

CLUSTERS DEVELOPMENT AND INTEGRATION SUPPORTING TOOLS AND METHODS

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Abstract: The article presents general concept of cluster evolution process. On the base of this model a new complex characteristic was built with additional details concerning each phase in course of integration process. The paper contains also suggestions of appropriate aiding tools useful during cluster shift towards more advanced forms. Both, the detailed model of cluster evolution as well as the set of applications supporting it were specified on a base of previously obtained experience during cluster CINNOMATECH structuring.

Key words: cluster development, applications, tools.

1. Introduction

The contemporary trends in manufacturing indicate that such changes as globalisation, ICT technologies development, products customization, short term contracts realization and increasing interest in innovations make companies operate in new business structures. Enterprises willing to come up with requirements for a dynamically changing market consolidate their efforts creating clusters. Cluster in the most general interpretation means geographical concentration of an industry that derives profits from the close location [1]. The term was first introduced and disseminated by American economist Michael Porter. He defined cluster as *a geographically proximate group of interconnected companies and associated institutions in a specific field based*. He distinguished two kinds of clusters: vertical where members are linked with a buyer/supplier relationship, and horizontal in which common customers or technology join enterprises [2], [3]. The United Nations Industrial Development Organization, UNIDO, describes clusters as *sectoral and geographical concentrations of enterprises that produce and sell a range of related or complementary products and, thus, face common challenges and opportunities. These concentrations can give rise to external economies such as emergence of specialised suppliers of raw materials and components or growth of a pool of sector-specific skills and foster development of specialised services in technical, managerial and financial matters* [4]. Cluster creating and development is a very complex process. From the moment when independent companies declare their participation in the “association” to the efficient cooperation and high added value creation there is a long way on which trust is built and appropriate communication and management mechanisms are developed. It is especially composite task because of the heterogeneous character of this structures. Different categories of entities that may be involved in cluster are shown in figure 1. It is easy to predict that in each group presented there are different rules of external communication and internal organizational culture. Members of cluster have to undertake actions which enable them to avoid miscommunication in order to collaborate effectively. The initial phase of cluster integration usually takes relatively long time up to couple years depending on how intense the process of incorporation is.

Trust is mentioned as an essential success factor in mature clusters [5], [6], [7], [8], [9], [10]. Authors analyze how to emphasize and measure this component. It was defined as

a good that can not be bought or imported. The trust in business relations is desirable and it forms priceless competitive advantage factor in the global economy [11]. However, it is necessary to precisely describe methods and tools which serve to the trust built and support successful cluster integration and development. Each phase of the cluster evolution requires another actions to be undertaken and instruments to support this actions.

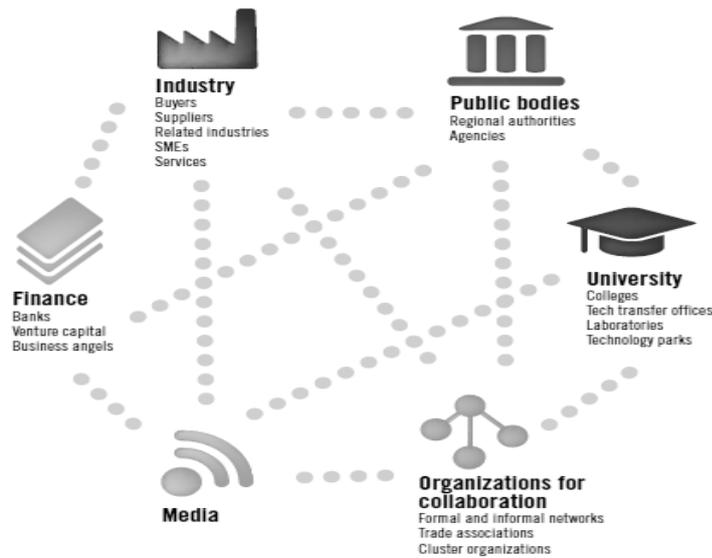


Figure 1. Categories of entities involved in clusters [12]

2. Cluster evolution process

Clusters are established to gather diversified resources and competences that may be necessary in process of identification and exploitation of chances appearing on the market. Sometimes it is bottom- up initiative when enterprises need to increase their flexibility Or capacity to gain competitive advantage. This kind of cluster are usually less formalized at the very beginning. There is also many cases of top-down initiatives when public bodies together with technology park begin to support integration of a local enterprises representing particular industry. In the latter case, collaboration process is subsidised and has to be based on an appropriate documentation and structure. Despite of the type of the initiating entity the phases of the cluster development are similar. The three general stages are shown in Figure 2.

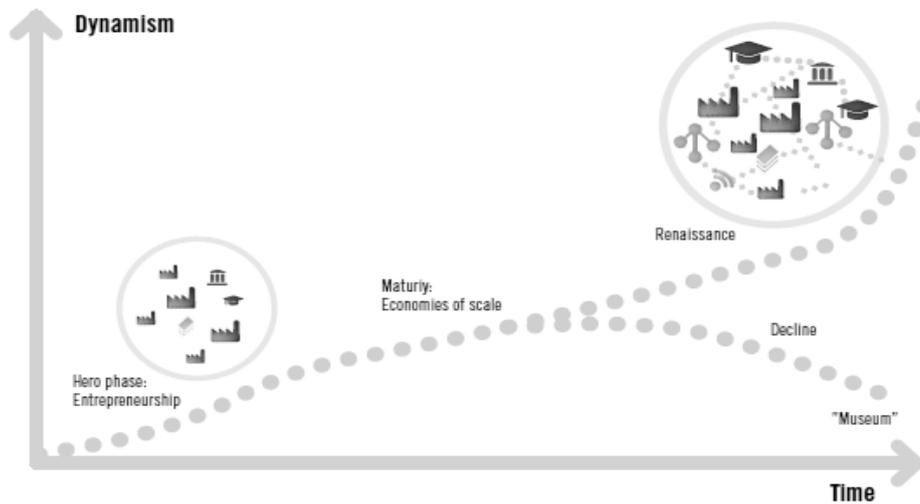


Figure 2. Cluster evolution process [12]

Cluster emergence - Entrepreneurship – cluster emerges in exact location either because of favorable factors such as climate, forest resource, transportation route, university or in consequence of historical accidents. Example of the latter case may be business, started by one person, which grows and results with spin-offs formation and establishes regional “center” specialized in particular service or production type. In both situations crucial role is played by one person or small group of people (Hero or Heroes) which convince other that it is worth to create links and take advantage of common potential (intellectual, technological, infrastructural or other). The Hero gathers social capital and creates formal and informal networks both personal and corporate. This person searches for organizations for collaboration and persuades them to join the cluster. If the participants are opened and the offer created together suits to the market needs then the cluster begins to work and matures. On the way to this point cluster usually increases level of specialization, gains new participants altogether with their skills and starts cooperation with universities to be more innovative. Briefly for the successful course of the first phase (cluster emergence) elements shown in table 1 should appear [12]. These factors may be divided into two groups. These which has to be generated inside the cluster and the environmental factors dependent on the regional policies.

Maturity: Economy of scale - in this phase clusters usually become more static. The companies which turned out to be the core of cluster as the most active and involved, concentrate on the chosen operation field and take advantage of efficiency and economics of scale. New members are acquired rarely. It is very important for a mature cluster to have links with global market. This increases probability of future development. As it is shown in Figure 2 there are two possible scenarios for mature cluster. One of them anticipates collaboration with more linkages and advanced technology development. The other variant is demise of a cluster. The bad scenario may result from excessive concentration, heavy government involvement saving and subsidizing companies, radical technological shifts originating from other locations, war or other extreme circumstances [12].

Table 1. Impact factors in first phase of cluster development [12]

Internal	External
<ul style="list-style-type: none"> - social capital - formal and informal networks - competing strategies - demand - infrastructure - R&D 	<ul style="list-style-type: none"> - national/regional policy and programs - science/innovation policy - industry/SME/entrepreneurship policy - cluster policy and programs

Cluster lifecycle described above and pictured in figure 2 is quite general. The extensive case study analysis conducted for clusters from Asia and Europe, with separate section describing chosen Polish clusters, presented in [13] enables to characterize more precisely process of cluster evolution and compliments the model presented in [12]. The lifecycle consists of the stages described below.

1) Cluster emergence

As it was mentioned at the beginning of this section cluster may appear in result of bottom-up or top-down initiative. In both cases it is recommended to specify legal form of the cluster. This enables to gain funds for collaboration and to make an agreements with organizations outside. The most popular legal forms are:

- mutual cooperation agreement referring also to the exchange of experience,
- partnership agreement,
- cooperative agreement,
- commercial partnership agreement,
- Association,
- capital group.

In this phase there has to be chosen a group of people representing cluster and responsible for the decision making. It is best when leaders are elected in democratic way. The management board should be heterogeneous. People from different categories of entities present in the cluster should compose it. After establishing the cluster it is worth to analyze its structure. Initial composition shows whether it is vertical or horizontal concentration of business. In horizontal structures there will be a lot of competition because of similar range of skills. Companies which have comparable offer usually do not want to share knowledge. It is difficult to gain high level of trust. In this situation it is good to search for core competences for each partner and develop them as unique in the cluster. In vertical structures it is easier to built trust because members work in different places of value chain and are compatible. The most probable option is a hybrid vertical and horizontal structure. Cluster members in the first phase get know each other and show what kind of added value may offer to the group.

2) Cluster growth

In this phase members of cluster undertake actions favorable for integration and enabling to gain short time profits. Example of this activity are following:

- Increase of the purchasing capacity through organizing groups of buyers within cluster members. Negotiating better prices of energy, fuel, office supplies or materials. Bigger volume ordered for a group encourages seller to offer better contract terms. Sometimes cluster may hire specialist to take care of negotiations in transactions made for the group.

- Common investment in training. This action refers both to the management of the companies and different categories of staff employed in the manufacturing entities involved in the cluster. The first group may need additional knowledge about efficient collaboration and complex project coordination while in the second, qualification improvement may have long term effects such as innovative project implementation.
- Cluster promotion- publishing materials promoting new cluster its competences and capabilities.
- Searching for specialists – sometimes in the cluster there is a need for experts or well qualified staff from particular field. Cluster members may organize recruitment process together and lower its cost this way.
- Common trips to the business trades and brokerage events – this kind of action requires former determination of the common cluster image and strategy. The cluster has to be promoted as a new quality, not the simple set of independent companies. It has to have logo, mission, vision and strategy. On the common stand the representation of the cluster promotes competences developed in collaboration process that may be sold under the cluster mark sign. Similar rules should obey during brokerage events which bring great opportunity to gain new orders national and international or acquire new members. This may be crucial if the cluster members identifies a chance on the market which may be used only after adding some kind of skills to the group. Trades and brokerage events also give a chance to meet other cluster members and create new linkages.
- Common investment in infrastructure – this point suggests building or renting additional space for production and offices. The common founding may also be allocated in machine and tools. However in such situations there is always necessity to negotiate where the new - bought facilities will be placed and how they may be used beside cluster projects.

Some of the activities listed above enable companies to decrease expenses. The profits are made through savings. Single entity does not have such a potential for investments in development. This is first occasion for the cluster members to see advantage of being involved in collaboration. During different activities organized together the leading group of the most involved companies emerges. The most probably they will be an “engine” of the future undertaking and obviously decisive voice in choice of the future tactic.

During the cluster growth its members get know each other realizing internal orders. One or more enterprise produces for other cluster members. In this way the capabilities of each partnering entity may be checked. Moreover the new linkages emerge and the skills in coordination, communication and management are improved. Profits are generated mainly thanks to the economy of scale. The orders that would be rejected by individual entity because of lack of appropriate technology or capacity are realized. If the collaboration effects are positive and dynamic of operation sustained then the cluster shifts to the next phase – maturity, otherwise it declines.

3) Maturity

It is a phase which results from building new qualities and values in the previous stages. When the cluster members develop mechanisms which enable them to realize standard orders fast and successfully then there is a potential for innovative projects. Before the complex undertakings are initiated the cluster members should know how to share responsibility, privileges, duties, risk, costs and profits during project realization in cooperation. The new original projects enable to generate high added value but they also

carry higher risk level. On this stage it is important to monitor potential risk factors and implement improvements to reduce costs of management and coordination. High level of trust is essential here. High level of flexibility in cluster is desired but the policies and regulations can not be omitted. The most important refer to the profits share and price calculation.

Figure 3 shows proposed model of the cluster evolution process in detail.

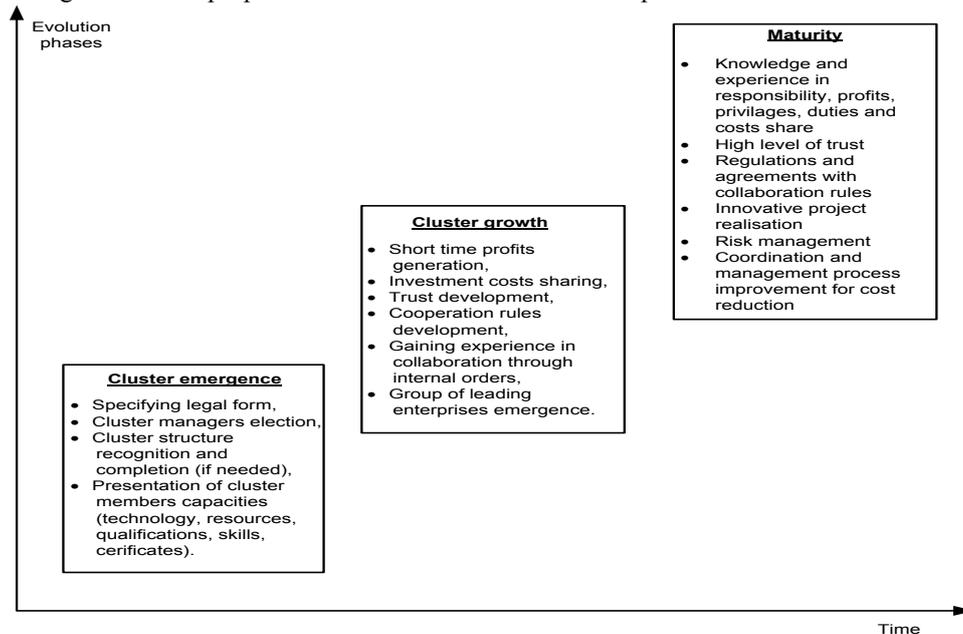


Figure 3. The cluster evolution phases in detail

In each of the phases shown in Figure 3 trust is needed. The processes that happen during each phases may be different depending on a cluster specific activity but in the most cases of successful integration the presented trends occur. It is not always easy to capture the moment of getting to the next phase for this reason the boxes in Figure 3 overlap with respect to the vertical axis. Obviously there is many risk factors that may hamper the integration process, slow it down or completely stop. The most common elements generating uncertainty are: lack of trust, loss of communications, inadequate collaboration agreement, obstacles in process of information sharing, lack of management commitment and wrong partner selection. To efficiently conduct, coordinate and support cluster integration process minimizing probability of the risk factors occurrence it essential to use appropriate tools.

3. Tools and applications recommended in different phases of cluster evolution

In the first phase of cluster emergence it is very important to show that an approach to integration was made. So called “Hero(s)” who built cluster pillars should promote the idea among manufacturers and authorities in the region. More people know about the undertaking the bigger chance for acquiring better partners. The best means of communication in this case will be well positioned Website, leaflets, catalogues, posters

and presentations on a business meetings. Meeting should be also organized by representatives of a new cluster to make a potential participants familiar with the idea and future benefits resulting from the partaking. Internally the most desirable is an online data base presenting characteristic of each partnering enterprise and institution. The value brought by members into the cluster should be clearly shown. In order to list competences there should be special database built containing appropriate categories. Such tool will help to built set of additional competences in the future which result from linkages generated during integration process.

While cluster grows its members realize orders in cooperation so it would be very helpful to use an application listing all machines and spare capacities that may be utilized in collaborative work. The purchasing groups should be supported with application enabling offers comparison and possibly participation in binding process while buying. Moreover a repository with documents regulating cluster activity should be built and available for all members and updated regularly.

Mature clusters realizing complex projects need advanced and intelligent tools. The regular cooperation may be much more efficient on the stage of the task assignment thanks to the decision support system. The advisory application would help to match the best entity for a particular task realization and in this way suggest configuration of the team for a chosen order matched to the customer needs. The decision process, in this case, requires many analysis of data from several sources. For this reason the developed system supporting partner selection in dispersed manufacturing environment should consist of four different layers. It is assumed that the enterprises operating within cluster have to be connected with each other. This function is fulfilled with application based on Internet technology which enables easy communication, data and document exchange. This is very popular tool used not only in clusters but also in organizations which have divisions in different localizations. PDM/PLM application may also be an integral part of the advisory system. The fact that there is great variety of PDM/PLM applications available on the market increases probability that members of the cluster use different tools in this field. In such case there is necessity of data conversion to uniform data format and make it readable for every organization belonging to the association. This layer functionality enables stock, orders/projects and documentation control. Module aiding partner selection will acquire from PDM/PLM data related to the order e.g. list of operations necessary for its realization, process time per unit for each task, ordered quantity as well as information about company such as quality level gained by the manufacturing unit. Production Capacity Exchange Platform mentioned as an independent tool on the stage of cluster growth may also be an element of advisory system delivering very important data. It provides the advisory system supporting with information regarding type of technology made available by members in a given month and number of man – hours offered within each category of tasks. Module supporting partner selection is a key element of the entire advisory system therefore the developed algorithm, set of inference rules and selection criteria.

Additionally on this stage the archive of an expert knowledge connected with innovative project would be very useful. In case of innovative project risk calculating formulas and preventing action list could be very helpful. Figure 4. pictures the cluster evolution phases altogether with aiding tools recommended.

The detail characteristic of the cluster evolution phases and selection of the tools useful on each stage was made on the base of experience gained during establishing and

Development phase	Development phase	Development phase
Cluster emergence	Cluster growth	Maturity
Applications & tools	Applications & tools	Applications & tools
<ul style="list-style-type: none"> • Website, • Leaflets, • Catalogues, • Posters • Presentations during business meetings • Online database presenting characteristic of each partnering enterprise and institution • Categorization of competences 	<ul style="list-style-type: none"> • Application listing all machines and spare capacities that may be utilized in collaborative work • Application enabling offers comparison and possibly participation in binding process while buying. • The repository with documents regulating cluster activity should be available for all members and updated regularly. 	<ul style="list-style-type: none"> • Decision support system for task assignment suggesting configuration of the team for a chosen order realisation matched to the customer needs • Expert knowledge database

Figure 4. Tools and applications useful Turing luster development process

developing Cluster of Innovative Technologies in Manufacturing (CINNOMATECH). The cluster brings together about 50 companies and institutions, most of which have headquarters in Lower Silesia. These manufacturers are mainly from the metal processing industry, production of machine parts and cutting tools sector. The cluster includes service institutions from education, research and development institutions as well as representative of finance sector, IT services and consulting in the field of cutting process planning, machining tools selection, and optimal use of electricity. Companies in the Cluster represent the following fields:

- metal processing (turning, milling, grinding),
- technology services,
- distribution of machine tools,
- research and development within the area of metal production,
- management of production systems,
- consultancy and vocational education

The mission of CINNOMATECH is “to support the development of the region's economy and strengthening the competitiveness of companies in the manufacturing sector” and the strategic objectives are:

- Creation of networks of enterprises, government, universities and business institutions,
- Increasing the capacity of innovative companies,
- Ensuring flow of information between participants of the Cluster,
- Supporting the establishment and creation of conditions for effective commercialization of research results,
- Developing and launching new products / services that are innovative,
- Promoting regional and Polish manufacturing industry, creating a common brand,
- Creating favorable conditions for innovation of the manufacturing industry by operating costs reduction.

4. Conclusion

Adaptation of a new business structures is nowadays a significant success factor for enterprises. Manufacturers have to adopt mechanisms enabling them to communicate quickly and process great amount of heterogeneous data to effectively and efficiently

operate in groups. The character of relations between cluster participants changes over time. For this reason it is very important to know critical fields in each evolution phase where suitable tools and method enable to convert weakness into strength and move to the next stage. The information presented in the article may be very useful for cluster animators and participants increasing chances for success in collaboration.

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