Journal of the Economic Geographical Society of Korea
Vol.13, No.3, 2010(416~441)

Creating Generic Cluster Indicators based upon an Agent-centred Cluster Framework

Jun Ho Jeong* · Hag-Soo Kim**

Abstract : This paper attempts to develop a framework articulating a suite of indicators of cluster development, based upon existing work on the economic geography of clusters, cluster frameworks and indicators and cluster policies. Unlike other work the framework adopted here emphasizes adaptive and proactive roles played by agents, whether individual or collective, within the cluster when understanding it as a learning environment to capture an implication made from adopting the cluster perspective. Some possible indicators are operationalized and suggested even if they are not definitive and exhaustive. The conceptual framework and the specific indicators suggested can provide policy-makers and key stakeholders in clusters with a proper set of tools for measuring the level of cluster development, maneuvering a broader strategic planning exercise for successful cluster development.

Keywords : cluster, agent-centred cluster framework and indicators, learning, cluster policies

1. Introduction

Since the 1990s the cluster phenomenon typically represented as successful local economies such as Silicon Valley in the USA and the Third Italy in Europe has swept through both policy and academic circles due to its positive effects such as rates of new firm formation, productivity, innovation and growth (Porter, 1990, 2001; OECD, 1999). In particular, the policy circle has accepted the cluster theory as an answer to the challenges created by increasing global competition around the globe and the growing significance of innovation in economic growth. According to the

This is a revised version of the paper titled as "Creating generic cluster indicators between Korea and the EU", which was originally prepared for "KORANET Workshop on Co-operation Policy Foresigh" hosted by the Austrian Federal Ministry of Science and Research and National Research Foundation of Korea in 2010.

* Department of Real Estate, Kangwon National University

** Research Fellow, Korea Economic Research Institute

cluster theory, competitive advantage can be generated not only from firm-based resources but also from the resources located in the firm's geographically adjacent business environment. The concept has been so popular around policy-makers as a tool for enhancing national and regional competitiveness, innovation and growth (OECD, 1999, 2001).

In spite of this popularity, the key dimensions of clusters remain highly unclear, their definitions are still disputed and packed with divergent or contradictory meanings to be consistent, and the means of identifying and encouraging clusters are still in its infant stages (Martin and Sunley, 2003; Russ and Jones, 2008). The current fascination with clusters especially in policy circles addresses a need for a comprehensive understanding of the aspects contributing to the development of clusters, and the factors influencing the success or failure of cluster policies in order to effectively, efficiently and appropriately support clusters through public intervention and private initiatives (DTI, 2004). Thus, comparable indicators, whether qualitative or quantitative, of both the incidence and relative degree of cluster development will be a necessary requirement for such an understanding. Given that Korea and the EU are very interested in cluster development initiatives, the elucidation of a theoretically based and easily replicable set of indicators for measuring the current status and future prospects for the development of clusters will be very useful and helpful for both policy-makers and key agents in clusters (Arthurs *et al*., 2009).

This paper examines some of the conceptual issues encountered in generating cluster indicators and proposes a preliminary set of indicators that, if adopted, would provide the basis for future modification. First, reviewing some of challenges regarding the definitions of clusters and existing examples of cluster indicators is conducted in order to recognize the key success factors, the actors and the roles of clusters and their policies as relevant to endogenous national and regional growth in the knowledge-based economy. Second, a generic cluster framework, termed as an 'agent-centred cluster framework' here, is proposed, comprising six domains and twenty-two sub-domains, and then specific indicators, although not definitively and exhaustively, are suggested. Finally, a summary and a conclusion are followed to reflect on the significance of this analysis on cluster indicators.

2. Conceptualizing clusters

1) Existing concepts of clusters

The most widely accepted concept of clusters around policy circles and academia can trace back to Porter's (1990) definition:

"Clusters are geographically close groups of interconnected companies and associated institutions in a particular field, linked by common technologies and skills. They normally exist within a geographic area where ease of communication, logistics and personal interaction is possible. Clusters are normally concentrated in regions and sometimes in a single town".

Porter has considered spatial proximity,

networking and specialization as a crucial constituent of clusters. He suggests clusters as a means of increasing national competitiveness since clusters could be understood as a spatial representation of creating competitive advantages external to individual firms but internal to the cluster as a whole. Although clusters may be viewed as elements determining competitive advantages, they are not necessarily confined to being local but extended to being national or even crossing borders in scope, thus leading to the measurement problem of clusters in a clear and comparable way.

In order to extend Porter's concept and apply it to the level of policy, Nauwelaers (2003), a member of the EU policy advisory group, defines clusters as:

"A cluster is a mode of organization of the productive system, characterized by a geographical concentration of a critical mass of economic actors and other organizations, specialized in a common field of activity, developing inter-relations of a market and non-market nature, and contributing to innovation and competitiveness of its members and the territory".

According to this type of definition, clusters are more than networks and geographical agglomerations because they are conceived as a mode of production or market organization in which other gradients of clusters are added such as structural character, critical mass and the importance of innovation unlike those found in Porter's. Given the EU contexts where cross-bordering economic activities are easily and frequently found, even stimulated, and concerns about the EU's lagging behind its competitor, the USA, in the knowledge-based economy, the scale of economies and innovation are highly taken into account.

As suggested by Maskell and Lorenzen (2004), clusters as a mode of production or market organization have structural characteristics different from networks as a temporary business group formed by project-based business relations (Table 1). While networks are considered as a sort of market organizations with strong ties through institutional arrangements such as the practices of subcontracting in which firms as a shareholder are leading the related economic actors in business. For example, some of the Korean chaebol's subcontracting practices seem to be related to this category, while clusters are operated as a social institution with weak ties where firms as a stakeholder are taking the lead in business such as Silicon Valley in the USA and the Third Italy in Italy. Although clusters as an institutional milieu could not reduce business uncertainty in a substantial way, compared with networks, the related agents are engaged in community building to decrease uncertain business climate in a collective way. Even if clusters do not necessarily guarantee superior economic performance to that of networks, the benefits of clustering arising from geographical proximity can be capsulated: the reduction of costs through the efficiency of resources; and the generation of knowledge through technological externalities (Maskell and Lorenzen, 2004).

In particular, in emphasizing the benefit of knowledge creation derived from spatial clustering more than others in the OECD contexts of delivering innovation policies, den Hertog,

Table 1. A Comparison of market organizations: networks vs. clusters

Networks	Clusters
Institutional arrangements	Institutional milieu
Firm as a shareholder	Firm as a stakeholder
Strong ties	Weak ties
Club institutions	Social institutions
Trust and sunk costs	Social trust and reputations
Codebooks	Social codebooks

Source: Maskell and Lorenzen (2004)

Bergman and Charles (2001) attempt to understand clusters as a reduced innovation system:

"The cluster approach is more than just an analytical instrument for passive use, clusters also offer a robust organizing framework for addressing or removing systemic imperfections in the functioning of these reduced-form national innovation systems (NIS)."

Where the process of innovation may be accepted as an interactive one, clusters could be regarded as an operational translation of innovation systems. This definition appears to be instrumental in that innovation policies may be more and effectively delivered and spatially represented at the local level. The major differences between clusters and innovation systems lie in the degree of specialization and relative importance of innovation. According to Porter's (1990) definition of clusters, the latter may not necessarily become a critical part of cluster development, whilst it becomes a fundamental gradient of innovation systems. The former is relatively higher for clusters than that of innovation systems.

2) Redefining clusters

As earlier mentioned, clusters are geographical phenomena. Before going on a discussion on the definition of clusters, it is needed to distinguish among co-location, agglomeration and cluster. The co-location of firms has little relevance in terms of competitiveness because the firms in question do not underline the local dimension, or they do not consider within it as important vis-à-vis their own competitiveness. For example, during the early days of industrial development in Korea some industrial complexes might be included in this type of the spatial concentration of firms. Agglomeration refers to the case where co-location increases firms' competitiveness because of some economic benefits such as linkage and scale effects. However, these effects are essentially passive. Although firms consider the local area as important, active interactions with other local firms are not highly regarded as critical.

As illustrated in Figure 1, clusters are different from the agglomerations and co-locations of firms because collaborators are located at the center of clustering. Firms' competitiveness could be enhanced by the spatial clustering of firms since it

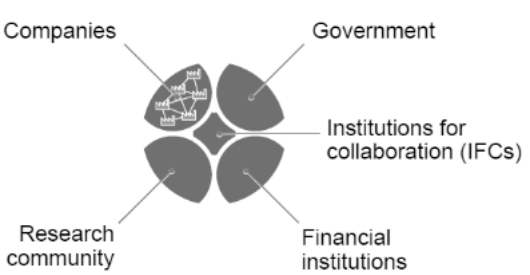


Figure 1. Representative key actors in cluster development

Source: Sölvell, Lindqvist and Ketels (2003)

makes possible collaborative relationships with a range of local suppliers, customers, competitors, universities, research institutions, financial institutions and public agencies.

An eminent economist, Alfred Marshall (1920) suggests three general benefits of industrial concentrations including the pooling of labor markets, intermediate inputs and technological spillovers through which local external economies could be external to individual firms but internal to the cluster as a whole as earlier stated. As Mishan (1971) argues external economy assumes that an economic actor can not recoup all the benefits of his or her investment from the price of products which he or she produced, i.e. some of the benefits are being leaked to other actors. External economies are thus involuntary and incidental in nature. Although local externalities may be considered as a critical part of explaining clusters, it is not sufficient for them to explain the nature of clustering.

As stated before, these benefits appear to be generated in a passive rather than an active way. As Schmitz (1999) argues, deliberate collective actions should be added here for economic actors to capture the true positive effects of spatial clustering, something viewed as a fundamental gradient of clusters. In such a sense, clusters may be regarded as spatial representations generating a collective efficiency, i.e. a type of competitive advantage resulting from a combination of local external economies and deliberate collective actions. Therefore, clusters could be developed not only by the effect of market size (Krugman, 1995) but also by that of formal and informal interactive learning between innovative actors (Saxennian, 1994).

Despite Porter's (1990) popularity of the discussion about clusters in the context of enhancing national and regional economic competitiveness, there is very little agreement about the specific definitions of clusters, the proper public policies in respect to clusters and their success indicators (Martin and Sunley, 2003). Listing the factors comprising clusters have been frequently undertaken, entailing such factors as spatial proximity, vertical and horizontal relationships between the actors, the use of common technology, labor pool, central research center, and quality of the social network among actors.

Given this confusion, clusters need to be seen as a dynamic and complex system. Capitalizing upon existing studies on the definitions of clusters, it is needed to consider three dimensions: economy, society and geography. The dimension of economy means the benefits of external economies, resulting from industrial agglomeration such as the pooling of skilled labor, the networking between intermediate suppliers and the effect of knowledge spillover, as earlier mentioned by Marshall (1920). Since these effects may be incidentally generated in nature, the benefits could be confined only to an individual firm rather than all the firms co-located as a whole. In order to highlight the active nature of clustering and to overcome this weakness in the conceptualization of clusters, it is needed to bring the dimension of society into a vital aspect of cluster development, leading to take into account deliberate collective external effects. That makes possible a reconceptualization of clusters different from the passive industrial agglomeration and simple co-location of economic activities (see

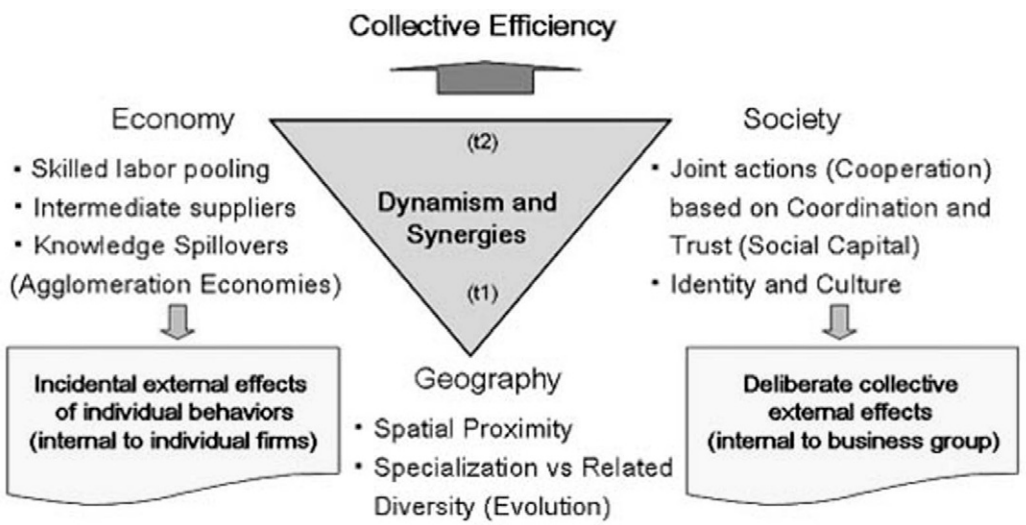


Figure 2. Reconceptualization of clusters: a search for collective efficiency

Source: adapted from Schmitz (1999)

Figure 2).

As illustrated in Figure 2, the development of clusters involves collective actions based upon trust and cooperation and competition allowing social capital to be accumulated in the local area, local identity and culture to be formed among the economic actors participated in the development of clusters. Furthermore, spatial proximity encourages formal and especially informal interactions between economic actors to be more intensified, allowing tacit knowledge to be informally traded and embedded in the local area, and it drives economic activities to be locally specialized, but sometimes related diversity to be evolved such as in the Third Italy (Boschma and Iammarino, 2009). Since the excessive local specialization of economic activities is likely to be susceptible to external economic shocks, thus leading clusters to become more volatile, evolving related variety in local area could be taken into consideration as a crucial component of the development of clusters.

Collective actions include not only bilateral and multilateral cooperation between actors but also cooperation at the horizontal and vertical levels of value chains: strategic alliances, joint R&D, joint utilization of equipment, associations and consortiums, cooperative inter-firm linkages. They are external effects derived from both incidental individual actions and consciously intended joint actions. Clusters can be thus viewed as an economic, social and geographical phenomenon leading both traded and untraded interdependencies into synergism within a certain limited geographic space.

Allowing for three dimensions of clusters - economy, society and geography, clusters could be perceived as a spatial dynamic based upon collective efficiency over time. If the difference between comparative and absolute advantages

may be recognized and clusters are dependent upon the competitive advantage of local area, it would be difficult for successful clusters to be replicated elsewhere. In such a sense the phenomenon of clusters is understood as a world of possibility in which endogenous regional development is sought to cultivate and exploit the capability of local collective assets. Therefore, what is more important in clusters seems to be a group of businesses embedded in the local area rather than an atomic individual firm, making possible not only cost reduction but also innovation. It is expected that more employment and innovation can be generated from a dynamic cluster phenomenon.

3. Reviewing existing work on cluster policies and indicators

1) General aims of cluster policies

At the regional level boosting innovation involves engines, transmissions and drivers in innovation activities which should be combined and recombined to enhance regional economic performance (Russ and Jones, 2008). The engines refer to idea powerhouses, whether public or private research institutes. The transmissions signify intermediary organizations that transfer that power to real businesses in regions. The drivers are the entrepreneurs who should navigate the economic roads of the real world. In some regions the engines are missing. In others engines are powerful but there are few intermediaries to translate those ideas into business ideas. In still others the underlying culture of the region is too path-dependent on large firms opening up a new business. Given these contexts, building up innovation systems appears equivalent to developing clusters at the regional and/or local level, as recommended by den Hertog, Bergman and Charles (2001).

In essence, cluster policies adopt a systemic approach to innovation policies, horizontally linking industrial, regional and technological policy instruments. They may be regarded as a creative and deliberate combinations and strategic extensions of various existing policies. As recommended by OECD (2001), the recent policy focus is upon enhancing conditions for firms to innovate. In this regard, policy intervention for cluster development tends to be focused upon eliminating systemic incompleteness derived from limited inter-firm interactions, asymmetric information, mismatches between knowledge infrastructure and business demand, an absence of major clients and so on (Nauwelaers, 2003), and finally upon driving the effective working of localized innovation systems.

As Andersen *et al.* (2006) point out policy-makers are very interested in identifying and understanding the factors that promote clusters' success because they acknowledge this as being an important contributor to formulating more effective measures supporting clusters to innovate. Critical factors for successful cluster development tend to be shared and common among successful clusters. For example, DTI (2004) has identified and highlighted ten factors for successful cluster development: 1) networks and partnerships; 2) strong skills base; 3) innovation and R&D capacity; 4) the presence of large firms; 5) adequate

infrastructure; 6) entrepreneurial spirit; 7) access to finance; 8) the role of traditional business support activities; 9) the context in which the cluster operates; and 10) the role of a supportive policy environment. Out of critical success factors set out here three factors have appeared to be central to successful clusters including networks and partnerships, strong skills base and innovation and R&D capacity.

However, these attributes set out above do not necessarily appear central to successful cluster development or even it seems to be impossible for clusters to hold all the factors within the limited spatial boundary, i.e. a kind of self-sufficiency syndrome. Policy-makers want these success factors to be installed only in a small industrial estate, i.e. a self-sufficient space. As evidenced by a lot of science parks in Europe, Japan and Korea these types of clusters could be regarded as a valuable real property rather than a hub for innovation (Castells and Hall, 1994). Although physical infrastructure with high quality might increase property values it does not automatically guarantee partnerships and innovation potentials there. In this regard it is noteworthy to state that while cluster development in scope might be local, innovation is not necessarily confined only to being local. Concentrating within a limited locality in a planned way all the activities corresponding to each stage of value chains appears absurd, including R&D, production and assembly, supporting services (e.g.: marketing, financing, business consulting, etc.) and so on.

Furthermore, when intervening in cluster development, the obsession not only with space in scope but also with time in depth should be avoided (DTI, 2004; Andersen *et al.*, 2006). For example, clusters could be developed by the stage of development — embryonic, established, mature and declining — and the type of industry — traditional industries-based cluster and high-tech industries-based one.

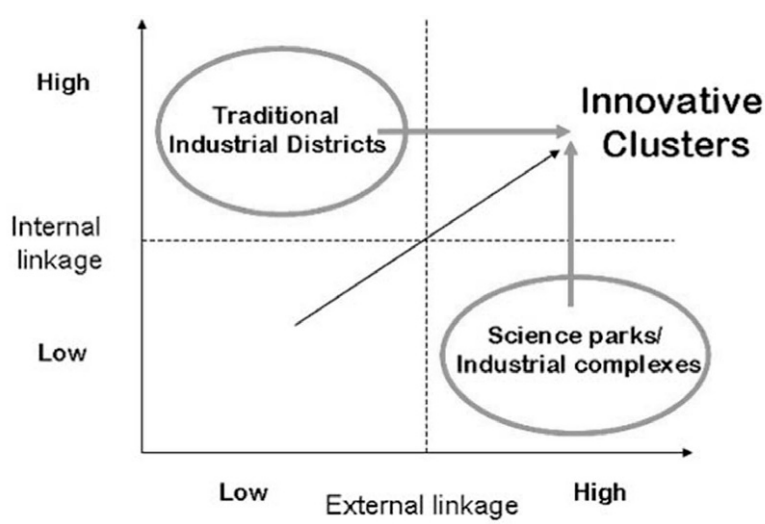


Figure 3. General objectives of cluster policies

The current cluster policies in Korea and the EU generally aim at enhancing competitiveness through innovation. As shown in Figure 3, for example. In the case of industrial districts cluster policies push external linkages to be increased. However, industrial complexes wish to be transformed into innovative clusters through increasing internal linkages based upon cooperation and trust. In other words, the supporting public policies role is to fill the gaps identified in the strengths and weaknesses of clusters.

Especially clusters have caught the attention of economic development policy-makers in the recent years. However, what a cluster policy does and does not mean remains a source of confusion (Cortright, 2006). Some understand that cluster initiatives are just some new sort of government-led economic development program, one that may entail preferring some industries to others, i.e. a new way of picking winners, since clusters have often been discussed as a part of public-sector economic development efforts and deliberate collective actions have been understood as an essential component of cluster development as earlier stated.

It seems that this understanding has prevailed in cluster initiatives in Korea, due to a kind of policy inertia resulting from government-led industrial policies that prevailed in the past years, especially in the 1970's and 1980's. The Korean government has attempted to transform industrial complexes and research parks into innovative clusters since the mid 2000's. For example, Taeduk Research Park has had very weak partnerships and networking within it, few spin-offs and very limited commercialization, while industrial complexes have had no enough innovation potentials, still acting as production bases for exporting.

In summary, the following three factors such as skill, R&D and networks and partnerships (spillovers) appear crucial to successful cluster development. These attributes exactly correspond to those considered as important contributors to endogenous economic growth (Romer, 1986). In this regard, a cluster is said to be a spatial version of endogenous economic growth in that the spatially localized spillover effects of innovation may be augmented through partnerships and networks stimulated by repeated interpersonal relationships within the local area.

2) Existing work on cluster indicators

As mentioned earlier, policy-makers are eager to develop clusters as a means of increasing national and regional competitiveness through innovation. Some work on an understanding of the framework conditions that affect cluster performance, i.e. the factors that promote clusters' success has been undertaken with different aims and perspectives. In this paper four examples have been selected through internet searches and academic papers. They have distinct framework conditions to identify success factors for cluster development and the resulting measurement indicators for cluster performance. In what follows the focus will be put upon the models for measuring cluster performance.

(1) Case 1: Monitor Group, Council on Competitiveness, USA

The first example is concerned with Porter (2001)'s work with the US Council of

Competitiveness to evaluate cluster development and innovative performance at the regional level. Porter (2001) suggested analytical tools, benchmarking results and lessons learned with key decision makers. This work was carried out by the Monitor Group deeply engaged with M. Porter based upon industrial official statistics, firm surveys and in-depth interviews of business leaders. Due to building up a database on this information, it is possible for cluster's economic and innovation performance to be traced over time.

As illustrated Figure 4, the analytical framework tries to link between innovative capacity and resulting economic performance, especially productivity. Depending upon the structure of Porter's Diamond model shown in Figure 5, comprised of four areas of determining regional productivity including 'factor conditions', 'demand conditions', 'context for firm strategy and rivalry', and 'related and supporting industries', indicators consist of three parts: 'innovation', 'business environment' and 'output' (Table 2). 'Innovation' measures regional innovative capacity in terms of the number of patents, fast growth firms and initial public offerings (IPO), and size of venture capital investments, while 'business environment' consists

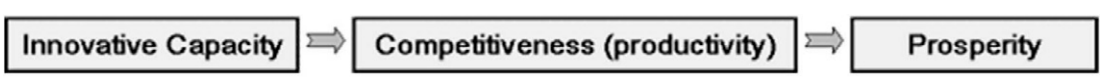


Figure 4. Monitor Group's framework conditions for innovation

Source: Porter (2001)

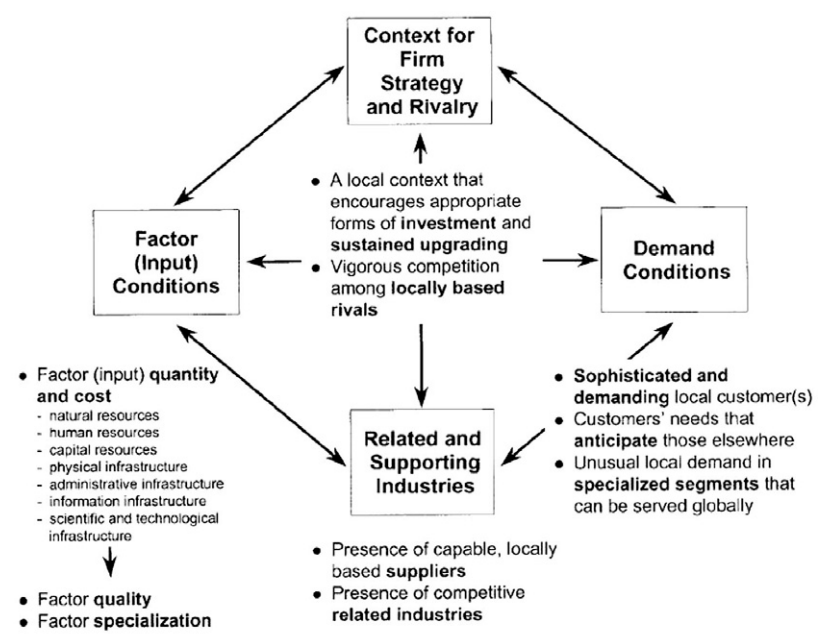


Figure 5. Porter's diamond model: determinants of regional productivity

Source: Porter (2001)

Table 2. Innovation indicators: the case of the Monitor Group

Innovation	Business Environment		Output
	Common	Cluster-specific	
Patents	Basic research	Specialized research centers	Employment
Venture capital Investments	Skills of workforce	Specialized talent base	Wage
Fast Growth Firms	Education	Specialized training	Productivity
Initial Public Offerings	Physical Infrastructure	Sophistication of demand	Exports
	Supply of Risk Capital	Intensity of rivalry	
	Quality of Life	Degree of cooperation	
		Related and supporting	

Source: Porter (2001)

of two parts: 'common' and 'cluster-specific'. The first part is measured in terms of degree of basic research, skills of workforce, education, physical infrastructure, availability of risk capital and quality of life, whist the latter is composed of indicators such as specialized research centers, specialized talent base, specialized training, sophistication of demand, intensity of rivalry, degree of cooperation and related and supporting determining region-specific competitiveness.

'Output' measures cluster's economic performance in term of regional average wages, unemployment, productivity and exports reflecting the overall economic conditions. It is expected that there is a temporal lag between input (innovative capacity) for increasing productivity and output represented by prosperity.

(2) Case 2: Massachusetts Technology Collaborative, USA

The second example is related to the work of the John Adams Institute (2009) responsible for analyzing critical issues of Massachusetts in the USA, identifying needed actions and resources, promoting collaboration among key agents and supporting policy-making. Since 1997 the John Adams Institute has published an annual Index of the MA Innovation Economy capitalizing upon the analytical framework for innovation illustrated in Figure 6. This framework presents a link between resources to economic results through an innovation process that refers to the dynamic interaction between research, technology development and business development. Finally, the economic impact evaluates the outcomes produced by the innovation economy, which is divided into parts: cluster and state level. Innovation potential accounts for resources such as skilled labor, market demand and cluster environment.

This model presents cause and effect linkages between framework conditions and cluster performance. The indicators selected for each of the framework's three areas illustrated in Table 3 are based upon objective and reliable statistical data sources.

The indicators consist of three domains: 'innovation potential', 'innovation process', and

'economic impact'. The first measures regional innovative capacity in term of inputs, finance, human resources, R&D, demand, and quality of life using indicators such as resources, investment capital, federal academic and health R&D expenditures, intended college major of high school seniors & high school dropout rates, public secondary & higher education expenditures, educational attainment and engineering degrees awarded, population growth rate and migration, and housing affordability. 'Innovation process' consists of three parts that measure 'business development' in term of new business incorporations, IPO and M&A and technology fast 500 firms and Inc. 500 firms; 'technology development' in terms of small business innovation research awards and regulatory approval of medical devices and biotechnology drugs; 'research' in term of corporate R&D expenditures, publicly-traded companies, patent applications, patent awards and invention disclosures, technology licenses, royalties and industry-sponsored academic award. 'Economic impact' assesses regional and cluster's economic performance in terms of employment, wage, sales, household income, and exports (Table 3). These specific indicators have been a little bit modified over time and several ones are compared with the national averages.

(3) Case 3: National Research Council, Canada

The third example is associated with the cluster initiative of Canada's National Research Council (NRC) that has been an advocate of cluster-based development since the mid-1990s (Arthurs *et al.*, 2009). It has been aimed at developing local

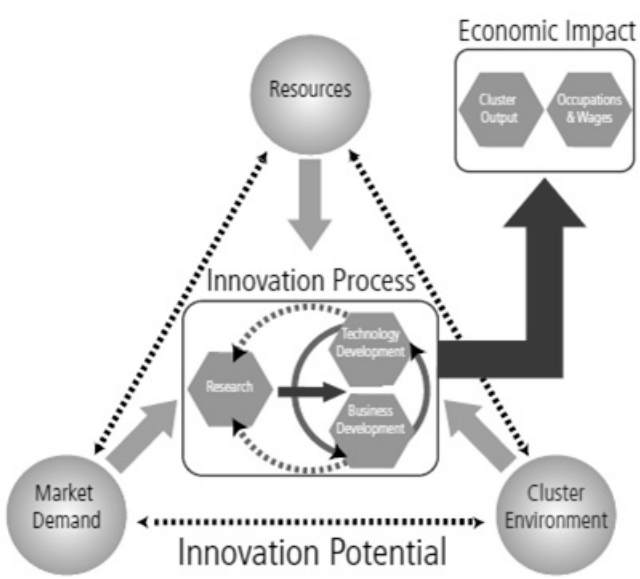


Figure 6. MTC's innovation framework

Source: John Adams Institute (2009)

Table 3. 2008 Index of the Massachusetts Innovation Economy

Innovation Potential	Innovation Process			Economic Impact
Resources	Business Development	Technology Development	Research	
Investment Capital	New Business Incorporations	Small Business Innovation Research Awards	Corporate R&D Expenditures, Publicly-Traded Companies	Industrial Cluster Employment & Wages
Federal Academic and Health R&D Expenditures	IPO and M&A	Regulatory Approval of Medical Devices and Biotechnology Drugs	Patent Applications, Patent Awards and Invention Disclosures	Corporate Sales, Publicly-traded Companies
Intended College Major of High School Seniors & High School Dropout Rates	Technology Fast 500 Firms and Inc. 500 Firms		Technology Licenses, Royalties and Industry-Sponsored Academic Award	Occupations and Wages
Public Secondary & Higher Education Expenditures				Household Income
Educational Attainment and Engineering Degrees Awarded				Manufacturing Exports
Population Growth Rate and Migration Housing Affordability				

Source: John Adams Institute (2009)

capacity in science- and technology-based innovation with the broader goal of supporting national economic growth. NRC requires indicators to screen the progress of its cluster initiatives, to support reporting requirements to the federal government, to assist in program planning and management of current and future initiatives, and to help communications with actors within the clusters, the provinces and the government (Arthurs *et al.*, 2009).

As shown in Figure 7 the NRC cluster framework divides between current conditions (inputs) and current performance (outputs) and specifies those areas where NRC involvements have an influence as indicated by grey boxes. NRC considers cluster performance as a result of firm activities affected by various framework conditions because NRC recognizes that a cluster is in essence a business process. Furthermore, NRC acknowledges that all the indicators are not equally important to the conditions or performance of a cluster (Arthurs *et al.*, 2009).

Cluster indicators are made up of two components: 'current conditions' and 'current performance'. The first consists of three constructs that measure the cluster's supporting organizations,

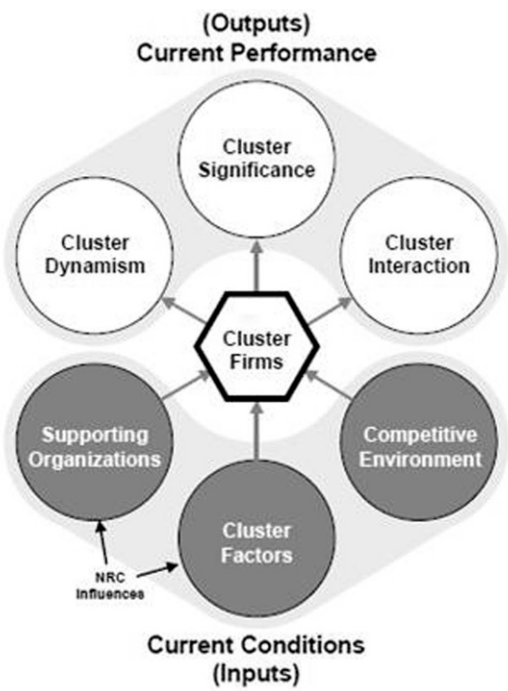


Figure 7. NRC's cluster framework

Source: Arthurs *et al.* (2009)

the competitive environment of customers and competitors, and the factors in the environment of the cluster which affects all of these actors, while the latter is comprised of three constructs which evaluate the cluster's significance in terms of the number and size of core companies, the span of their responsibilities and their reach to distant market; interactions within the cluster and beyond the cluster; and the cluster's dynamism in terms of innovativeness and growth. The cluster performance as a whole relies upon the success of the individual firms and is regulated by cluster factors, supporting organizations and competitive environment (Table 4).

(4) Case 4: Cluster Benchmarking Model, Norway

The final example is the Norwegian cluster benchmarking model (Andersen *et al.*, 2006). It is

Table 4. NRC's cluster model constructs and indicators

Inputs

Concepts	Constructs	Sub-constructs	Indicators
Current Conditions	Factors	Human Resources	Access to qualified personnel
			Local sourcing of personnel
		Transportation	Quality of local transportation
			Quality of distant transportation
		Business Climate	Quality of local lifestyle
			Relative costs
			Relative regulations and barriers
	Supporting organisations	Innovation and Firm Support	Contribution of NRC
			Contribution of other research organisasations
		Community Support	Government policies and programmes
			Community support organisations
			Community champions
		Suppliers	Local availability of materials and equipment
			Local availability of business services
			Local availability of capital
	Competitive Environment	Local Activity	Distance of competitors
			Distance of customers
		Firm capabilities	Business development capabilities
			Product development capabilities

Outputs

Concepts	Constructs	Sub-constructs	Indicators
Current Conditions	Factors	Human Resources	Access to qualified personnel
			Local sourcing of personnel
		Transportation	Quality of local transportation
			Quality of distant transportation
		Business Climate	Quality of local lifestyle
			Relative costs
			Relative regulations and barriers
	Supporting organisations	Innovation and Firm Support	Contribution of NRC
			Contribution of other research organisasations
		Community Support	Government policies and programmes
			Community support organisations
			Community champions
		Suppliers	Local availability of materials and equipment
			Local availability of business services
			Local availability of capital
	Competitive Environment	Local Activity	Distance of competitors
			Distance of customers
		Firm capabilities	Business development capabilities
			Product development capabilities

Source: Arthurs *et al.* (2009)

concerned with elaborating a model of cluster-specific growth drivers in the knowledge economy. Furthermore, this model takes up the drivers of growth in the knowledge-based economy developed by the OECD (2001) in terms of access to and use of human resources, knowledge building and knowledge sharing, and entrepreneurship as shown in Figure 8.

Cluster-specific framework conditions are then examined and the relationships between framework conditions and performance are considered. In this model the focus is upon the microeconomic framework conditions for innovation in terms of access to and use of human resources, access to and use of knowledge, rivalry, and dynamism from new firms. Economic outcomes are measured in terms of employment, productivity, wages, profits, turnovers, exports, and so on, as with most cluster analytical models set out before. As Andersen *et al* (2006) point out this model allows the government to develop fact-based cluster policies.

Drawing upon the examples of cluster analytical models, some characteristics can be drawn as follows:

First, most cluster analytical models are based upon Porter's (2001) diamond model and Marshall's (1920) three factors for industrial agglomerations as central gradients of cluster-specific performance. In fact, they could be said to be an extension and modification of these two models. However, as earlier mentioned, these two models appear better suited to industrial-focused economy rather than knowledge-based economy. The MTC and Norwegian models are exceptions, with being better adapted to the knowledge-based economy.

Secondly, most of the attempts on generating cluster indicators approach in a similar way in which similar data are employed and gathered, capitalizing upon information from a combination of statistics and surveys. There exist limited endeavors to compare and benchmark with most-performing clusters (Andersen *et al.*, 2006).

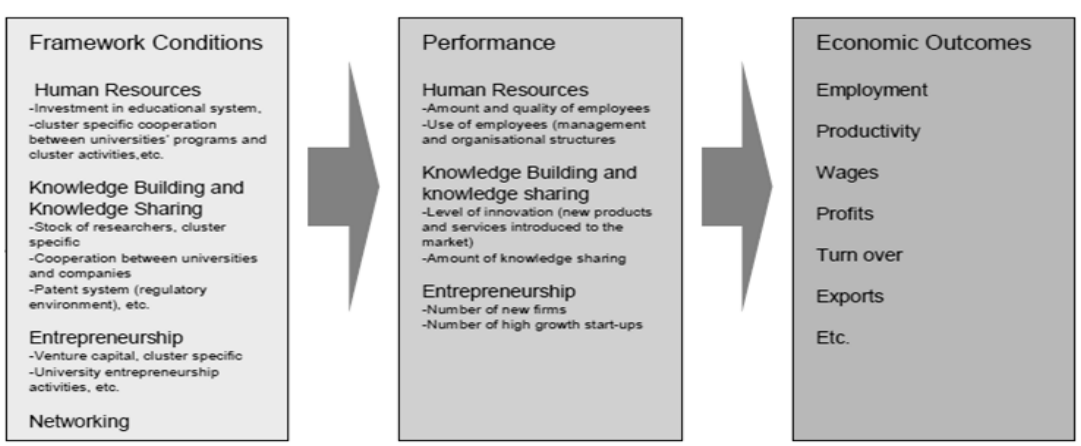


Figure 8. Cluster benchmarking model constructs and indicators

Source: Andersen *et al.* (2006)

Finally, any systematic attempts have not been made to examine the correlation and/or causal relationship between cluster-specific framework conditions and cluster performance. Although the examples presented above assume that the framework conditions are input factors that affect the cluster performance expressed as outputs, it appears difficult to distinguish the apparent relationship between them. Thus, there exists little evidence of using consistent indicators by which to measure cluster development as pointed out by DTI (2004).

3. Creating cluster indicators

As implied from the above discussions on clusters, current cluster policies reflect clearer awareness of the economic and social interventions at a local level which support the emergence of strong, innovative economies. Also, the concept of cluster which has been so attractive to policy-makers may be due to the recent key policy trends appearing in Europe and in Korea: 1) the decentralization of policy-making authorities to a sub-national level; 2) a shift of policy intervention to more systemic approach to development; 3) a more private sector engagement in the design and implementation of policy (Taylor and Raines, 2001).

Such popularity of cluster policies across policy circles has addressed a need to monitor and measure the performance of cluster over time and space as above presented by some examples regarding cluster indicators. It seems, however, the case that there is little evidence of using reliable indicators by which to track the development of cluster. In this regard creating such indicators is important for two reasons: to assess the impact of cluster measures; and to benchmark performance (DTI, 2004). In what follows drawing upon the above knowledge regarding the elements of clusters and examples of cluster indicators developed, an attempt will be made to do so.

1) Criteria for selecting cluster indicators

As already set out in the discussion on the concept of clusters, since clusters are multi-faceted, it appears essential to acknowledge this and reflect those elements conceived as the most important in cluster development. Thus, understanding the different aspects of clusters and tracking their respective performance as cluster indicators are a vital step in identifying the strengths and weaknesses of clusters and the appropriateness of consequent policy interventions.

Given this awareness of the nature of clusters, Russ and Jones (2008) recommend some criteria for selecting cluster indicators as follows:

- Evolutionary nature of clusters should be considered.
- Complex adaptive system character of clusters should be considered.
- Social and human capital aspect of clusters should be considered.
- Knowledge should be identified and measured.
- Networking aspects of clusters with the environment should be considered.
- Activities as well as institutions should be identified and measured.

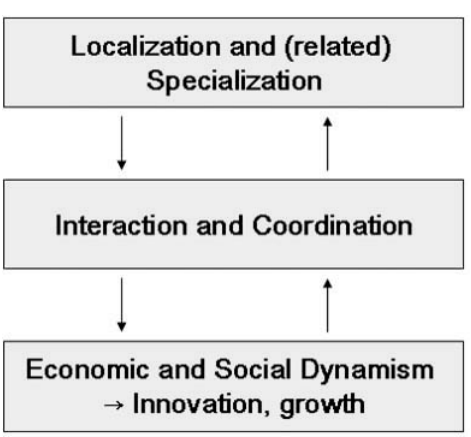
• Funding should be identified and measured.

DTI (2004) suggests the most important dimensions of clusters which should not be missed in developing cluster indicators, involving 'networks and partnerships', 'innovation R&D', 'skills', and 'economy and enterprise', the first three aspects encapsulated as the fundamental drivers of cluster development; whilst the last one as the economic performance of clusters.

Keeping in mind the different and complex aspects of clusters, cluster indicators should capture at least three elements: localization, interaction and coordination, and economic dynamism illustrated in Figure 9. Clusters are based upon general economic principles involving the Smithian social divisions of labor, the Arrowian learning by doing, the Schumpeterian innovation and entrepreneurship, allowing clusters to generate positive local external economies such as knowledge spillovers, social networks and inter-firm linkages, while negative effects such as lock-in effects derived from excessive specialization, decreases in perceived competitive pressures from more emphasis upon the building-up of local community and self-sufficiency syndromes from strong ties among agents and excessively planned policy intervention for picking winners as before mentioned.

What the current cluster policies are regarded as more than a repackaging of existing policies is that they are different from traditional networking policy in that promoting networks involves not only individual linkages between firms but also the links between these firms and other competitive sources such as research centers, universities and supporting service firms, addressing collective market failures in cluster development especially with regard to skill and R&D capacity (Taylor and Raines, 2001).

As shown in Table 5, it appears very difficult to measure most important aspects of clusters in comparable and quantitative ways. For example, geographical co-location and industrial input-output linkages may be relatively easily measured, while informal knowledge spillovers and



General Economic Principles involved:

- Smithian division of labor
- Arrowian learning by doing
- Schumpeterian innovation and entrepreneurship

Derived from cluster's benefits:

- Knowledge spillovers
- Social networks
- Inter-firm linkages

Figure 9. Three aspects intrinsic to clusters

Table 5. Degree of measuring illustrative some benefits of clustering

Characteristics of Clusters	Social Context	Degree of measurement
Co-location	Shallow	Easy
Co-location and Technological Proximity	↓	↓
Input/Output Complementarities		
Co-location and Synergic effects		
Marshallian Externalities		
Network Firms		
Labour Mobility		
Explicit Collaboration		
Informal Knowledge Spillovers	Rich	Hard

cooperation can not be easily measured, belonging to the dimension of interaction and coordination, because the intangible benefits of clustering have profound and rich social contexts.

In spite of this difficulty with reflecting as many aspects of clusters as possible and measuring exactly the different aspects of clusters, especially intangible ones frequently cited as the most important aspects in cluster development, measuring the performance of clusters should reflect improvements in the performance of constituent parts of clusters and the consequent effects which have had on the development of clusters.

2) Agent-centred cluster framework

With increased attention on innovation occurring not only within firms but also between firms and other sources of sectors and regions, innovation has been increasingly understood as an incremental and social process of knowledge networking (OECD, 2001). In addition, there is an awareness of such knowledge being generated through a sort of localized process, i.e. the concept of clusters. These points make it possible for policy-makers to know them as the function of a local system consisting of firms, supporting organizations, research community and so on. Supposing that learning is in general understood as a process of translating information into knowledge, clustering could be regarded as the development of learning environment.

According to Argyris and Schon (1978), there are three types of learning: single-loop learning; double-loop; learning and triple-loop learning. The first refers to a process of detecting and correcting drawbacks on behavior based upon experience like trials and errors, the best described as a simple signal-response model of behavior such as adjusting levels of output with regard to demand, with a view to achieving existing goals and objectives not moving beyond the current values and norms. The second type of learning, conceived as a model of response and adjustment, tends to question goals and assumptions derived

from existing framework through reconceptualizing problems and restructuring priorities and assumptions, leading to improve the flow of knowledge and information within firms. The third type of learning described as learning to learn refers to a high order process of conceptualizing key components of the modus operandi of learning system consisting of the relationships between firms and other sources of sectors and regions, requiring agents to reflect on existing systems of innovation and to accept new ides and a ways of operating contributing to competitiveness in a proactive way.

Supposing that clusters may be viewed as an effective means to improving innovation and knowledge based upon a systemic approach, they can be referred to as a kind of learning environment in which double and triple-loop learning play a key role in innovation (Paul *et al.*, 2004) as illustrated in Figure 10. As cluster development is based upon the collective and institutionalized dimensions of clusters, a concern could be raised that the role of individual agents may be underestimated (Paul *et al.*, 2004). As already discussed, the nature of clusters is collective and institutionalized, contributing to innovation and knowledge, and policy interventions for cluster development have also a systemic approach rather than an individual orientation, which appears deeply associated with the type of tripe-loop learning. Agents are both individual and collective in the course of cluster development. Building up cluster communities thus involves cultivating the common sources of competitiveness within the cluster such as skills, the specific linkages among agents across sectors and regions and an awareness of the cluster's competitiveness with regard to other clusters, reinforcing the internal community by a recognition of collective advantages and external rivalry (Taylor and Raines, 2001).. In this regard the role of agents, whether individual or collective, is not necessarily underplayed.

The element of cluster, partnerships and networks, frequently cited as the most important in cluster development may be formed through a strategic approach adopted by policy-makers although interventions supporting innovation may

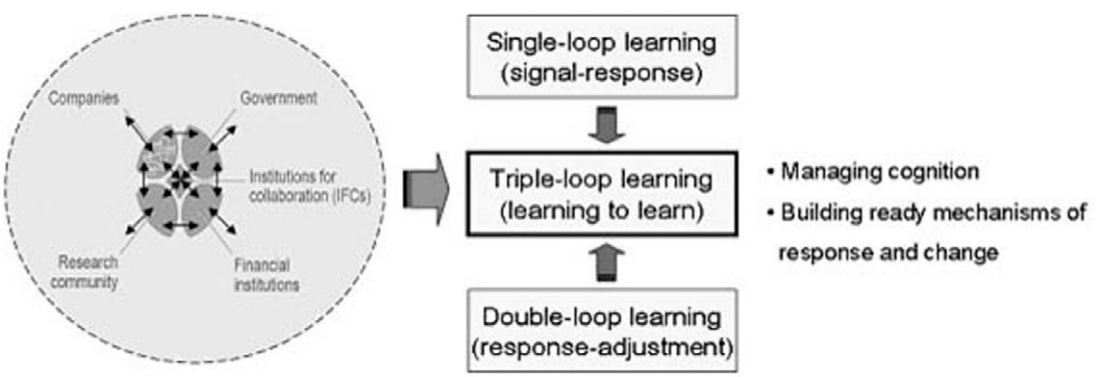


Figure 10. Clustering as a learning environment

Source: adapted from Paul *et al.* (2004)

take some time to come to fruition. Cluster leadership and identity deliberately coordinated and intentionally created by a variety of actors in clusters provide a basis for organizing systems of triple loop learning for the growth of innovation.

Both types of double-loop and triple-loop learning directly related to innovation respectively imply the adaptive and proactive efforts of agents (Paul *et al.*, 2004). It is thus assumed that agents are more than their environments, enabling them to select, adapt or ignore aspects of their existing configurations of innovation and to deliberately and strategically make up new learning systems through the continuous questioning of existing attributes of clusters.

In this sense recognizing adaptive and proactive agents is important in cluster development. Measuring this refers to being more interested in the dimensions of interactions and coordinations with a systemic perspective, avoiding 'local traps' (Paul *et al.*, 2004). In the sense of relatively more emphasizing the open and dynamic governance and networking with weak ties, the cluster framework for creating cluster indicators is termed as an 'agent-centred cluster framework' shown in Figure 11.

As with other examples presented above the agent-centred cluster framework in this paper assumes that there is a causal and correlation link between drivers and output. The dimension of drivers consists of two parts: tangible drivers termed as 'value chain' and 'innovation base'; intangible ones as 'governance' and 'networking', while the element of output is called as 'dynamism'. The tangible drivers may be considered as measuring the aspect of clusters referring to as 'localization and specialization', whilst the intangible ones as assessing the part of clusters indicating 'interaction' and 'coordination'. The output corresponds to the economic

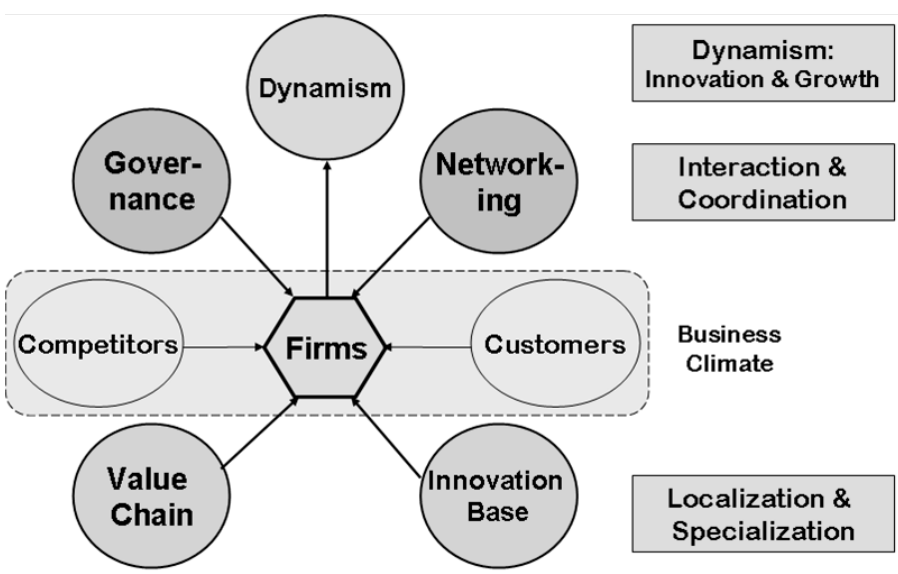


Figure 11. agent-centred cluster framework

performance of clusters measured as innovation and growth.

In addition, although Porter (2001) has especially referred to 'firm strategy and rivalry' and 'demand conditions' as one of the most important factors determining regional productivity, the part of these is combined in this model as 'business environment' consisting of competitors, customers and business climates because local rivalry and demanding customers may be thought to be less important in clusters in Korea and the EU than in clusters in the USA.

Comparing the framework with Porter's model (2001), both 'value chain' and 'innovation base' are almost analogous to Porter's 'factor conditions' and 'networking' nearly corresponds to Porter's 'related and supporting industries'. With regard to the former, this framework has two constructs unlike Porter's model (2001) in order to reflect both the nature of clusters as business processes across firms' value chains and the degree of innovativeness which has been much less highlighted in Porter's model (2001) as set out before.

In contrast to Porter's model (2001) and other examples presented above, this framework endeavors to highlight deliberate public and private efforts to build up community-based relational capital with weak ties as well as strong ties, promoting trust, the sharing of knowledge and the questioning and reframing of norms and assumptions and contributing to long-tern collective competitiveness. In this paper the term 'governance' is employed in the sense that it denotes not only shared schemas for regulating behavior and disseminating information but also coordinating and guiding mechanisms whereby knowledge is created, operated and refined and existing knowledge is sometimes discarded to help learning and innovation (Paul *et al*., 2004).

3) Cluster indicators selected

The choice of indicators relies upon the nature of the cluster, the nature of intervention adopted, and the overall policy objective (DTI, 2004). For the indicators to be valid and helpful, they should identify measurable variables as well as be operational, i.e. to be affected by the policies and decisions of the driving factors. The rationale for creating indicators is that someone may need to repeat the process of identifying and measuring a number of times for different clusters. From a policy-maker's point of view, the intent of setting up a compilation of indicators is to gauge the progress of collaborative cluster initiatives, assist in driving the process, align partners and improve fact-based communication with the public. Rather than using results of subjective personal agendas to drive the strategic change initiative, the indicators could provide facts, establish a history and assist in identifying and determining trends (Russ and Jones, 2008).

Although this framework adopted here appears to be similar and consistent with the proposed framework of measurement found in the existing work earlier illustrated as already mentioned, the construct 'governance' has been relatively more highlighted to emphasize both public and private deliberate and intended endeavors to alter and reframe collective learning system within the cluster. Since the work of measuring clusters still remains in its infancy, it would almost be impossible to definitely measure the performance

of a cluster.

As illustrated in Table 6 and 7 the agent-centred cluster framework adopted here is operationalized through specified indicators, capitalizing upon existing studies on cluster indicators as already mentioned. These indicators involve the approach that the different aspects of clusters should be identified and measured as already mentioned. Potential indicators recommended in Table 6 and 7 below are neither definitive nor comprehensive but offer an illustration of possible indicators by which cluster development can be identified and measured.

'Value chain' consists of three sub-domains measuring various factor conditions across the firms' business processes within the cluster including R&D capability, production suppliers and supporting services. 'Innovation base' is made up of four sub-domains that assess the degree of provision of physical and innovative bases encompassing human resources, financial capital, physical infrastructure and information infrastructure. 'Business environment' is measured in term of local competitors, demanding customers and business climates like relative costs of living and doing business.

'Governance' consists of four sub-domains that identify and measure the extent of social capital and public and private efforts for building up community-based relational capital, entailing internal awareness and external representation, public policies and programs, recognition and social capital and responsibility. 'Networking' measures the degree of interactions within the

Table 6. Illustrative cluster indicators: tangible drivers

Domains	Sub-domains	Indicators
Value chain	R&D capability	• Contributions of local institutions to ideas, knowledge and innovation • Availability of technology transfer capability
	Production suppliers	• Local availability of materials and equipment
	Supporting services	• Local availability of business services
Innovation Base	Human resources	• Access to qualified personnel • Sources of qualified personnel • Distance of qualified personnel sources
	Financial capital	• Local availability of (risk) capital
	Physical Infrastructure	• Quality of local transportation infrastructure • Connections to national and international transportation systems • Availability of specialized form of infrastructure
	Information Infrastructure	• Access to key business information • Quality of communication infrastructure
Business Environment	Competitors	• Distance of most important cluster's competitor
	Customers	• Distance of most important cluster customers
	Business climate	• Relative businesses costs of living, doing business

Sources: modified from Cassidy *et al.* (2009); Porter (2001); and Russ and Jones (2008)

Table 7. Illustrative cluster indicators: intangible drivers and outputs

Domains	Sub-domains	Indicators
Governance	Internal and external awareness representation	• Internal awareness of cluster members • Existence of shared representation • Engagement with some of trade associations
	Public policies and programs	• Contributions of public institutions to ideas, knowledge and innovation • Provisions of public-aided funds for new product development • Targeted inward investment promotions
	Recognition	• External recognition by others • Collective (marketing) initiatives to attract external actors
	Social capital and responsibility	• Relative innovativeness • Quality of local lifestyle • Economic inequality • the amount of donation
Networking	Inter-firm linkages	• Partnerships and alliances within cluster's firm • Engagement in clustering activities • Linkages within the cluster network
	Academic and community resources and support	• Adequacy of local development support • Adequacy of academic (vocation schools, colleges, universities) local support
	Linkages between clusters	• Partnerships and alliances between clusters • Engagement in inter-clustering activities • Linkages between cluster networks
Dynamism	Employment	• Number of persons employed per cluster
	Wages	• Pay of cluster per employed in cluster
	Productivity	• Value added per employee in cluster
	Exports	• Value of commodity exports per industry and cluster
	Innovativeness	• Revenues from new product development

Sources: modified from Cassidy *et al.* (2009); Porter (2001); and Russ and Jones (2008)

cluster and the rest of the world. 'Dynamism' gauges the performance of the cluster in terms of innovativeness and growth.

The data for the framework indictors can be collected through a series of standardized firm surveys, official business statistics and structured interviews with a subset of firms and other key actors in clusters. Because many of the benefits of clustering, including the creation of tacit knowledge, social capital and the backing of collective learning, are intangible and thus difficult to gauge. After collecting the data for the indicators, an interpretative task should be undertaken in order to have value for policy makers and cluster stakeholders, to compare between clusters and to benchmark successful clusters in the context of the cluster's stage of development.

4. Concluding remarks

This paper has attempted to develop a framework articulating a suite of indicators of cluster development, capitalizing upon existing work in this field. Unlike other work the framework adopted here stresses adaptive and proactive roles played by agents, whether individual or collective, within the cluster when understanding it as a learning environment to reflect an implication made from adopting the cluster approach that involves complex coordination mechanisms between a wide group of different actors in the public, private and non-profit sectors in addition to a key group of firms. Some possible indicators have been operationalized and suggested even if they are not definitive and exhaustive.

Drawing upon the critical work on the definitions of clusters, clusters are thought to be found as multi-faceted: economy, geography and society. The work of measuring clusters undertaken here endeavors not to miss the different aspects of clusters cited as the most important for the development of clusters.

Both the general conceptual framework and the specific indicators derived from it, even if illustrative and modified only from existing work and examples, not from real surveys and interviews conducted with firms and key actors in clusters in Korea and the EU, can provide policy-makers and key stakeholders in clusters with a proper set of tools for measuring the level of cluster development, comparing them between Korea and the EU and maneuvering a broader strategic planning exercise for successful cluster development.

References

Andersen, T., Bjerre, M. and Hansson, E. W., 2006, *The Cluster Benchmarking Project: Pilot Project Report: Benchmarking Clusters in the Knowledge-based Economy*, Nordic Innovation Center, Oslo.

Argyris, C. and Schön, D. A., 1978, *Organizational Learning: A Theory of Action Perspective*, Addison-Wesley, MA.

Arthurs, S., Cassidy, E., Davis C. H. and Wolfe, D., 2009, "Indicators to support innovation cluster policy," *International Journal of Technology Management* 46(3/4), pp.263-279.

Boschma, R. A. and Iammarino S., 2009, "Related variety, trade linkages and regional growth in Italy," *Economic Geography* 85(3), pp.289-311.

Castells, P. and Hall, P., 1994, *Technopolis of the World: the Making of the 21st Century Industrial Complexes*, London: Routledge.

Cortright, J., 2006, *Making Sense of Clusters: Regional Competitiveness and Economic Development*, The Brookings Institution Metropolitan Policy Program, Impresa.

DTI, 2004, *A Practical Guide to Cluster Development*, London: HMSO.

den Hertog, P. Bergman, E. M. and Charles, D., 2001, "Creating and sustaining innovative clusters: towards a synthesis", in OECD (ed), *Innovative Clusters: Drivers of National Innovation Systems*, Paris: OECD, pp.405-419.

John Adams Institute, 2009, *Index of the MA Innovation Economy*, Massachusetts Technology Collaborative.

Krugman, P., 1995, *Development, Geography and Economic Theory*, MIT Press, MA.

Marshall, A., 1920, *Principles of Economics: An Introductory Volume* (8th edition), London:

Macmillan.

Martin, R. and Sunley, P., 2003, "Deconstructing clusters: chaotic concept or policy panacea?", *Journal of Economic Geography* 3(1), pp.5-35.

Maskell, P. and Lorenzen, M., 2004, *Firms & Markets, Networks & Clusters: Traditional & Creative Industries*, paper presented to DRUID Winter-Conference, 2004.

Mishan, E. J., 1971, "The Post-war literature on externalities: an interpretative essay", *Journal of Economic Literature* 9(1), pp.1-28.

Nauwelaers, C., 2003, *Innovative Hot-Spots in Europe: Policies to Promote Trans-border Clusters of Creative Activity*, Background Paper on Cluster Policies prepared for Trend Chart Policy Workshop, 5-6 May 2003 Luxembourg, EU Commission.

OECD, 1999, *Boosting Innovation: the Cluster Approac*h, Paris: OECD.

OECD, 2001, *Innovative Clusters: Drivers of National Innovation Systems*, Paris: OECD.

Paul, T., Clark, G. and Smith, H. L., 2004, "Cognition, learning and European regional growth: an agent-centred perspective on the "new" economy", *Economics of Innovation and New Technology* 13(1), pp.1-18.

Porter, M. E., 1990, *The Competitive Advantage of Nations*, New York: Basic.

Porter, M. E., 2001, *Clusters of Innovation: Regional Foundations of U.S. Competitiveness.*

Romer, P., 1986, "Increasing returns and long-run growth", *Journal of Political Economy* 94, pp.1002-1037.

Russ, M. and Jones, J. K., 2008, "Regional economic development indicators for a knowledge-based economy with knowledge deprivation", *Journal of Regional Analysis and Policy* 38(2), pp.189-205.

Saxenian, A., 1994, *A Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Harvard University Press, MA.

Schmitz, H., 1999, "Collective efficiency and increasing returns", *Cambridge Journal of Economics* 23, pp.435-483.

Sölvell, Ö., Lindqvist, G., and Ketels, C., 2003, *The Cluster Initiative Greenbook*, Ivory Tower, Stockholm.

Taylor, S. and Raines, P., 2001, *Learning to let go: the role of the public sector in cluster building in the Basque Country and Scotland*, European Policies Re-search Centre (Paper No. 48), University of Strathclyde.

교신: 정준호, 200-701, 강원도 춘천시 효자 2동 192-1, 강원대학교 사회과학대학 부동산학과, 전화: 033-250-6838, 이메일: jhj33@kangwon.ac.kr

Correspondence: Jun Ho Jeong, Department of Real Estate, Kangwon National University, 192-1, Hyoja-2dong, Chuncheon, Kangwon-do, 200-701, Korea, Tel: +82-33-250-6838, e-mail: jhj33@kangwon.ac.kr

최초투고일 2010년 8월 10일
최종접수일 2010년 9월 13일

한국경제지리학회지 제13권 제3호 2010(416~441)

행위주체 중심 클러스터 사고 틀에 기반한 클러스터 지표 개발에 관한 연구

정준호* · 김학수**

요약: 클러스터에 관한 경제지리학, 클러스터 사고 틀과 지표에 관한 기존의 사례와 연구에 대한 비판적 검토를 통해 본 연구는 행위주체 클러스터 사고 틀에 기반한 일반적인 클러스터 지표를 개발하고 이를 제시한다. 기존의 연구와는 달리, 클러스터가 기업뿐만 아니라 다양한 공공, 민간 행위주체 간의 복잡한 조정 메커니즘을 수반하여 이들 간의 학습 시스템으로서 클러스터가 이해될 수 있다는 점에서, 본 연구는 개별 또는 집합적인 행위주체가 수행하는 적응적이고 전향적인 역할을 강조한다. 이를 바탕으로 사용 가능한 클러스터 사고 틀과 지표들이 기존 연구들에 대한 수정과 보완을 통해 제시된다. 이러한 지표는 매우 포괄적이고 확정적인 것은 아니지만, 클러스터 정책입안자나 주요 행위주체들에게 해당 클러스터 발전의 적정한 측정과 그에 따른 발전방향을 제시하는 유용한 척도로서 기능할 수 있을 것이다.

주요어: 클러스터, 행위주체 중심 클러스터 사고 틀과 지표, 학습, 클러스터 정책

* 강원대학교 사회과학대학 부동산학과
** 한국경제연구원 연구위원