THE CLUSTERS COMPETITIVENESS

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Abstract:
Clusters and networks have been identified as crucial instruments for implementing the EU's Europe 2020 strategy. The EU 2020 flagship initiatives "Innovation Union" and "An integrated industrial policy for the globalisation era" specifically refer to clusters and networks as critical tools for sustainable competitiveness. The present article aims at studying thoroughly the researches and the general systemic models of the economic clusters while orienting them towards the practice of setting up, growth and evaluation of clusters competitiveness on the regional, national, continental and global levels. We define in a structural-functional manner the business and integrative innovative clusters, the clusters typology and competitiveness determinant factors. We analyse the evaluation methods of economic active clusters: qualitative evaluation; cluster mapping (identification, monitoring, and analysis); cluster certification; cluster ranking; cluster competitiveness.

Key words: *clusters, networks, systemic models, competitiveness, evaluation*

JEL classification: http://www.aeaweb.org/journal/jel_class_system.html

1. Introduction

The words "competitiveness" and "cluster" did not exist in the vocabulary 40 years ago. After 1970, the acceleration of globalization and of world coopetition (COOPEration and / or compeTITION outside the organization) and the evolution of sciences have gradually outlined the new concepts. At present, the words "competitiveness" and "cluster" has a clear meaning, being considered as essential for progress in all domains. Nevertheless, the concepts lack a generalized systemic approach of clusters competitiveness.

Clusters and networks have been identified as crucial instruments for implementing the EU's Europe 2020 strategy. The EU 2020 flagship initiatives "Innovation Union" and "An integrated industrial policy for the globalisation era" specifically refer to clusters and networks as critical tools for sustainable competitiveness (EU-ECR, 2012).

The present article aims at studying thoroughly the researches and the general systemic models of the progress and the competitiveness based on clusters, while orienting them towards applied competition and coopetition specific to the 21st century and future millenniums.

2. Sustainable integrative competitiveness

At present, it is unanimously accepted the truth that **the main engine of progress** in nature, society, mentality, action and affection is the **coopetition** (Brandenburger, Nalebuff, 1996; Kauffman, 1997; Banathy, 2000; Chaisson, 2001), and the **competitiveness** of entities generations g determines at a large extent their evolution in the space-time-resources domain $D_{str}(t,g)$, in close or remote territories, on short, medium, long and prospective terms. The evolution of Mankind and the acceleration of

globalization on the Earth, since 1970, have gradually outlined a new concept and brought about, in all countries, the most important meta-performance in the Universe: **lasting / sustainable integrative competitiveness.**

Competitiveness K(t,g) means, as a general rule, the ability and the capacity of an entity / system S(t,g) to win, to obtain success and welfare in the coopetition of the outer environment / environments and within a certain time horizon (Popa, 2002, 2003; Popa, Pater, 2006). Competitiveness is a meta-performance (an integrated complex group of distinctive performances; "performance of performances") of high importance for the lasting and sustainable progress of live or un-live entities in the Universe / Multiverse.

The **lasting $K_{id}(t,g)$ / sustainable $K_{is}(t,g)$ integrative competitiveness** means the ability and the capacity of a (S_S) system of systems to optimise from an integrative-hierarchy perspective its internal environment, to be a winner in the coopetition (confrontation and / or cooperation in successive-parallel cycles c and generations g) of its external environments, without causing damage, to simultaneously achieve welfare, for a very long („lasting") / unlimited („sustainable") period of time.

Total competitiveness $K_{tot}(t,g)$ expresses, as a general rule, an ability, a capacity, a meta-performance determined in a dynamic simultaneous-successive-paralleled way in all the inner and outer environments of the entities, by the integrated whole of these entities (all the resources, structures, processes, programmes and performances). $K_{tot}(t,g)$ integrates competitiveness along the entire hierarchy of systems from Mankind, world economy up to businesses and persons, in all the 7 environments (natural; demo-psycho-linguistic; socio-cultural; political-juridical-administrative; socio-economic / of business; of innovation; security) and having as object all the 7 resource categories (natural; human; social; material; informational; financial; time). The vertical integration (hierarchic) and the horizontal integration (environments and resources) are, along the years, more profound and entail total competitiveness of Mankind.

At **macro** level, on the planet Earth, **total competitiveness** reflects how state federations, nations, regions, districts, localities, companies and organizations develop resources, technologies, policies and integrated management of competences, in order to attain prosperity and profitability and to develop competitiveness and value culture, while protecting the environment and preserving bio-diversity and resources on unlimited term (Garelli, 2006; Popa, Pater, Cristea, 2008).

Based on the general concepts, the definitions of artificial systems competitiveness can be explained on hierarchic levels, as follows:

- **Competitiveness at Macro / mezo level $K_{Mm}(t,g)$**: the ability and the capacity of an entity (state federation, nation, region / county, area, locality) to create and maintain an environment that favours the producing of surplus value for the companies (organizations) and the increase of welfare for the people / inhabitants, while protecting the environment and preserving bio-diversity and resources.
- **Competitiveness $K_{EC}(t,g)$ of the enterprise** (company, network of companies) / **cluster** (agglomeration of companies and performer organizations on the domestic and global market): the ability and the capacity of a company / cluster to carry out successful coopetition by the majority of the business B on the target markets / segments / niches on long term, while protecting the environment and preserving bio-diversity and resources, as a basis for the prosperity of those interested (owners, employees, communities, nature etc.).
- **Competitiveness of the business $K_B(t,g)$**: the ability and the capacity of the company to carry out successful coopetition by means of the Business as considered on the target markets / segments / niches / crenels for the duration of one or more contracts

concluded with clients and suppliers, while protecting the environment and preserving bio-diversity and resources.

● **Competitiveness of assortment i** (product, service, work) $\mathbf{K_i(t,g)}$: the characteristics of the assortment i which, based on the relation global quality N_{gi} / price P_{vi} (cost C_{ci}) at the final consumer, allow the assortment to be positioned and sold competitively on the target market / segment / niche / crenel, within certain efficient businesses, companies and clusters, while protecting the environment and preserving bio-diversity and resources.

It is obvious that the notion of competitiveness is much more comprehensive that those of variety, quantity, terms, quality, resource consumption, access to resources, efficiency (productivity, profitability etc.) which it includes. Always, at all levels and in all domains, - quality, productivity, profitability etc. are parts of competitiveness.

3. Clustering and clusters as determinant factor of competitiveness and progress

A **cluster C(t,g)** is a grouping of a number of "something" (physical or abstract entities) potential competitive in its proximate external environment. The notion "cluster" is more and more used in science (physics, astrophysics, chemistry, biology, health sciences etc.), computing, economics, management etc. and have a systemic character (Katseneliboigen, 1997; François, 1999; Castellani, Hafferty, 2009; Jensen, 2009). Yet, the cluster is not defined in a rigorous and systemic manner.

Despite its lack of profoundness, generality and conceptual clarity, (Martin & Sunley, 2003), the notion of cluster has gained wide recognition as a model of industrial promotion and policies at both national and regional level (Porter, 1998; Press, 2006). Are known little and limited systemic approaches of cluster concept in economics, management and governance (Sölvell, 2008; Jensen, 2009).

The lasting / sustainable progress in all domains is generated by inoclusters**,** by integrative-innovative clusters. The **inoclusters** (innovative clusters) are systems of real systems $\{S_S\}$ generating progress in the natural and / or artificial environments, from macro cosmos to micro cosmos, in various time dimensions (transient, temporary, lasting, sustainable). The **sustainable inoclusters** generate progress in all natural and / or artificial environments, from macro cosmos to micro cosmos, on unlimited term, by the systems of real systems $\{S_S\}$ successive-parallel generations g, g+1, ….. Mankind tenaciously tends to turn into a sustainable macro-cluster, since the beginning of the 21st century.

From a general functional-structural perspective, **clusters C(t,g)** are **spatial-temporal agglomerations / concentrations of systems** in D_{str} (t,g) domains of the Universe / Multiverse (from macro-cosmos to micro-cosmos), having within their structure four categories of functional components:

● Three categories of components of the self-determined internal environment M_{aint}:

[1] Internal community (**Comint**) which gives the cluster its identity in the target proximate external environment M_{pext} [4],

[2] Internal and / or external facilitators (**Facilit**) which stimulate cooperation and competitiveness of the internal community components [1] and of the determinants [3],

[3] Determinants (**Detint**) of the self-determined internal environment M_{aint} specific features of the cluster which ensures the life and functioning of the internal community [1] and of internal and / or external facilitators [2],

● A category of components of target proximate external environment $\{M_{pext}\}$

[4] External connectors (**Conext**) for components [1] & [2] & [3] which ensures the cluster's connexion with the target proximate external environment $\{\mathbf{M_{pext}}\}$ of **C** (initial suppliers, final consumers for cluster and Nature).

Irrespective of the category (natural and / or artificial), the clusters are implicit and transient innovators, by creating the M_{crS} (t,g) critical masses of the components E(t,g) and products that form the systems of real systems $\{S_S\}$, generators of becoming / change processes (…. → progress → stagnation → regress → stagnation → progress → ….).

Clustering is a continuous process of creation, functioning by current restructuring and dismissing of successive-parallel generations g = 1, 2,…., n, n+1, …., of clusters / clusters of clusters in D_{str} (t,g) space-time-resources domains of the Universe / Multiverse which meet the existence requirements of $\{S_S\}$ systems of systems.

The progress in our Universe / Multiverse relies on competitive sustainable inoclusters (the progress-generating specific critical masses M_{cr}(t,g) and the integrative innovation in the system environments) within D_{str}(t,g) space-time-resources domains. In any space-time-resources domain D_{str}(t,g) of the Universe / Multiverse characterized by stability within favourable / unfavourable limits for the existence of $\{S_S\}$ systems of systems, the clustering cyclically generates more complex E(t,g) entities **(+ΔW),** more diverse **(+ΔZ)** and in big quantity **(+ΔQ)** entities that produce as exits more or less competitive {i} „products" **(± ΔK_i)** which become / may become resources for the next becoming / change cycles and determine more or less the **(± ΔB)** welfare in the **D_{str} (t,g)** domains. The internal clusters (of resources, execution, governing) and the clusters of clusters that give birth to the {i} „products" are the main becoming / change generating factors. Integrative innovative clusters (inoclusters) C_{ino}(t,g) are the only one to generate lasting / sustainable progress in the space-time-resources domains $\{D_{str}(t,g)\}$.

Long time progress can be achieved within D_{str}(t,g) space-time-resources domains only by the system lasting / sustainable integrative competitiveness **K_{ids}(t,g)**, as effect of the prevalence of positive critical factors / causes (+).

Stagnation is achieved through insufficient competitiveness $K(t,g) < K_{crit}(t,g)$, as effect of the prevalence of neutral (≈) and contradictory (±) critical factors (causes).

Regress is achieved through non- competitiveness, as effect of the prevalence of negative (-) critical factors (causes) and crisis.

4. The clustering in business and innovation environment

In economy and innovation the clusters (synonyms: pôles de compétitivité – France; Kompetenznetze - Germany) are **dynamic agglomerations / bunches / geographical concentrations** (street in a locality, …, global market) **of organizations,** having within their maximal structure (innovative clusters / inoclusters) four categories of flexible / fluctuant integrated subsystems (Popa, Pater, Cristea, 2008):

[1] Company networks (**Compnet**) with: **[1.1]** Leader companies ("product assemblers" or network coordinators) / groups of coordinating organizations in Compnet; **[1.2]** Innovation, production / services, sale, training companies; **[1.3]** Research-Development-Innovation companies (Universities, R&D institutes / companies); **[1.4]** Financing institutions (Banks, non-reimbursement financing funds, national and EU financing programs etc.),

[2] Facilitators (**Facilit**): Institutions / organizations / networks for cooperation and competitiveness under stability or crisis conditions, with: **[2.1]** Centres of Competitiveness, Councils of Competitiveness; **[2.2]** Chambers of Commerce, Industry and Agriculture, other business organizations; **[2.3]** Development Agencies (regional, county, local); **[2.4]** Other facilitators: legal and monitoring institutions and bodies, employers associations, unions, professional organizations, media etc.

[3] Local Public Administration (**Pubadm**): **[3.1]** local / **[3.2]** regional / **[3.3]** euro-regional / **[3.4]** national / federal Government

[4] External connectors (**Conext**): **Consumers** on target markets / segments / niches / crenels with specific demand, in continuous behaviour changing and consumers from other proximal external environments (natural, demo-psycho-linguistic, socio-cultural, political-juridical-administrative, security etc), **Initial Suppliers** from external environments.

In a strict sense, clustering ("cluster development" or "cluster initiative") is defined as business and innovation cluster establishment and development in economy.

In all the countries that lack competitiveness, the managerial and political culture (scientific management, clusters and clustering, competitiveness policies and management etc.) is rather precarious at all levels and the domestic capital clusters are very rare or they do not exist at all. In these countries, there are pre-clusters **PC** naturally established, within 3 - 10 years since the establishment of the leader company (of „product assembler" or „network assembler" type). In case these countries attract important direct investments, the transfer of resources (management, technologies, cooperation and quality culture, financing etc.) is effected relatively easy and through the following:

- rapid establishment of regional clusters **CE** linked to the global market by means of „foreign mother-companies" (solution used by all multinational exporting companies),
- link / inclusion of efficient domestic companies and foreign companies operating on the national territory to the clusters of clusters of trans-national companies,
- short-time establishment of a national / global cluster by a joint venture or foreign leader company acting as a „complex product assembler" (ex. The best automotive cluster in Romania, having as leader company Dacia Group Renault Pitesti, with 188 1st rank suppliers of which 54 from Romania and thousands of suppliers on the national and global market, was set up in 4 years, 2000-2004)

In the countries and regions where the clustering process is rather slow, the analysis, promotion, establishment, evaluation and certification of clusters / clustering shall be done within a **more complex / comprehensive vision**, starting with "pre-cluster potential germs (**GP**)", to be identified in the top of competitive companies and organizations, which can "crystallize" pre-clusters and clusters / competitive clusters.

5. Determinant factors of clusters competitiveness

The sustainable competitiveness (on unlimited term) $\mathbf{K_{isE}(t,g)}$ of an human entity E (Mankind, country federation, country, region, locality or economic sector, respectively **cluster**, organization) reflects the suitability of their SUPPLY / OFFER O_E $\{F_{Oi}, V_{Oi}\}$ to products DEMAND $D_{i\ N/m/s/n/c}$ $\{D_{i\ N/m/s/n/c}\}$ of the target internal and external environments (Nature; markets / segments / niches / crenels) for sustainable progress in a unlimited period of time Δt. In principle:

$$K_{isE}(t,g) = f(C_{KE}, O_E, L_E, E_{gE}, I_{CI}, I_m, I_M, D_{i\ N/p/s/n/c}, \Delta t) =$$
$$= f(C_{KE}, F_{Oi}, V_{Oi}, L_E, E_{gE}, I_{CI}, I_m, I_M, F_{Di}, V_{Di}, \Delta t) =$$
$$= f(C_{KE}, \{i\}, Q_{Oi}, T_{Oi}, N_{gOi}, P_{vi}, L_E, E_{gE}, I_{CI}, I_m, I_M, Q_{Di}, T_{Di}, N_{gDi}, C_{sai}, \Delta t) \quad (1)$$

Factors from the intern environment $\mathbf{M_{int}}$ of the entity E / cluster C are rather various:

● $\mathbf{C_{KE}}$ [pcs, …., EUR, RON,…. / t.p.u.] is **the competitive ability (capacity) of the entity E / cluster C**, defined by the $\{Q_{vi}\}$ quantities of the$\{\ i\ \}$ products with intrinsic competitiveness $\{K_i\} = \{N_{gi} / P_{vi}\}$ imposed by the exterior target environment (Nature; market / segment / niche / crenel with N_{gi} needs & Q_{ci} quantities and solvency specific

C_{sai}) that can be produced and / or efficiently purchased and sold in a time period Δt, satisfying the actual demand $\{D_{i\ N/p/s/n/c}\}$ of the target exterior environments,

● { i } & $\{Q_{Oi}\}$ / $\{T_{Oi}\}$ is the supply **/ offer flexibility** F_{Oi} **of the entity E / cluster C defined by the variety & quantity / time period for the customers and consumers from the target market / segment / niche / crenel**

» *variety of the supply/ offer (range of goods) in the market { i }* is given by the range of goods (assortment) i = 1,2,…..p that the entity E can assimilate, produce and sell / change

» *quantity of the supply in the market* Q_{Oi} is given by the ability of the entity to process in the considered time period unit (t.p.u.), defined

~ physically Q_{Oi} [pcs, ... / t.p.u.] production / transaction volume and physical selling in a time period unit (t.p.u)

~ value-oriented Q_{Or} [EUR, USD, RON, …. / t.p.u.] revenue / income / turnover

» *durations* T_{Oi} *of the supply in the market* of the entity E are given by the following durations:

~ of the life cycle of the offered assortment T_{cvi} [months / range]

~ of the new assortment assimilation T_{cai} [days / sort]

~ of the management, production and commerce T_{cpci} [days / pcs; lot]

● **{N_{gOi} / P_{vi}}** is the **position (value) V_{Oi} on the market of the** entity E or **cluster C** supply / **offer** defined by the global quality **N_{gOi}** / price **P_{vi}** for customers on the target market / segment / niche / crenel

» *quality of the supply / offer in the market* N_{gOi} is defined by absolute or relative [quality level N (indicator r) compared to a standard product (indicator e)]

~ of the market supply / offer itself N_{gOi} [points] or / and $N_{reOi} = N_i / N_e$

~ of the processing and commerce (special indicators, with important effect)

» *prices / tariffs and costs of the supply on the market* defined by

P_{vi} [EUR, USD, RON, …. / piece, ….] selling price for the i product to the customers on the market, based on

C_{ci} [EUR, USD, RON, …. / piece, ….] complete cost for the i product

C_c [EUR, USD, RON, …. / t.p.u.] complete costs at entity E level

● **L_E** [EUR, USD, RON, …. / t.p.u.] is the **liquidity** of entity E / cluster C given by the cash solvability in bank(s) accounts by which the cashing, payment, crediting etc. operations are made,

● **E_{gE}** is the **global efficiency** of entity E / cluster C functioning by restructuring, characterized by a large number of technical, ecologic, ergonomic, aesthetic, socio-cultural and economic indicators (with threshold values, respectively with specific objectives: maximization or minimization), of which the most important belong to the economical and ecological:

» *the investment's economic efficiency* of entity E / cluster C, define by period of recovery of necessary investment (indicator r), in comparison to standardized period (index rn) specific to the branch $D_r \leq D_{rn} \rightarrow$ min [years] for

~ starting new businesses {A}

~ assimilating new i products

~ the restructuring the entity E

» *the economic efficiency of* the entity E / cluster C *functioning*, define by

~ profitability (profit, profit rate)

~ productivity W_{pa} [EUR, USD, RON, …. / pers.year] → max

~ loading of processing capacity $I_{uc} = Q_{ef} / C_t$ [%] → max

~ other economical efficiency indicators

» *the ecological efficiency of* the entity E / cluster C *functioning*, define by specific and aggregated indicators.

Factors from the external environment M $_{ext}$ of the entity E / cluster C are also, widely spread:

- **{I_{Cl}}**: innovative clustering indicators of entity E / cluster C (increase / decrease rate: number of inoclusters, inoclusters level of competitiveness, ….)
- **{I_m}**: external **conjuncture** indicators at a **mezo** level (increase / decrease rate: economic, catastrophes, pollution, population, professional training, inflation, unemployment, monthly medium-sized income / person, investments, patented and applied inventions, artistic production, ….),
- **{I_M}**: external **conjuncture** indicators at a **Macro** level (increase / decrease rate: economic, catastrophes, pollution, population, professional training, political stability, inflation, unemployment, monthly medium-sized income / person, investments, patented and applied inventions, scientific production, artistic production, sport events, national security, ….),
- **actual demand {D $_{i\ N/m/s/n/c}$ }** of the target exterior environment (**N**ature; **m**arket / **s**egment / **n**iche / **c**renel) with needs (global quality N_{gDi} & physical quantity Q_{Di}) and absorption capacity / solvability C_{sai} specific in a time period.

6. Evaluation of business and innovation clusters

Clustering and performing integrative innovation within inoclusters entail, in a successive-parallel manner, the $K_{id}(t,g)$ lasting integrative competitiveness and welfare (long term) / the $K_{is}(t,g)$ sustainable integrative competitiveness and welfare (unlimited term) of components in external environments $M_{ext}(t,g)$. This fact, consistently demonstrated after 1990, led to developing cluster and clustering evaluation (DIACT, 2006; EU-ECM, 2006; EU-DGEI, 2007; EU-CME, 2007) respectively: (a) qualitative evaluation; (b) identification / monitoring / analysis (mapping); (c) certification; (d) ranking (hierarchy) of performing / competitive clusters. Each method has its advantages and limitations.

(a) Qualitative evaluation (QE) of clusters and clustering is based solely on the use of qualitative information that is available through interviews with local experts

(b) Cluster mapping (CM) is a high potential tool that can help identify, on a statistical basis, the existing, growing, declining and emerging industry clusters in a given geographical area.

(c) Certification of clusters (CC) / clusters of clusters must be conducted by a national and regional authorized body, by using standard criteria and procedures (DIACT, 2006).

(d) Ranking (hierarchy) of performing and competitive **clusters / pre-clusters** can be performed in various manners, by using many various criteria. The lowest number of criteria (aggregated criteria: world export share / world production share / world market share / national market share / regional market share / local market share) allows cluster ranking on **twelve competitiveness levels of clusters**:

[10] world's strongest cluster (leader in the global market)
[9] among world's top 3 (very important shares in the global market)
[8] among world's top 10 (important shares in the global market)
[7] internationally significant cluster (medium shares in the global market)
[6] federally significant cluster (small shares in the global market)
[5] nationally significant cluster (too small shares in the global market)
[4] regionally significant cluster (very small shares in the global market)
[3] area significant cluster (very small shares in the national market)
[2] locally significant cluster (very small shares in the regional market)
[1] establish cluster (uncompetitive cluster)

[-1] existing pre-cluster (uncertain)
[-2] potential embryonic pre-cluster (more uncertain)

7. Conclusion

The present paper presents the new research and action sub-domain defined as "cluster-based sustainable integrative competitiveness (on unlimited term)", by the following contributions:

- a functional-structural definition and characterization of **competitiveness, clusters, clustering**, which allows the systemic approach and the unitary application of these concepts, in most various domains of reality [science (physics, astrophysics, chemistry, biology, health sciences etc.), economics, engineering, computing, management, governance etc.],
- an analysis which emphasizes the essence of progress in any domain of reality: cluster-based sustainable integrative competitiveness,
- a systemic analysis of clusters competitiveness within business and innovation environments, of the progress ways in this domain.

Future research will go deeper in the identification and optimization of clustering and competitive clusters / clusters of clusters in other complex domains of reality.

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