

# The Analysis of the Information and Its Influence in the Industrial Cluster

Yuming Zhang<sup>1,2</sup>, Kai Li<sup>1</sup>, Yanhua Nie<sup>2</sup>

<sup>1</sup> School of Business Administration, Northeastern University, Shenyang, 110004, China

zhang0510386@163.com

<sup>2</sup> School of Business, Bohai University, Jinzhou, 121013, China

**Abstract:** With the information playing a more and more important role in economical development, whether the knowledge and information could be quickly innovated, transferred and diffused in the course of industrial cluster in the district has already become a standard of weighing the development potentiality of industrial cluster. In this paper the information conduction model has been established based on three kinds of cluster and the information conduction model has been analyzed. The result of the research shows that coupling degree of information influences stability of industrial cluster; the information sharing is an essential condition of the stability of industrial cluster; structures of different industrial clusters are corresponding with those of different information systems, amount of information or entropy has close relation with division of labor and choice optimum structure of industrial cluster; the more developed division of labor in cluster is, the more economic organization structure suitable for choosing is; the larger the entropy of industrial cluster is, the larger possibility of choosing optimum economic structure is.

**Keywords:** industrial cluster, information coupling, information conduction, modular, information sharing

## 1. INTRODUCTION

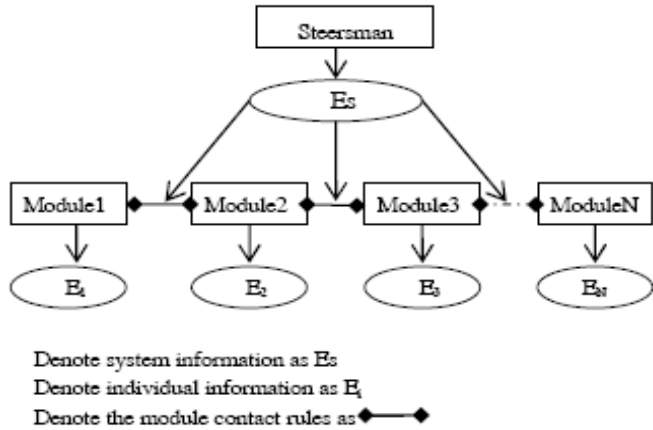
When explaining the industrial cluster, the traditional regional theory and economy development theory just emphasize the externality of industry; they can not explain how information and knowledge make a proliferation in the district. Some people make an argumentation about the knowledge proliferation, spillover in the district and the influence on innovation, such as Marshall<sup>[1]</sup>, Wang Jici (2001)<sup>[2]</sup>. But there are few argumentations about how information proliferates in district. Porter (1998) holds the view that a vast market, technique and other professional knowledge will accumulate in enterprises and organizations in the industrial cluster, which makes it easy to acquire knowledge<sup>[3]</sup>. Therefore, the effect of improving productivity, even to the maximum, still appears in the information communication of the different departments in the interior unit. Chen Yun (2003) studies information sharing and cooperation innovation in the industrial cluster<sup>[4]</sup>. Wang Jici (2001) thinks two effects lie in the industrial cluster district. One is the close-effect: the cost of gathering and bargaining goes down because of abutting on each other or close contact; the other is society-effect: forming the atmosphere of studying together, cooperation and being charged with risk. In fact, the sufficiency of information exchanging is the main function of geography centralization in traditional industrial cluster. Whether Marshall's technology spillover theory or Williams' human capital investment theory is the problem of knowledge link on the foundation of adequate knowledge exchanging, but they make little study on the information in the industrial cluster. This essay studies the information structure, entropy and effect of the industrial cluster from the view of information in order to analyze the influence of information factors on the industrial cluster.

## 2. INFORMATION AND ITS INFLUENCE IN THE INDUSTRIAL CLUSTER

The industrial cluster is a set of the related companies and organizations that are close on the geography and located in the particular industry district because they have something in common and they are complementary to each other. Because different industrial clusters have different organization structures and information structures, we divide industrial cluster into three branches to analyze.

**2.1 Information and its influence in the enclosed small enterprise cluster**

At the beginning of 20<sup>th</sup> century the industrial cluster that Marshall has observed is the typical representative of the enclosed small enterprise colony. At that time the whole economic geography boundary is quite obvious, and colony's regional economy has not been brought into line with the network of globalization, therefore the contact that the industrial cluster and the outside has merely happened in the product sale and the exportation, moreover its market is also confined to home country. The status of the enterprises is close, therefore there is no leadership status of the leading enterprise, and industrial cluster's organization has symmetrical structure. The characteristic of this kind of industrial cluster is that the degree of external relation is low, and there is a lack of the renewal and supplement of outside knowledge. Moreover in industrial cluster, due to insufficient fund, small enterprises are incapable of carrying out constructing marketing network. Therefore the information carries on the concentration activity only in respective enterprise or the module, and enterprises share few information. From the view of information study, the information structure of this kind of industrial cluster belongs to the function level system; Figure 1 shows the conduction model of the enclosed small enterprise cluster.



**Figure1. Conduction model of enclosed small enterprise cluster**

This kind of structure has limited the market scope of the industrial cluster region. According to the Smith theorem, the division of labor is restricted by market scope, and in this kind of industrial cluster, the division of labor being evolved with the depth development is difficult, therefore the externality economy spillover of the enclosed small enterprise industrial cluster is not strong; its following development potential is insufficient. In history quite a few once prospered small enterprise industrial clusters gets down silently, which should have certain relation with the incapability of continuing to innovate the development, caused by lacking of contact with the external, and the small enterprise industrial cluster of Mexican Leon shoemaking was the typical illustration [3]. The Mexican Leon shoemaking industrial cluster has a long history, as well as certain scale, and the exportation superiority of adjoining America, however as time goes on, its competitive power is dropping unceasingly. Why? It is not difficult to discover that this industrial cluster has weak relation, the degree of market operation and the commercialization of the industrial cluster is low, the production merchant knows nothing about the terminal market information, and lacks the information, in particular about design, popular tendency and quality feedback information.

According to above analysis, the enclosed small enterprise industrial cluster is restricted by the market scope of the industrial cluster region, which affects the division of labor. In fact, the information amount has close relation with the division of labor of the industrial cluster and the choice of the most superior organizational structure.

Introduced concept of entropy of information theory:

$$S = \log_2 f \quad (1)$$

By formula (1), the concept of entropy is relative with information. Denote the entropy and amount of information as  $S$  and  $H$ , then  $S = H = -\sum N P_i \log P_i$ ;  $P_i$  is the probability of arisen for each state. The  $f$  is the diversity of source of system information.  $S$  is the monotone increasing function of  $f$ . when the system is at the natural economy condition,  $f=1$ ,  $S=0$ . Thus it can be seen, with the developing of the division of labor of industrial cluster, the economic organization structure for sampling is more; industrial cluster information entropy is bigger, then the possibility to choose one optimal economic organization structure is bigger, which is called in the information theory the intensity to choose is bigger. The cybernetics initiator, Vena believed that, the entropy is a concept which corresponds with the information, and thought in a system the information amount is the measurement of its organization degree. Basically, due to the limitation of the division of labor, the information entropy of the enclosed small enterprise industrial cluster is not high, and its economic organization's structure evolves with difficulty, therefore causes the industrial cluster to be extremely unstable. According to Yang Xiaokai, when market intelligence system and advertisement are not developed, even though much remote enterprise may enhance the economic efficiency mutually through the cooperation of the division of labor, but because the cost of mutual information search is excessively high, the probability of the structures of these possible economical divisions of labor to appear is nearly zero. But when the division of labor of the enclosed small enterprise industrial cluster is enhanced, because the production chain extends unceasingly, namely the series connected module increases, the overall effectiveness index of intelligence transmission drops, therefore the competition among colleagues should be encouraged, increasing the parallel module to be chose to prevent the dropping of the overall index. At the same time, with the developed division of labor, the parallel coupling has developed, so long as the economical legislation guarantees equality competition, assuring the competition information to be high enough, the parallel coupling possible to be chose will have an effect, its information pattern will also change along with it, the industrial cluster will achieve reliable revolution, the life cycle of industrial cluster will be lengthened.

## 2.2 Information and its influence in the wheel-and-axle industrial cluster

A wheel-and-axle industrial cluster is a region where there is only one or several enterprises which take the industry as a core and a region around which there are suppliers and other related activities. The structure of the wheel-and-axle cluster can be seen as a wheel and an axle. Examples of such cluster are the automobile industry in Detroit, U.S., Boeing Corporation in Seattle, U.S., Toyota Corporation in Toyota City, Japan and BaoShan Steel Corporation in Shanghai, China. In such kind of region, minor suppliers or buyers rely heavily on the big core enterprise. The core of the region is a monopolize enterprise of a single industry. For example, Toyota Corporation, as a core enterprise in the wheel-and-axle cluster, takes the leading position. Therefore, the position taken by enterprises in the cluster is not equal and the cluster's organization structure is asymmetric. The information system structure of the wheel-and-axle industrial cluster is a parallel-rank. One basic feature of its information conduction model is the intense information assimilation throughout the whole organization, whether the module is vertical or horizontal. Figure 2 shows the conduction model of the wheel-and-axle cluster.

In a wheel-and-axle industrial cluster, much trade takes place between the suppliers and the core corporation in the region. Information spillover among enterprises in the cluster is intuition response for survival through cooperation. Thus, it provides very good condition for the assimilation of some specific information. The core corporation becomes the leading module in the industrial district and fulfils the task of assimilation,

transmission and information sharing<sup>[6]</sup>. The degree of information assimilation indicates the extent to which the core corporation shares information with its suppliers and clients.

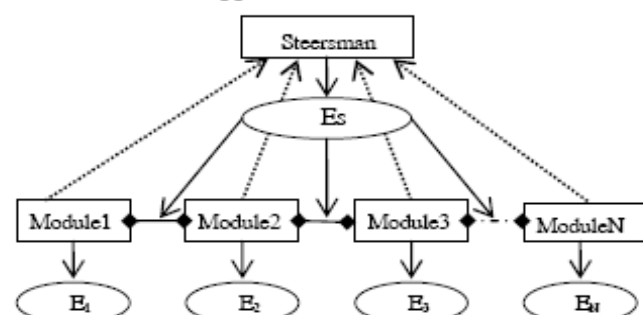


Figure 2. Conduction model of wheel-and-axle cluster

From the view of the industrial cluster, the essence of a cluster is the gathering of supply chain. In forming a system for a wheel-and-axle industrial cluster, a higher degree of information coupling means the core enterprises share more information with the member enterprises of the supply chain. By contrast, if enterprise shares no information with its suppliers and clients, the degree of information coupling will be naught. In such case, the enterprise can only make predications on the basis of former data or react only to the real demands of its clients. If so, the enterprise is isolated in the supply chain. This kind of cluster is unstable and thus hard to survive. All of this indicates that information sharing is a necessity for a stable industrial cluster. Conclusions from Chen Yun and the others also proved this. They believe that information sharing in industrial cluster can improve its innovation environment. The better the innovation environment of the industrial cluster becomes, the more contribution cooperation will make to increasing profits. And with that enterprises are willing to provide more source of information to share. With the expansion of industrial cluster, the enterprises' motivation to share information becomes strengthened and thus they are willing to share more of their information source. In reality, more information sharing occurs in industrial cluster which has good cooperation and innovation environment or which is larger on scale. In the cluster, a less competitive enterprise can benefit from information sharing by gathering with big enterprises although it does not necessarily do business with the big ones.

From the view of information entropy, it is obvious that the discrepancy of information source in wheel-and-axle industrial cluster is greater than that of the enclosed small enterprise cluster. For this reason, the entropy of wheel-and-axle industrial cluster is greater than that of the enclosed small enterprise cluster. And the division of labor of the wheel-and-axle industrial cluster, in turn, is more delicate than that of the enclosed small enterprise cluster and the former provides more organization structure for choosing. Besides, compared with the enclosed small enterprise cluster, the wheel-and-axle industrial cluster is more stable.

### 2.3 Information and its influence in technology-oriented knowledge cluster

The production activity of technology-oriented knowledge cluster mainly covers advanced segments of the value chain, such as products' core technique, the R&D of new products, etc<sup>[7]</sup>. Therefore, the advantage of this kind of cluster lies in the spread, proliferation and innovation of covert knowledge. And this cluster is often the gathering place for talents with high and new technology. For its special advantages mentioned above, the enterprises in this cluster must take root in the local network and act as a direct participant. Typical example for this cluster is the high technology cluster region in the Silicon Valley, U.S. Besides, Bangalore cluster in India and Zhongguan Village in Beijing, China also belong to this kind of cluster, which are far from full development.

The organization structure of technology-oriented knowledge cluster is a parallel one and its information structure is one developed from the assimilation and alienation of the third-party intermediate. Figure 3 shows

the conduction model of the technology-oriented knowledge cluster. Nearly all the enterprises in the cluster compete in innovation at particular market.

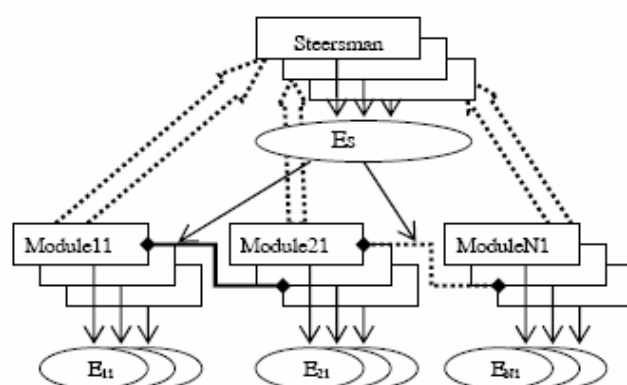


Figure 3. Conduction model of tech-oriented knowledge cluster

These enterprises face the same technology environment (i.e. highly relevant in activity) and their innovation can be mutually replaced. Their activity in information processing must include each other, considering enterprise competition or efficiency of information. Different from the earlier established integrate enterprise, IBM as an example, these innovation enterprises do not develop relevant conception for new product system beforehand. Rather, they disperse to conduct innovations at chink market. They combine the parts which are developed from these dispersed efforts to gradually form a new product system. This special change in innovation benefits from the information processing in different chink markets which is independent and self-reliant to the greatest extent. This is an important reason why the technology-oriented knowledge cluster is so effective.

Suppose  $\{E_{ij}\}$ , as a module team, in this cluster is a certain number of enterprises. In a cluster, what usually happens is that dozens of enterprises compete for researching and developing a promising technique. That is, each  $E_{ij}$  undergoes information alienation first and then in competition, connection rule or the standard process which joins the interface of each module will be developed, improved and innovated. In fact, when an enterprise in cluster succeeds in exploiting new product, new craft and administration method and gains the accompanying technique and market information, these new gains will spillover in the cluster by means of division of labor and cooperation, outside contract and social relations and finally become shared information and knowledge of the whole cluster. The spillover of information only occurs in the cluster net. Without the relation network, the spillover will disappear at once. Baldwin and Clark (2000) proved theoretically that in view of the great uncertainty of R&D, several units (small enterprises) are encouraged to compete in the innovation of particular module<sup>[8]</sup>. Though this means a repetitive investment in resource, it is effective to the society as a whole. But if things mentioned above are to be realized, the necessary condition is that the experiments must keep independent from each other, i.e. the R&D of each experiment must keep unknown to each other among the enterprises.

From the view of information entropy, it is obvious that the discrepancy of information source in technology-oriented knowledge industrial cluster is greater than that of the wheel-and-axle industrial cluster. For this reason, the entropy of technology-oriented knowledge industrial cluster is greater than that of the wheel-and-axle industrial cluster and the enclosed small enterprise cluster. And the division of labor of technology-oriented knowledge industrial cluster is more delicate than that of the wheel-and-axle industrial cluster and the enclosed small enterprise cluster, and the former provides more organization structure for choosing. Besides, compared with the technology-oriented knowledge industrial cluster and wheel-and-axle industrial cluster, the technology-oriented knowledge industrial cluster is more stable.

Above what we discuss is the information structure problem of the enterprise cluster, it exists more intensive information exchanges among the enterprises than new classic price mechanism. In fact, the information structure contains a lot of types; we only research three types of them. For the more general industry organization, its structure is dissimilar and thus it should correspond to different information system structure. Such as the Horizontal Hierarchies system structure<sup>[9]</sup>, in which under the framework of the whole hierarchies (manager-underling) their tacit information concerning the system environment would be assimilated, and the information exchanges with up and down would expand to a perpendicular relation, the activity decision of the management level correspondingly would include the factor of the consensus formation or collective decision, the whole organization would run through intensive information assimilation; This kind of information structure can moderate nicely to harmonize the mission with very strong complementarity to each other (such as assembling automobile or the steel rolling process); moreover, it encourages the information communication among the research and development sector, manufacturing sector and the market sale sector, compared with product design innovation that involved an important principle to breakthrough it is more advantageous to promote the product craft process to be continuously creative. Participatory Hierarchies system structure is established under the general framework of the mission specialization, characterized by the cross-boundary information sharing. If the information ability of the subordinate level is stronger, delivering the observation of that level to the system environment to the management level is more efficient concerning the information; continuous strengthening of complementarity to each other of the operability mission unit of the subordinate level makes it necessary to share information horizontally, the characteristics of this kind of structure is added with high degree of the perpendicular and the horizontal information assimilation. For example, the high codified information is exchanged by a formal organization channel in the German enterprise such as worker's committee, fulfilling information share.

### 3. CONCLUSIONS

Different organization structures of different industrial cluster result in different information conduction models. The information structure changes in accordance with the changes of organization structure of industrial cluster, from simple to complex. The information efficiency of technology-oriented knowledge cluster is higher than that of wheel-and-axle industrial cluster and, in turn, the information efficiency of the wheel-and-axle industrial cluster is higher than that of enclosed small enterprise cluster.

Information sharing is a necessity for the stability of industrial cluster. No sharing will do harm to the stability of cluster. Amount of information or the entropy has a close relation with the division of cluster and the choice of the optimal organization structure. The more developed the division of labor in the cluster is, the more choice there is in choosing the economic organization structure. The greater the information entropy in a cluster is, the greater the possibility is in choosing the optimal economic organization structure.

The enhancement of information coupling in a cluster will promote the agglomeration and the industrial cluster district will thus gain development advantage. Study shows that industrial agglomeration in a certain region doesn't necessarily mean the appearance of continuing competitive advantage and innovation ability. As knowledge and information becomes more and more important in economic development, whether the industry in the region can be created, transferred and proliferated information quickly in the agglomeration process has become a standard of measuring the development potentials of industry and influenced the further industrial agglomeration and the gain of advantage in regional economic development. Therefore, how to use the interior force of the industrial agglomeration region to promote a high mobility of information, knowledge and other production factors in the region has become the focus of the study of industrial cluster and regional economic development.

## REFERENCES

- [1] Marshall A. (1920). *Principles of Economics: An introductory Volume*. 8<sup>th</sup> Edition, Macmillan, London.
- [2] Wang J. C. (2001). *Innovative Space: Enterprise Cluster and Regional Development*. Beijing: Peking University Press.
- [3] Porter M.E. (1998). *Clusters and the New Economics of Competition*. Harvard Business Review, Vol.98.
- [4] Chen Yun. (2004). *Research of Information Sharing and Cooperative Innovation in Industrial Cluster*. System Engineering Theory and Application, (8):55-57.
- [5] Rabelotti R. (1995). *External Economies and Cooperation in Industrial Districts: A Comparison of Italy and Mexico*. Brighton: University of Sussex.
- [6] Baldwin, C. Y. and K. B. Clark. (1997). *Managing in an Age of Modularity*. Harvard Business Review, Vol.75 (5): 84-93.
- [7] Qiu Baoxing. (1999). *Research on Small Enterprise Cluster*. Shanghai: Fudan University Press.
- [8] Baldwin, C.Y. and K. B. Clark. (2000). *Design Rule: The Power of Modularity*. Cambridge, MA, vol.1.
- [9] Masahiko Aoki. (2001). *Towards a Comparative Institutional Analysis*. Shanghai Far East Publishers.