEs, the involvement of higher education and research institutions, the free movement of highly skilled labor and availability of specialized consulting services within the cluster are considered the main explanatory mechanism for the success of these clusters.

In this context, the classical concept of network of companies, which designates a form of cooperation between companies legally independent, geographically dispersed, but with common interests in economic terms - has evolved into the concept of collaborative networks of innovative technological systems with respect to network configuration referring to coordinate cooperation between the various organizations that pursue a common goal: the development of a region; and the concept of technological cluster evolved into the "pôle de compétitivité" (in French ap-

proach) or innovative cluster facilitated by the availability of the nature of information technology to transform into a cumulative process and "institutional density" which facilitates cooperation and technological knowledge flow, leading to the accumulation of "strong local base of knowledge" and create a system like "innovative millieu" [15], [16], [17]. Within such a system, SMEs begin to depend one on another and to take advantage of the local knowledge base, if this interdependence does not stuck on the "old, competitive and unstable paths" [18], but causes a continuous flow of product and process innovations, diffusion of knowledge and collective learning processes at local or regional level, public-private partnerships being the synergistic factors that lead to innovative milieux [19], toward learning regions [20], creative regions, knowledge based regions etc. [8], [13].

Realizing that technological progress is at the heart of regional development and decision-makers could support the development of technology clusters towards transforming them into regional innovative clusters, learning environments and innovative regions or areas of knowledge, quickly penetrated regional growth and development policies of the EU Member States [15], [16], closely related with the pulses set in the Lisbon Strategy on "knowledge based economy" and later with the approach of the Territorial Agenda 2020 and the specific smart growth objectives of Europe 2020 strategy. The current financial and economic crisis is pressing even more to stimulate the innovation process and increase the role of regions in this context. The EU reports and strategic documents demonstrates that innovation policy should focus not only on research and development or science and technology, almost exclusively concentrated in a few regions of the EU, especially capital regions, but "to anticipate" appropriate policy mix for innovation covering all the dimensions of innovation, including those concerning organizational process, creativity, design, etc. and all the regions of Europe [21], [22], [23]], and the reality of a high concentration of technological capabilities in the developed center of the EU must change gradually and create space for regions and companies with a lower absorption capacity. But how to change this in favor of the less favored regions in conditions of economic crisis? The most common response is by stimulating both innovation and entrepreneurship through innovative regional clusters [22], [23]]. According to the 2013 European Cluster Observatory star rating [24], there are 92 clusters in Romania that have received at least one star depending to the extent to which clusters have achieved critical mass by employing measures in terms of size, specialization and focus [25].

In this context, the clustering potential of the North-West Region of Romania is sensitively high in the Figure 4 mentioned industries, where we represented the number of employees in the stars classified industries:

With a diverse economic structure, characterized by the shift from predominant development of strong labor intensive sectors to the services sector, particularly the intelligence intensive and high value-added industries, that require skilled and specialized labor force, North West Region of Romania has a certain degree of regional specialization for the following industries: furniture industry, electrical equipment, metallurgy, leather and footwear industry. for the following industries: furniture industry, electrical equipment, metallurgy, leather and footwear industry [26], according with Zaman's methodology for calculating apparent or revealed regional comparative advantage indicator, based on the top main regional trade exporters in the EU and between the EU extra trade [27].

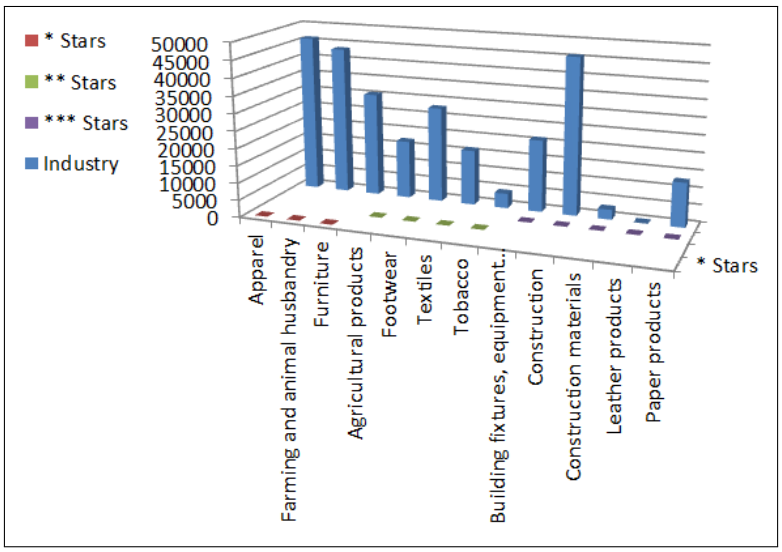

Figure 4: Star Clusters in North- West Vest Region of Romanial/

(Source: Star Clusters in Romania, Center for Strategy and Competitiveness, CSC Stockholm School of Economics, April 2011, http://www.clusterobservatory.eu/common/galleries/downloads/Star_clusters_Romania.pdf)

Regarding economic agglomeration, according with most recent regional development strategy 2014-2020 draft plan [26], in the North-West region there were 6 registered clusters, out of which only 4 are active as shown in Table below:

Table 1. Clusters situation in North-West Region of Romania

Cluster	Field of activity	Location	Information about association initiative under cluster structure and status
Romanian Water Cluster	water energy industry	Cluj-Napoca	Information not found - unfunctional
Geothermal Cluster	renewable energies, services in tourism	Oradea	Created in 2009 through CLUSTHERM (Creating a Central European Thermal Water Research Cluster) project, financed through FP7, Regions of Knowledge Programme (REGIONS-2007-2), Coordinator: INNOVA szak-alfld Regional Development and Innovation Nonprofit Ltd (HU), http://www.clustherm.eu/. - unfunctional
TREC - Transnational Renewable Energies Cluster	renewable energies	Cluj-Napoca	Created in 2012, through TREC (Transnational Renewable Energies Cluster) project, financed through SMART +, INTERREG IVC Programme, Coordinator: North-West Regional Development Agency, Romania, http://www.nord-vest.ro/Document_Files/Noutati/00001234/ciic6_1.%20TREC%20-%20concept,%20activitati,%20viziune.pdf. - active
Cluster Mobilier Transilvan	furniture	Cluj-Napoca	Created in 2012, bottom up, as a non-governmental organization through legal association of 18 firms from furniture industry, 3 catalyst organizations, 1 public institutions and 1 university, website: http://transylvanianfurniture.com/ - active
Cluj IT Cluster	IT & C	Cluj-Napoca	Created in 2012, bottom up, as a non-governmental organization through legal association of 28 IT & C companies, 6 public institutions and catalyst organizations, 4 universities, website: http://www.clujit.ro/ - active
Agro-Food-Ind Napoca	agro-food	Cluj-Napoca	Created in 2013, bottom up, as a non-governmental organization through legal association of 13 companies and associations from agro-food industry, 2 catalyst institutions, 3 public administration institutions, 2 universities; website: http://www.agrotransilvaniacluster.ro/ - active

Source: authors' processing

Looking at Figure 4 and Table 1, we should notice that, despite its sensitively high clustering

potential in apparel, farming and animal husbandry, agricultural products, footwear, textiles, tobacco, building fixtures, equipment and services, construction, construction materials, leather products, paper products [26], only furniture industry is covered with active cluster in the region. Surprising is the absence of a cluster in the apparel, footwear, textiles industries, despite existing industrial agglomerations and tradition in the region.
According to the Cluster Programme and Policy Stress Test for North-West Regional Development Agency Regional Innovation Strategy [28], the score of the North-West region is of 9 points out of 50 points, which places the region in the "yellow area" of the "league of clusters" traffic light, the minimum limit for compliance with the "green zone" being of 40 points. The weaknesses identified in the North West region of Romania after applying the policy stress test are related to the management approach of clusters and the internationalization of their activity, the malfunction integration of regional programs for clusters in the general context of industrial policy and economic development policy, the critical points being related to the implementation, monitoring, evaluation and impact of regional programs for clusters and the absence of a national policy for clusters.

4 Conclusions

The analysis of economic agglomerations in North-West Region of Romania shows the predominance of economic agglomerations based on simple agglomeration economies (especially, industrial parks) and high difficulties in the implementation and ensuring sustainability on long term of economic agglomerations based on economies of dynamic agglomeration (especially, innovative clusters) and highlights the need of instruments to improve the management approach of clusters and to stimulate the innovative process, and also collective learning processes through cooperation and relationality. In this context, the proposed Cloud Service Management System model aims to represent an important support for the development of existing clusters and to find solutions for the functionality and sustainability of new clusters in the North-West region for valuing high regional clustering potential. In this respect, broad range of cloud services that can be rent by firms from same industry, aligning cluster members on value chain. A number of services can be adapted to the cluster specificity: project planning, marketing planning, strategy, business plan, KPI's system etc.; knowledge management, open virtual library, e-learning, working groups, application procurement, legislation Info, Match-making, funding opportunities Portal, common EU projects, etc. Within such a system, actors begin to depend one on another and to take advantage of the local knowledge base, if this interdependence causes a continuous flow of product and process innovations, diffusion of knowledge and collective learning processes at local or regional level, public-private partnerships being the synergistic factors that lead to innovative clusters. The proposed model will help to tackle the functionality and long-term sustainability issues of innovative clusters in the North-West region of Romania and will represent the base of an integrated network that will bring together human resources trained within the project in interdisciplinary applied research and SMEs networks from the North-West region of Romania and will contribute decisively to the accumulation of the "critical mass" of resources for research, development and innovation for increasing regional competitiveness.

Through the development of some model for structured planning and development of innovative clusters, our future steps will be focused on testing of model on a pilot cluster in order to stimulate learning, relationships and cooperation within innovative clusters, the development of the following innovative services: methodologies and methods for planning and structured development of innovative clusters, handbook for the management of innovative clusters, system of integrated software for managing clusters and knowledge, and fostering cooperation within an innovative cluster.

Bibliography

[1] Lonea, A.M., Tianfield, H. and Popescu, D.E. (2013). Identity Management for Cloud Computing, *New Concepts and Applications in Soft Computing*, 417: 175-199.

[2] Linthicum, D. S. (2009); *Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide*, Addison-Wesley Information Technology Series.

[3] Open Group, *SOA and Enterprise Architecture*, Available online: http://opengroup.org/ [14.12.2013].

[4] Lonea, A.M., Popescu, D.E. and Prostean, O. (2012); The Overall Process Taken by Enterprises to Manage the IaaS Cloud Services, *Proceedings of the 6th European Conference on Information Management and Evaluation*, University College, Cork, Ireland, 13-14 September 2012.

[5] Vitek, A. J. & Morris, M.N, (2012); Service Oriented Cloud Computing Architectures, *UMM CSci Senior Seminar Conference*, Available online: https://wiki.umn.edu/ [07.11.2013].

[6] Entreprise Concept, Available online: http://enterprise-concept.com/ [05.12.2013].

[7] Sövell, Ö., Lindqvist, G. & Ketels, Ch. (2003); *The Cluster Initiative Greenbook*, Stockholm: Bromma tryk AB.

[8] Capello, R. & Nijkamp, P. (eds.) (2009); *Handbook of Regional Growth and Development Theories*, Edward Elgar Publishing.

[9] Porter, M. E. (1990); *The Competitive Advantage of Nations*, New York: Free Press.

[10] Porter, M.E. (1998); *On Competition*, Boston: Harvard Business School Press.

[11] Porter, M.E. (1998); Clusters and the new economics of competition, *Harvard Business Review*, November-December, 77-90.

[12] McCann, P. (2001); *Urban and Regional Economics*, Oxford: Oxford University Press.

[13] Armstrong, H. & Taylor, J. (2000); *Regional Economics and Policy*, Third Edition. Oxford: Blackwell.

[14] Karlsson, C. (2008); *Handbook of Research on Clusters*, Edward Elgar Publishing House.

[15] Ketels, Ch. & Svell, A. (2006); *Innovation Clusters in the 10 New Member States of the European Union*, European Communities, Available online: http://www.isc.hbs.edu/ [22.07.2013].

[16] European Commission (2007); *Innovation Clusters in Europe. A Statistical Analysis and Overview of Current Policy Support*, Europe Innova / PRo Inno Europe paper no. 5, DG Enterprise and Industry report.

[17] Hamdouch, A. (2008); Conceptualizing Innovation Clusters and Networks, *International Conference: Innovation Networks*, Tacoma-Seattle, Washington, USA, May 14-16, 2008, Available online: http://rrien.univ-littoral.fr/ [22.07.2013].

[18] Armstrong, H. & Taylor, J. (2000); *Regional Economics and Policy*, Third Edition. Oxford: Blackwell.

[19] Camagni, R. (ed.) (1991); *Innovation Networks: Spatial Perspectives*, London: Belhaven Press.

[20] Morgan, K. (1997); The Learning Region: Institutions, Innovation and Regional Renewal, *Regional Studies*, 31(5);491-503.

[21] European Commission (2011); *The urban and regional dimension of Europe 2020.Seventh progress report on economic, social and territorial cohesion*, Report from the Commission, Available online: http://ec.europa.eu/ [24.09.2013].

[22] European Commission (2012); *State of the Innovation Union Report 2012 - Accelerating change*, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - SWD(2013) 75 final, Available online: http://eur-lex.europa.eu/ [24.09.2013].

[23] European Commission (2013); *Innovation Union progress at country level 2013*, Available online: http://ec.europa.eu/ [24.09.2013].

[24] European Cluster Observatory (2013);Available online: http://www.clusterobservatory.eu/ [18.02.2014].

[25] European Cluster Observatory (2011); *Star Clusters in Romania, Center for Strategy and Competitiveness*, CSC Stockholm School of Economics, April 2011, Available online: http://www.clusterobservatory.eu/ [13.11.2013].

[26] Romanian North-West Regional Development Agency (2013); 2014-2020 Regional Development Plan (draft, September 2013), Available online: http://www.nord-vest.ro/ [18.02.2014].

[27] Zaman, Gh. (2010); *Sistemul de indicatori ai competitivitatii romanesti in contextul dezvoltarii durabile, communication for AFER Summer School*, University of Oradea, September 2010.

[28] Lammer-Gamp, K. (2013); *Results Cluster Programme and Policy Stress for North-West Regional Development Agency Regional Innovation Strategy*, European Secretariat for Cluster Analysis, Berlin