Cluster Competitiveness and Strategy Based on Modified GEM Model —An Analysis on Changsha Engineering Machinery Cluster in Center China

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Abstract: Clusters perform differently. Many studies have focused on the competitiveness and strategy, among which the GEM (Groundings-Enterprises-Markets) model is quite favored in practice though with some intrinsic drawbacks, i.e., heuristic, simple and general. By analytic hierarchy process (AHP), detailed and weighted indicators through SPSS analysis and a special cluster, we try to overcome the defects. We apply the modified framework into Changsha engineering machinery cluster in center China and evaluates the competitiveness in detail. Finally, we propose three strategies according to the modified GEM analysis, which are, cluster foundation improvement strategy, cluster innovation strategy and, global value chain strategy.

Keywords: Changsha engineering machinery cluster, Cluster competitiveness, Cluster strategy, Modified GEM model

1 Introduction

Firm capabilities are embedded within their value networks[1][2]. Cluster-based competition has become the main stream of competition for enterprises and regions [3]. There are thousands of clusters, widespread in all industries, great in economic scale and remarkable in industry characteristics. However, clusters are performing differently. While some vigorous and dynamic, many others are transient and declining. Most government-cultivated or market-driven clusters conglomerate without clear coordinating and synergy strategy.

Under a steady and simple environment, such conditions may be able to set the ball rolling, but, in a constantly changing surroundings, clusters can seldom step further. Especially when the economy depresses, clusters are apt to fall. The decline of many once prosperous clusters is a significant proof. For sustainable development, the strategic route suitable for a specific cluster should be found out based on cluster competitiveness appraisal[4].

There are two trends on cluster competitiveness appraisal research. One analyzes competitive advantage of clusters from qualitative respects, which analyzes and appraises comprehensive factors influencing clusters to get an overall overview of clusters. Porter[5] first normally and qualitatively appraised cluster competitiveness through his famous diamond model. Bergman[6][7]analyzed and appraised cluster competitiveness from three divisions, i.e., life cycle (time), geography (space) and relation (structure). Mitra[8] announced 11 attributes of clusters, and the ability to integrate these 11 respects can judge the competitiveness of an industrial cluster.

Another approach appraises cluster competitiveness through quantitative models. Collecting statistics information of various fields of a cluster, complicate models and mathematical calculations are done to evaluate cluster competitiveness. Based on Porter's diamond model, Padmore and Gibson[9] proposed a quantitative GEM (Groundings-Enterprises-Markets) model. This model assessed and scored each factor relevant to the competitiveness of clusters. The application of the model in Canada, U.S.A. and Australia indicates an effective quantitative analysis tool on appraising cluster competitiveness [10]. Though not quite perfect for its statistic and rough nature, still the model is of practical use and no other methods ever surpasses.

The qualitative approach is relative subjective, but total quantitative analysis also inevitably has its limitations since many factors are difficult to be quantized. In this article, we try to improve the GEM model to integrate qualitative and quantitative analysis together. Then the competitiveness of Changsha engineering machinery cluster is appraised and strategies are proposed accordingly.

2 GEM model and its modification

2.1 GEM model

Based on Porter's Diamond model and supply-structure-demand analysis, Padmore and Gibson developed a new framework, GEM model, to analyze cluster competitiveness. According to them, there are six determinants grouped into three pairs, which are, Groundings (resources and infrastructure included), Enterprises (supplier and related industries and firm structure, strategies and rivalry included) and Markets (local markets and access to external markets included). The model is scored according to rules as follows.

Step1. Score each of the determinants, on a world standard, using a scale from 1 to 10 (highest)

Step2. Combine the scores within a pair additively and with equal weights

PAIR SCORE=($D_{2i-1}+D_{2i}$)/2, D_{2i-1}, D_{2i}, etc，are the individual determinant scores.

Step3. Scale the overall rating, $GEM=2.5(\Pi_{i-1,3}(D_{2i-1}+D_{2i}))^{2/3}$

According to the authors, A neutral, marginally competitive cluster would have GEM=250 on this scale. If each of the six determinants scores at 7, then the GEM score would have 420, which shows high

competitiveness.

2.2 Modification of the model

GEM model successfully turned qualitative variables into quantitative indicators and was applied to evaluate the agriculture/food cluster in Shuswap and an advanced technology cluster in West Canada. Though successfully applied and widely adopted, still some drawbacks inhabited.

2.2.1 Heuristic method and modification

Since the score of the GEM model is appraised by only one or two experts with simple heuristic method, it is quite vague and subjective. Thus we step forward by interviewing relevant experts, managers and officers to find the specific determinants and determinant weights. Here we adopt the Analytic Hierarchy Process (AHP) to evaluate the relative importance of each indicator.

2.2.2 Simplicity and modification

The model scores six determinants directly without detailed indicators. As a complex system, it is difficult to appraise the competitiveness through such large scaled and unspecified indicators. So, to make it more practical, we detailed the indicators and chose some specific relative sub-indicators to get a whole insight into the cluster.

2.2.3 Generality and modification

The authors proposed a general model without considering industry conditions. In fact, the determinants will vary for different clusters. Here we analyze and evaluate the specific cluster, engineering machinery cluster in a particular region, and try to explore the rules in such clusters but not other kinds of clusters.

3 Competitiveness and strategy of Changsha engineering machinery cluster based on modified GEM model

3.1 Survey of Changsha engineering machinery cluster

Changsha, capital of Hunan province, locates in the center of P.R.China. Changsha engineering machinery industry burgeoned in early 1990s, now a cluster has formed round the two leaders, Zoomlion Heavy Industry Co., Ltd and Sany Heavy Industry Co., Ltd. Today, over 20 scaled engineering machinery manufacture enterprises aggregate round Changsha, among which are 6 large-middle sized ones. Some hundreds of complementary enterprises are also vigorous actors in the cluster. In 2003, the sales income increased 80% comparing that of the former year, while in 2004, though tight policy towards the industry by the center government of China, there still sees a 70% development. Specific competitiveness of the cluster is analyzed below based on the modified GEM framework.

3.1.1 Groundings of the cluster

As the capital of Hunan and with the Beijing-Guangzhou railway crossing through and has Zhuzhou, the second largest railroad stopover station, as its neighbor, the transportation system is quite effective. But comparing with that of the southeast cities, it is of no locational advantage.

Registered in the stock market and with the help of the local government, the leaders, Zoomlion and Sany both face no finance difficulty in general. But as to the whole cluster, many other enterprises are short of capital because of inadequate finance channels.

With the support and help of research institutes and colleges in Changsha, the technology of the cluster ranks first-class in China, but still a large gap comparing with international advanced level.

The cluster is abundant with human resources. Many colleges and research institutes aggregate in Changsha, which accommodates enormous learned and experienced experts.

The infrastructure of Changsha is deliberately constructed, offering efficient hardware for the cluster. But the software is not so harmonious. Sometimes the government may stand at a wrong position. Though in 2004, Changsha government issues the file, “Ideas on promoting the advantageous clusters”, to address the development of the engineering machinery cluster, it always goes too far. Also, there lacks trust between enterprises and individuals. Still with no cluster associations in effect, the cluster is loosely aggregated.

3.1.2 Enterprises of the cluster

Integrated supplying and related networks are rich in the cluster, but problems still exist. Though the suppliers are generally low centered and of no purchasing power, the key ones are relatively centered. Take Sany for example. Though with hundreds of suppliers, it can only choose chassis from VOLVO and ISUZU. Another disadvantage is their relationships are not intimate enough. Cooperation with suppliers is inadequate.

The structure of the cluster is fairly competitive with large-middle-small firms. With the lead of Zoomlion and Sany, All the organizations in the cluster have a common goal. Enterprises in the cluster cooperate well. The firms in the cluster have modern organization structure and most of them have ambitious, experienced manager teams. Products designed and produced in the cluster are competitive in domestic, but as to the international market, it is quite another thing.

3.1.3 Markets of the cluster

Local demand for engineering machinery products is quite thriving as the economy leaps forward rapidly. Railways, high ways, oil wells, city infrastructures are all under tense construction. As a report indicates, the demand of North America accounts for 30% of the whole demand, Western Europe accounts for 27% and China, the third, 17%. Chinese engineering machinery market is most potential and vigorous. Competition are more fierce in external markets. Generally, external markets are more perfect than local market for their well structured market economy.

Foreign brands have occupied half of the Chinese market share. Chinese engineering machinery products

only gain 1.6% of the international market share, and that of Changsha cluster is even lower. It is partly because of the distance to external demand, but, the deeper reason is in the entrance barriers by the developed countries through industry norm formulating and facilitating. Another reason is Changsha cluster orients at domestic demand but not external market, which directly leads to the incompetence of international market of the cluster.

3.2 Study method

3.2.1Define competence determinants in detail based on the modified GEM framework

On interviewing top managers in the cluster and adopting analytic hierarchy process, we induct three pairs, six determinants and 29 indicators.

3.2.2 Weight and score the indicators

On interviewing several top managers, research experts and relative government officers and an SPSS analysis, we get a synthesis appraisal showing in table 1.

Table 1 Indicators and scores of Changsha engineering machinery cluster

Determinants	indicators	Average score of indicators	weights	scores
Resources	location	6.208	0.148	6.39
	capital	6.012	0.251	
	technology	5.783	0.298	
	human resource	7.416	0.304	
Infra-structures	transport/ communication infrastructure	6.301	0.112	5.88
	business environment	4.796	0.241	
	industry policy	7.186	0.304	
	associations	3.023	0.145	
	research institutes/ colleges	6.284	0.207	
Supplier/ related firms	strength of suppliers	5.807	0.318	5.4
	cooperation with suppliers	5.213	0.294	
	strength of related firms	5.580	0.179	
	cooperation with related firms	4.872	0.218	
Enterprises structure/ strategies	unanimous in the cluster	7.236	0.152	5.77
	competition in the cluster	6.751	0.106	
	property structure	6.504	0.146	
	managers' ability	6.216	0.158	
	product competitiveness	4.285	0.201	
	strength of competitors	5.107	0.154	
	competition out the cluster	4.823	0.083	
Local markets	scale of local markets	7.128	0.286	6.47
	local market share	6.426	0.241	
	perfect of local markets	4.281	0.239	
	prospect of local markets	8.235	0.242	
External markets	distance to external markets	4.534	0.103	4.755
	scale of external markets	5.216	0.284	
	share of external markets	3.821	0.242	
	prospect of external markets	5.847	0.174	
	barriers to external markets	4.356	0.227	

3.2.3 Calculate scores of each determinants and total GEM score

PAIR SCORE Groundings (resources, infrastructure) =6.13

PAIR SCORE Enterprises (supplier/related firms, firm structure/strategies) =5.58

PAIR SCORE Markets (local markets, external markets) =5.63

$GEM=2.5(\Pi_{i-1,3}(D_{2i-1}+D_{2i}))^{2/3}$

=334

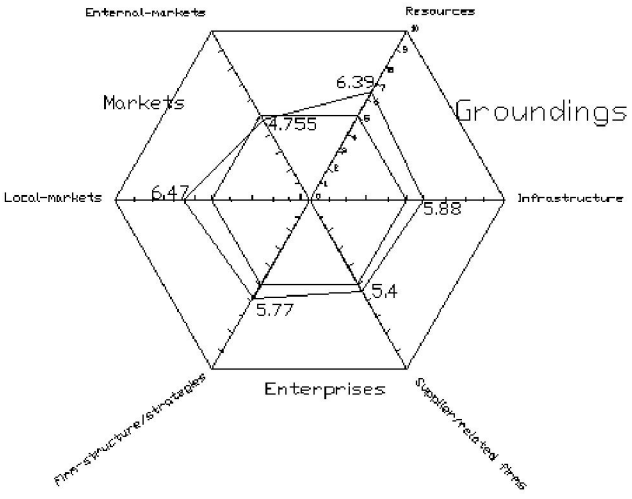

Fig.1 GEM assay evaluating Changsha engineering machinery cluster in center China

3.3 Strategies based on the modified GEM framework

The total scores rank at 334, indicating a prosperous cluster. But still some indicators are quite low. To achieve benign and sustainable development, the cluster must overcome its short panels. The following proposals may be practical.

3.3.1 Cluster foundation improvement strategy

According to the GEM evaluation, the pair score of groundings determinants get 6.13, which means competitive, especially the resources are abundant. But as to the sub-indicators, associations rank rather low, 3.023, which is quite inadequate in the cluster. Also, the business environment gets a fairly low score, 4.796, showing vicious environment of the cluster.

It is the government and association's responsibility to lay a more competitive grounding for the cluster. Though Changsha government highly stresses and supports the development of the cluster, it may have gone a wrong way. It intervenes the operation of the enterprises too much instead of offering a harmonious business environment. In fact, the function of a government is to build a public platform and provide soft and hard environment for clusters, to encourage the cooperation and collaboration, help build communication channels between enterprises to avoid low-leveled repetitive construction and vicious competition.

Changsha engineering machinery associations should be established to serve and coordinate the enterprises in the cluster. One important reason for the phenomenon of "large government, small business" lies in the fact of inadequate association in the cluster. There is only one national engineering machinery industry association, but no regional associations or other kinds of associations. Moreover, the function of the association is far from satisfaction.

3.3.2 Cluster innovation strategy

Enterprises are the main actors in the cluster. But the pair score ranks at 5.58, only fairly competitive as a whole, and some sub-indicators, such as cooperation with related firms, products competitiveness and competition out the cluster, score quite low.

To get higher scores for better development, cluster innovation strategy must be adopted. Product innovation and process innovation in the cluster are of eager necessity. The cluster must develop world-class products through continuous integrated technological innovation and process innovation.

Innovation actors should stand at the right position. The leading actors in the cluster, Zoomlion and Sany, should burden this all-round-win project. They should integrate with those middle-small sized firms, the research institutes and colleges, the local government, the suppliers and related firms together to facilitate cluster innovation strategy based on local culture.

3.3.3 Global value chain amalgamation strategy

The pair score of markets gets 5.63, the lowest of the three pairs. In fact, the local market is relatively competitive except for the perfect of the local markets. While the other determinant, external markets, ranks a rather low score.

The score signals strong necessity of local market perfection and especially the access to global market. A feasible strategy can be the global value chain amalgamation. The cluster should positively analyze the international division of the industry and join the global value chain to make resources most utilized. First of all, Changsha cluster should focus on a market segment and locate its products correctively to find a special cutting point in the global value chain. Second, since inadequate experience yet, the cluster should not run too fast in the global value chain but go at a healthy steady pace to avoid potential risks. There is still a long way for a better position in the global value chain, so the cluster must be positive and patient.

4 Conclusion

GEM model is a practical tool for evaluating cluster competitiveness, but has some natural defects，such as heuristic method, simplicity and generality. We try to overcome the drawbacks and modify the model by analytic hierarchy process to eliminate heuristic, and an SPSS analysis detailing and weighting the indicators to be complicate enough to adapt to the cluster, and analyzing a special cluster to reduce the generality.

With the modified model, we analyzed the Changsha engineering machinery cluster, a cluster most favored by the government of Changsha. Detailed indicators according to the modified model are scored and weighted by interviewing experts, managers and officers in the cluster. As a whole, the cluster is competitive, but some indicators are of urgent necessity to be improved. Thus, we propose some practical strategies to promote the cluster.

This is a successful attempt to apply the GEM model into China since the result of the model is in accordance with the reality in the cluster. Further study should apply the modified model to other industrial clusters with careful design.

References

[1]L. Oerlemans, M. Meeus and F.Boekema, Do networks matter for innovation? The usefulness of the economic network approach in analysing innovation, Journal of Economic and Social Geography, vol.89, no.7, 298-309, 1998.

[2]L. Biggier, Self-organizing processes in building entrepreneurial networks: a theoretical and empirical investigation. Human Systems Management， vol. 20, no.3, 209-222,2001.

[3]M. Porter, Clusters and new economics of competition. Harvard Business Review, vol.76, no.6, 77-90, 1998.

[4]B. Doeringer and G. Terkla, Business strategy and cross-industry clusters. Economic Development Quarterly, vol. 9, no.3, 225-237, 1995.

[5]M. Porter, The competitive advantage of nations. Free

Press, New York, 1990.
[6]E. Bergman and E. Feser Industrial and regional clusters: concepts and comparative applications. West Virginia: WVU Regionl Research Institute Web Book, 1999.
[7]E. Bergman and E. Feser, Innovation system effects on technological adoption in a regional value chain. European Planning Studies, vol. 9, no.5, 629-648, 2001.
[8]J. Mitra, Build entrepreneurial clusters. Final Dissemination Workshop, University of Luton, United Kingdom, 2003.
[9]T. Padmore and H. Gibson, Modelling systems of innovation: 11 A framework for industrial cluster analysis in region. Research policy, vol. 26, no.6, 625-641, 1998.
[10]National Research Council of Canada, Building technology bridges: Cluster-based economic development for western Canada, Ottawa, 1996.