

# Analyzing Model of Enterprises Cluster Learning Competence in Airport Economic Zone based on Self-Organization Theory

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## Abstract

Airport Economic Zone, as the new economic mode, gathering capital, technology and labor, forming enterprise cluster, resulting in the agglomeration and diffusion effect, will affect the economic development of surrounding areas. This paper expounds the connotation of enterprise cluster, think out spatial structure of enterprises cluster system consisting of the core layer, support layer and environment layer. And then analyzes the self-organization feature and mechanism of enterprises cluster evolution, discussed the prerequisite, cause, route, action mechanism and dynamics of enterprises cluster evolution. Finally, construct the analysis model of enterprises cluster learning ability, analyzes the relationship between enterprise cluster openness, learning ability and competitiveness.

*Keywords:* Enterprises Cluster, Self-Organization, Learning Competence, Information Diffusion Model, Airport Economic Zone

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## 1 Connotation and Constitution Elements of Enterprises Cluster

### 1.1 CONNOTATION OF ENTERPRISES CLUSTER

Airport Economic Zone, taking the airport as the geographic center, along the transportation lines radiating expansion, specifically is in a certain geographic range. Developing airport enterprises (including pilot enterprises and related enterprises) as the core, airport economic zone is a new economic pattern, gathering the funds, technology and labor, forming enterprises cluster, resulting in the agglomeration and diffusion effect, will directly or indirectly influence the economic development of surrounding areas.

Cluster is from the species of the ecology. Species is to be the population that living more or less consistent feature in the limited space of the same species of organisms of the collective. In the modern Oxford Advanced Learner's dictionary, cluster is to refer to the same and near the growing things. M. E. Porter point out, cluster is in specific areas, usually a leading enterprises as the core, a lot of closely related enterprises and related supporting organization in space agglomeration [1], is to form a strong, sustainable competitive advantage phenomenon. As a kind of economic organization, the internal connection between enterprise of enterprises cluster is to back to the division of labor theory. In this article, enterprises cluster is to refer to the mutual dependence and serve a similar market, many enterprises including leading enterprises and related enterprises and support services through cooperation, learning organization will form in the specific region. Division of labor is the enterprise cluster architecture, knowledge innovation and sharing of enterprise cluster is the authori-

tative, enterprises cluster is to adapt to the external environment through restructuring task, achieve the goal of the market by means of innovation and cooperation.

### 1.2 CONSTITUTION ELEMENTS OF ENTERPRISES CLUSTER

As a regional assembly enterprise internal organization and external relations, taking the related behavior subject as the hardware, taking the operating mechanism as the software, fusing material, information and energy, taking structure, objective, action and process in one, enterprises cluster is the unity of form and spirit. The spatial structure of enterprises cluster system is composed of three parts that includes the core layer, support layer and environment layer, the concrete structure is to be as shown in figure 1.

#### 1.2.1 Core Layer

The core layer of enterprises cluster is divided into vertical and horizontal two line. Longitudinal aspect generally includes suppliers, key enterprises and consumers, they are the relationship between upstream and downstream enterprises chain. Transverse aspect generally includes competitive and complementary enterprises. The core layer is the main body of enterprises cluster that determining the type and evolution direction of enterprises cluster. In the cluster formation stage, due to historical reasons or fortuitous event, some related enterprises is to gather in a region, formate a certain scale, and gradually attract to other enterprises and institutions to gather to the area.

#### 1.2.2 Support Layer

The support layer is essential to maintain the normal operation of enterprises cluster, support layer generally includes government agencies, knowledge service agen-

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cies, financial institutions and other intermediaries. The support layer is to provide funds, technology, human resource and other services for the core layer, and support the formation and evolution of enterprises cluster. In general, when the core layer is to develop to a certain extent, than can attract to corresponding institutions, and form the supporting system of enterprises cluster.

### 1. 2. 3. Environment Layer

Environment layer including geographical environment, social cultural environment, policy environment, technology environment, is the the background factors of enter-

prises cluster formation and evolution. In the stage of enterprises cluster will be easily affected by environmental factors, and when the enterprises cluster is to develop to a certain scale, people often ignore the influence of environmental factors.

Changes in the environment will often lead to drastic changes of enterprises cluster, such as the upgrading of technology and as change of market demand, can be the death warrant for the sustainable development of enterprises cluster. The world financial crisis of beginning in 1998 impacting on China's export-oriented enterprises cluster is the best evidence.

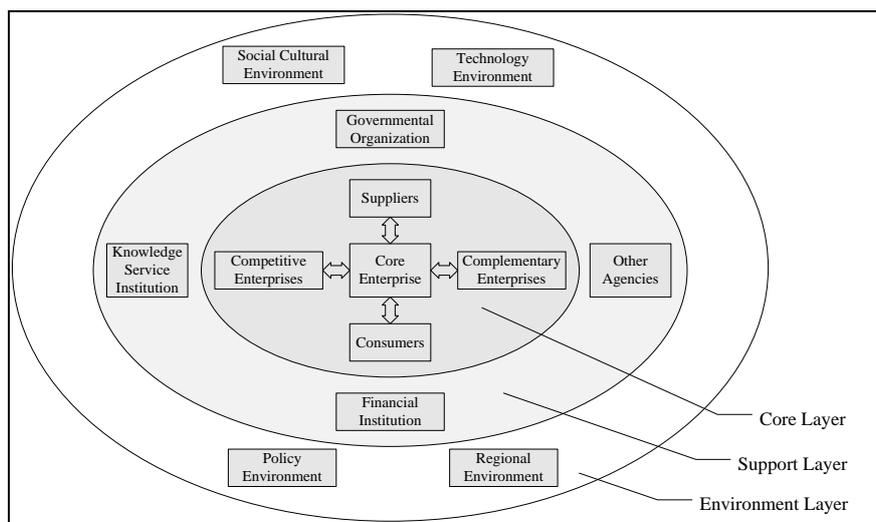


FIGURE 1 Enterprises Cluster Space Structure

## 2 Self-Organization Mechanism of Enterprise Cluster Evolution

### 2. 1 SELF-ORGANIZATION CHARACTERISTICS OF ENTERPRISE CLUSTER EVOLUTION

#### 2. 1. 1 The Uncertainty of Enterprise Cluster Evolution

In the evolution process of enterprises cluster, enterprises cluster will interact with the external environment, the internal factors of enterprises cluster system will change continuously with time, that will cause the uncertainty of enterprise cluster evolution [2]. That will make the formation of cluster organization system, and so the evolution of enterprises cluster is the self-organization process which has a target, and weakened even counteract uncertainty depending on the system power, so that enterprises cluster evolution will be along the good direction.

#### 2. 1. 2 The Entirety of Enterprise Cluster Evolution

Between each subject in the enterprises cluster is not isolated, and enterprises cluster has the capability of self adjustment, enterprises in enterprises cluster has the ability to coordinate with each other, the capability of self adjustment will assure the integrity of enterprises cluster evolution, at the same time also give adapting capability of enterprises cluster itself to the internal and external environment change.

#### 2. 1. 3 The Continuity of Enterprise Cluster Evolution

When the enterprises cluster is in a balanced state, external changes of enterprises cluster will not have an effect on the system, this is because the enterprise cluster is completely open, enterprises cluster being in equilibrium state has the ability to resist external shocks. When the enterprises cluster is in a relatively balanced linear state, fluctuation of external changes will make only a small impact on the industry cluster system, cause enterprises cluster system temporary deviation from the equilibrium state [3]. If the fluctuation cannot produce sufficiently large shock for the enterprises cluster's balance state, enterprises cluster will continue to weaken and even disappear, eventually return to a state of stable equilibrium. If the fluctuation of enterprises cluster become a great influence on the macro fluctuation, enterprises cluster is in an unstable state, at this time, it needs the government, industry associations and other measures, to promote enterprise cluster's development is become the new state of stable and orderly. Enterprises cluster evolution itself is a continuous development process from stable to unstable and to stable.

#### 2. 1. 4 The Complexity of Enterprise Cluster Evolution

The evolution of enterprises cluster is a process of different enterprises, different organizations interaction. The evolution of enterprises cluster is related to all aspects of the increase of enterprise quantity, technology innovation

and so on, is the result of interaction between government, is the result of nonlinear reciprocity of various elements within the clusters, and is put up the complexity of enterprises cluster evolution process. Therefore, the enterprise cluster evolution must consider the self-organization mechanism led by the complexity of enterprises cluster system itself.

2. 1. 5 The Spontaneity of Enterprise Cluster Evolution

In the macro environment of market economy, enterprises cluster is a open system far from equilibrium state. In the development process of enterprises cluster, enterprises cluster will obtain the negative entropy for the self-organizing evolution by means of the nonlinear interaction with the external environment,, and obtain the core competence of self-organization evolution by means of interaction among the internal factors of enterprises cluster. This will form the spontaneous evolution content, direction and

character of enterprises cluster, and make the spontaneous formation, development and perfection of enterprises cluster.

2. 2 SELF-ORGANIZATION MECHNISM OF ENTERPRISE CLUSTER EVOLUTION

As a complex adpting system, enterprises cluster system is the same as other self-organizing system, evolution process effected by internal mechanism is to reduce its entropy content through the material, energy and information with the external environment exchange, to process from disorder to order, from the lower order to higher order, from simple to complex [4]. In the whole process of enterprises cluster evolution, self-organization mechanism is infiltrating in every behavior of enterprises cluster and cluster innovation behavior, play a leading role in the evolution of enterprises cluster.

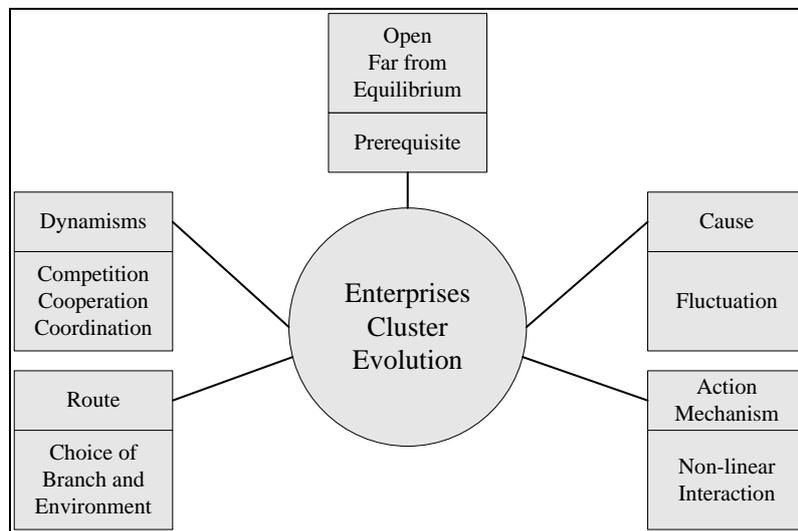


FIGURE 2 Self-Organization Evolurion Mechнизм of Enterprises Cluster

2. 2. 1 The prerequisite of enterprises cluster evolution is open and fra from equilibrium.

In the self-organization theory, a system is to form a self-organizing structure, the first condition is that system must be open. Only through open, continuously exchanging material, energy and information with the external environment, obtaining enough negative entropy, and far from equilibrium state, system will evlute to the direction of nonequilibrium entropy, thereby form the new ordered structure, tha is self-organization structure. . Enterprises cluster is a system composed of some enterprises, For exist, enterprises cluster must exchange with exterior resource. Through the open, clusters system will access to capital, technology, talent, knowledge and information negative entropy flow from external environment. At this time, only far from equilibrium, cluster system can form ordered structure. Keeping certain degree of opening, at the same time, enterprises cluster will exchange material, energy and information with the external environment, continuously innovate, make the cluster system far from

equilibrium and non equilibrium, so that enterprises cluster system can adapt to the changing external environment, promote the evolution of enterprise cluster to the benign direction.

2. 2. 2 The action mechнизм of enterprises cluster evolution is nonlinear action.

The interaction between the cluster system and environment as well as every element and behavior body of the internal cluster is nonlinear, the interdependence process between competition and collaboration is the process of cluster system evolution, transformation between competition and cooperation is the driving force of cluster system evolution. If there is no competition and cooperation between the cluster factors, and no interaction between the cluster system and external environment, there will be no new cluster structure, nonlinear relationship is the power that the cluster system will generate self-organizational behavior.

### 2. 2. 3 *The cause of enterprises cluster evolution is fluctuation.*

The fluctuation is the random force of system evolution, that can damage the system stability, also can make the system obtain new stability after losing instability. In open system of far from equilibrium, fluctuation plays a constructive role on the system, incentive system is the orderly evolution. Enterprises cluster is begin from the single enterprise gather, in the process of evolution, fluctuation has been playing an important role, micro fluctuation after the nonlinear interactions between the various elements of the cluster system will gradually enlarged as the huge fluctuation, thus cause enterprises cluster new ordered structure. Fluctuations of enterprises cluster contains fluctuation caused by policy, market, technology, talent and capital etc. . . Fluctuation has a triggering effect, when the system is in the full open, always exchange material, energy and information with the outside world, and change the relationship between the state and the elements. In the far from equilibrium state, a certain fluctuation cluster may be enlarged, so as to promote the cluster evolution. Just because of the open, the external disturbance factors (such as capital, advanced technology, talents etc. ) will be attracted into the cluster system, and cause the fluctuation of the cluster, the nonlinear interaction between the various elements within the cluster, the behavior subject is to further strengthen the interaction between cluster and environment.

### 2. 2. 4 *The route of enterprises cluster evolution is branch and choice of environment.*

Triggering action of fluctuation must be reached by bifurcation behavior and environmental selection. In the process of enterprises cluster evolution, at the critical point of the mutation, there may be many possible bifurcation. Multiple bifurcation in the process of cluster evolution is one of the dynamic mechanism of cluster evolution. If there are more than a new stable solution branches in bifurcation point, enterprises cluster is often face the problem of how to select, for example, when the government is lead enterprise clusters to the bifurcation, its evolution direction is often affected by inducing role of government. Enterprises cluster is a complex open system, internal fluctuations is the internal condition of its development, the selective role of the environment is the evolution of the external conditions. Such as, when the environmental incentive or pressure will reach a certain degree, cluster innovation and change are the inevitable trend of development of innovation cluster system, the motivation and desire to recover, then the environment will choose a most suitable with the power of reform, innovation cluster system will form a new steady state according to environmental needs.

### 2. 2. 5 *The dynamisms of enterprises cluster evolution is competition, cooperation and coordination.*

The interaction between the cluster system and cluster system environment and internal actors can be divided into competition and cooperation, which is nonlinear in nature.

The spatial concentration will improve the intensity of competition, competition more intense, force enterprises to continue innovation and reduce the cost, thus form the collaboration and competition of enterprises cluster. Transformation between competition cooperation and coordination is the driving force of the cluster system evolution. The nonlinear relationship between the cluster system is the power of generating self-organizing behavior. The nonlinear interactions of enterprises cluster evolution is the activities of competition cooperation and coordination among enterprises. And is the interactive activities of university, scientific research institution, intermediary institutions among enterprises cluster. From the perspective of synergetics angle, cluster unit emergence will make the system each unit (agency intermediary service enterprises, University, etc. ) nonlinear interaction, correlation energy is larger than the independent motion energy of each enterprise or institution, so as to make the system have ordered structure and form a cluster unit self-organization structure.

## 3 Analyzing Model of Enterprises Cluster Learning Competence

Enterprises cluster is the opening and complex system and a dissipative structure. At first, enterprises cluster is an opening system, because it requires constantly exchange with the outside world for material, personnel, information exchange. Meanwhile, it is a very complex non-equilibrium system, there does exist complicatedly nonlinear interaction and feedback loop among composed factors. Therefore, in the enterprises cluster the forming condition of dissipative structure completely possessed. As a dissipative structure system, enterprises cluster need to keep opening to the outside world, and obtain the necessary material for sustainable development. Because of the complex non-linear relation among the enterprises cluster, change of any factor will arouse the change of other factors, after the inevitable changes in the factors and give feedback to the initial changes in the factors affecting the new. The self-organization process of the sustainable development of enterprises cluster is be controlled by the feedback mechanism which effected by the non-linear relation. Different cultural atmosphere is bound to affect the opening extent of the enterprise; the opening extent of enterprises cluster is the key factor of affecting the learning competence of enterprises cluster.

Maynard Smith thought, the competing result between the species mainly depended on resources and the environment in theoretical biology, there is no evident relation between the environmental change and adaptability of animal or human behavior [5]. Kikuchi also saw individual differences in the relatively large difference between the East and West, and put forward a one-dimensional model of measuring the degree of individualism [6]. Chen discussed that different cultures how to affect one species behavior, and discussed different cultures how to affect two species behavior [7]. This paper will use the above method to analyze information diffusion model of one enterprise, and then discuss studying and competing model of two enterprises.

An information diffusion model of no central information source can be expressed as following [8]:

$$\frac{\partial n}{\partial t} = kn(N - n) - dn(1 - \alpha \frac{n}{N}), \tag{1}$$

where,  $N$  indicates the people scale of enterprise,  $n$  indicates the numbers of enterprise that have owned information,  $(N - n)$  indicates the numbers of enterprise that need accept new information,  $k$  indicates the growth rate of accepting new information in the studying process,  $dn(1 - \alpha \frac{n}{N})$  indicates the eliminating rate,  $d$  indicates the measuring criterion of study capability or the difficult extent of mastering technology,  $\alpha$  indicates the opening extent of enterprise and  $\alpha \in [0,1]$ , or means the accepting extent of strange thing. If  $\alpha$  is very small, that means the few of accepting new information, the bigger of the eliminating rate; if  $\alpha$  is very big, that means the more if accepting new information, the smaller of the eliminating rate.

Due to the ever-changing external environment, formula 1 can change the following randomized equation:

$$\frac{\partial x}{\partial t} = kx(N - x) - dx(1 - \alpha \frac{x}{N}) + \sigma k \xi(t), \tag{2}$$

where,  $x$  indicates random variable,  $\xi(t)$  indicates random disturbance item,  $\sigma$  indicates the variance of random disturbance item.

According to formula 2, the extremism of steady-state probability density of Fokker-Planck equation can be solved as following:

$$x_m = \begin{cases} N(1 - \frac{d}{kN} - \frac{K\alpha^2}{2N}) / (1 - \frac{d\alpha}{kN}) & \sigma < \sigma_c \\ 0 & \sigma > \sigma_c \end{cases}, \tag{3}$$

where,  $\sigma^2 = \frac{2}{k}(N - \frac{d}{k})$ .

And now, compare the two enterprises of different opening extent, supposing  $\alpha_1 < \alpha_2$ . Based on the certain material and technical circumstances, in the Steady-state solution, the number ( $n_1$ ) of have mastered information in the enterprise of small opening extent is smaller than the number ( $n_2$ ) in the enterprise of big opening extent, and that shows that when a new message arrives, the potential of absorbing new information in the enterprise of big opening extent is bigger than in the enterprise of small opening extent. This means that the enterprise of big opening extent has strongly creating capability [9]. And we can draw that the core competence of Enterprises Cluster with big opening extent enterprise is superior to small opening extent enterprise.

And now, we discuss the studying and competing model of two enterprises with different opening extent (Supposing  $\alpha_1 < \alpha_2$ ), the model is following:

$$\begin{cases} \frac{\partial n_1}{\partial t} = k_1 n_1 (N_1 - n_1 - n_2) - d_1 n_1 (1 - \alpha_1 \frac{n_1}{N}) \\ \frac{\partial n_2}{\partial t} = k_2 n_2 (N_2 - n_2 - n_1) - d_2 n_2 (1 - \alpha_2 \frac{n_2}{N}) \end{cases}, \tag{4}$$

$n_1, n_2$  respectively indicate the number that has mastered information in two enterprises with different opening extent. Supposing,  $k_1 = k_2 = k, N_1 = N_2 = N$ .

So, formula 1 can change to formula 5, as following:

$$\begin{cases} \frac{\partial n_1}{\partial t} = s_1 n_1 (M_1 - n_1 - \beta_{12} n_2) \\ \frac{\partial n_2}{\partial t} = s_2 n_2 (M_2 - n_2 - \beta_{21} n_1) \end{cases}, \tag{5}$$

where,  $M_i, s_i, \beta_{ij}$  respectively indicate the effective load, the effectively growth rate and the effectively competing coefficient based on certain material and technology,  $i$  and  $j$  respectively indicate the enterprise with different opening extent.

$$M_i = (N - \frac{d_i}{k}) / (1 - \frac{\alpha_i d_i}{kN}), \tag{6}$$

$$s_i = k(1 - \frac{\alpha_i d_i}{kN}), \tag{7}$$

$$\beta_{ji} = k(1 - \frac{\alpha_j d_j}{kN}), \tag{8}$$

From formula 8, the concomitant condition of two enterprises with different opening extent is as following:

$$\beta_{ji} < M_j < M / \beta_{ij}. \tag{9}$$

That is:

$$(1 - \frac{\alpha_1 d_1}{kN})(1 - \frac{\alpha_2 d_2}{kN}) > 1. \tag{10}$$

It is can be seen from the above formula, the two enterprises with small opening extent can coexist. The ultimately competing result is that one team completely replaced by another team.

If two teams have the same studying capability ( $d_1 = d_2$ ), the two enterprises with big opening extent can coexist, ability to learn, the greater openness of the two can co-exist with the enterprise. At this point the core competence of Enterprises Cluster is bigger than the above case. If the difference of opening extent between the two enterprises is bigger, the finally competing result is that the enterprise with big opening extent will replace the enterprise with small opening extent At this point the core competence of Enterprises Cluster is smaller than the case that

the two enterprises with big opening extent coexist. If the enterprise with lower opening extent wants to acquire advantage in competition, the one is to enhance the studying capability; another is to increase the opening extent of the enterprise [10].

If the two enterprises have different studying capability ( $d_1 \neq d_2$ ) and opening extent ( $\alpha_1 \neq \alpha_2$ ), the competing result will be diversification.

#### 4 Conclusion

In airport economic zone, there are centralizing many enterprises and intermediary service institutions, nonlinear action between them will promote the formation and evolution of enterprises cluster, the evolution of enterprises cluster has self characteristics and mechanism. The paper analyzes the connotation of enterprises cluster, put forward the spatial structure of enterprises cluster that includes the core layer, support layer and environment layer, and then discusses the enterprises cluster evolution of uncertainty, continuity, complexity and self-organization feature, point out

#### Reference

- [1] M. E. Porter, Clusters and the new economics of competition, Harvard Business Review, 1998(November/December): 77~90.
- [2] G. Nicolis, I. Prigogine, Self-organization in Non-equilibrium Systems, John Wiley & Sons, 1997. 3.
- [3] Kan Kenhua, Shen Xiaofeng, Prigogine and theory of dissipative structure, Xi'an, Shaanxi Science and Technology Publishing House, 1982
- [4] W. Ebeling, H. Ulbricht, Self-organization by Nonlinear Irreversible Processes, Springer-Verlag, 1996.
- [5] Maynard Smith J. , Model in Ecology, Cambridge University Press, Cambridge (1974).
- [6] Chen Ping, The origin of the division of labor and social disintegration stochastic model, civilization bifurcation, economic chaos and Evolutionary Economics, Economic Science Press, 2000(01), P237-247
- [7] Korczynsk A; Matter of Distrust: Explaining the Persistence of Dysfunctional Beliefs in Regional Clusters [J];Growth and Change; September 2007; Volume 38, Issue 3,pages 341~363
- [8] Lado; Too much love in the neighborhood can hurt: how an excess of intensity and trust in relationships may produce negative effects on firms Strategic Management Journal[J]; September 2009; Volume 30, Issue 9, pages 1013-1023
- [9] Garofoli; The structure and evolution of industrial clusters: Transactions, technology and knowledge spillovers [J]; Research Policy, September 2006, Volume 35, Issue 7, 1018-1036
- [10]Henry Etzkowitz, James Dzisah. Unity and diversity in high-tech growth and renewal:learning form Boston and Silicon Valley[J]. European Planning Studies,2008, 16(8): 1009-1024

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