



Evaluation of competitiveness of Foshan ceramic industry and selection of promotion path

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Abstract. Ceramic industry is the traditional comparative advantage industry in Foshan. It plays an important role in promoting economic and social development and is facing the key stage of transformation and upgrading of industrial cluster from the mature stage. Its vulnerability, risk and other related competitiveness evaluation and promotion issues, much attention. GEM model and AHP model are used to evaluate the competitiveness of Foshan ceramic industrial cluster. The research shows that the competitiveness of Foshan ceramic industry cluster has a strong competitiveness in China, including "foreign market, enterprise structure, strategy and competition, facilities" and other factors have a certain competitive advantage, while "resources, suppliers and related supporting industries, local market" and other aspects have a certain degree of relative insufficiency. In view of this, this paper puts forward the development path of ceramic industry from the aspects of industrial structure adjustment, development mode transformation, talent training and introduction mechanism, which has theoretical and application value for the green and sustainable development of Foshan ceramic industry.

Keywords: Foshan, Ceramic industry cluster, Industrial competitiveness, GEM model, AHP model

1 Introduction

Foshan is one of the birthplaces of China's ceramic industry and has become one of the important driving forces of Foshan's development. However, as a world-class ceramic producing area, the development of Foshan's ceramic industry still has problems such as high energy consumption, unreasonable industrial structure, backward production technology, and relatively weak industrial competitiveness [1]. As a regional industrial organization, industrial cluster describes the agglomeration of enterprises in a specific industry in a certain region according to their own internal economic characteristics [2]. The rapid development of ceramic industrial cluster has attracted extensive attention of scholars. Many scholars have conducted abundant re-

searches on industrial competitiveness, mainly including index analysis, regional comparison method and diamond model method. Yuhong Cao et al. analyzed the formation mechanism of intelligent automobile industry competitiveness by using PSL method [3]. Touping Yang et al. used factor analysis to analyze the competitiveness of cultural industry from three levels: basic, explicit and potential [4]. Jingwen Li et al. used principal component analysis and analytic hierarchy process to analyze the industrial competitiveness of major automobile production areas in China [5]. Guangbin Cheng et al. studied the competitiveness of different industries in China and ASEAN by combining the basic indicators of comparative advantage and absolute advantage, and explored the entry point of mutual cooperation between the two industries [6]. Junyan Huang et al. used diamond model to analyze the competitiveness of hybrid rice seed industry in Jianning County, and put forward strategies to enhance industrial competition to further promote regional agricultural competitiveness and increase farmers' income [7]. Wei Cao et al. used Groundings-Enterprises-Markets (GEM) model to explore the development of competitiveness of tourism industry clusters in the study of Anhui tourism industry clusters [8]. Many scholars' research on industrial competitiveness has important theoretical value for the promotion of industrial competitiveness. However, there are few researches on cluster competitiveness of ceramic industry, and most of them are qualitative researches. In this paper, Foshan ceramic industrial cluster as an example, with the help of the classic model of quantitative evaluation of industrial cluster competitiveness – GEM and AHP, the current development of Foshan ceramic industrial cluster facing the sustainable development of quantitative analysis, and put forward the Foshan ceramic industrial cluster competitiveness promotion path choice.

2 Research methodology

2.1 Overview of GEM model

GEM model is innovatively developed based on diamond model, which involves three pairs and six decisive factors [9]. "Factor pair I" refers to the basic level, including resources and facilities, reflecting the supply factors of industrial clusters. "Factor pair II" refers to the enterprise level, including the structural elements reflected by the enterprise's scale, benefits and suppliers. "Factor pair III" involves the market level, including internal and external markets, reflecting demand factors. As shown in figure 1. GEM model quantization includes three steps, which are: (1) factor scoring or assigning; (2) Calculate the score of "factor pair"; (3) Calculate the total score of industrial cluster competitiveness.

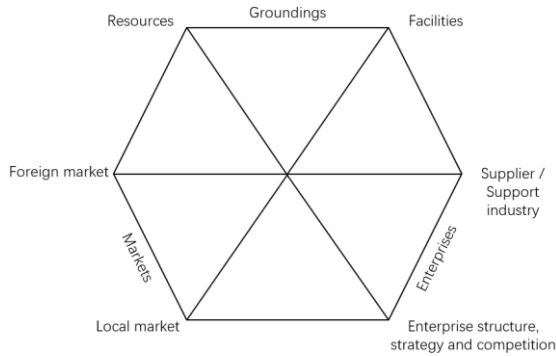


Fig. 1. GEM models.

2.2 A Overview of AHP Model

Analytic Hierarchy Process (AHP) is a multi-criteria decision-making method for transforming qualitative problems into quantitative analysis [10]. Its characteristic is to divide each influencing factor of complex problem into relative order level, make it orderly. According to the subjective judgment structure of the objective reality, combined with the objective judgment results of the analyst, quantitative description is made. In order to evaluate the competitiveness of Foshan ceramic industry cluster scientifically and accurately, this paper applies AHP to quantitatively analyze the internal maximum risk of Foshan ceramic industry cluster [11].

3 Evaluation of competitiveness of Foshan ceramics Industry cluster

The competitiveness of industrial clusters refers to the competitive advantages of related industries in a certain region in terms of operating efficiency, product quality and sustainable development. The analysis of industrial competitiveness should include factors affecting regional development such as industrial synergy and transfer [12]. The complexity and comprehensiveness of the evaluation of industrial competitiveness are determined by the extensiveness and systematicness of the influencing factors [13]. In this paper, the classical model of quantitative evaluation of industrial cluster competitiveness (GEM and AHP) is used to quantitatively analyze the risks faced by the current development of Foshan ceramic industry cluster, making the analysis results more scientific and feasible.

3.1 Sample composition

In order to ensure the authenticity of the evaluation results, this paper designed a questionnaire on the development of Foshan ceramic industry cluster according to the research questions. From April 2021 to August 2021, the research team conducted

three field investigations on Foshan ceramic industry, conducted in-depth interviews with the managers of ceramic enterprises, and clarified the importance and status quo of Foshan ceramic industry cluster competitiveness evaluation indicators on the development of its ceramic industry. The questionnaires were filled in by senior executives and industrial research experts. A total of 100 questionnaires were sent out, and 92 were effectively received, with a recovery rate of 92%.

3.2 Competitiveness Evaluation

According to GEM model theory and the principle of analytic hierarchy process, three elements and six factors of GEM model are taken as the first-level index system. On the basis of field investigation and reference of existing research results, each level index is subdivided into a number of level 2 indexes, so as to construct the competitiveness evaluation index system of Foshan ceramics industry cluster, as shown in Table 1.

The hierarchical model in Table 1 is compared in pairs based on expert scores and suggestions from relevant departments, and the 1-9 scale is used to transform the qualitative comparison results into quantitative judgment data, forming the following comparative judgment matrix:

$$R = \begin{bmatrix} 1 & 1/2 & 1/3 & 1/5 & 2 & 1/2 \\ 2 & 1 & 2 & 1/2 & 1 & 1 \\ 3 & 1/2 & 1 & 1 & 2 & 1/2 \\ 5 & 2 & 1 & 1 & 3 & 2 \\ 1/2 & 1 & 1/2 & 1/3 & 1 & 1/3 \\ 2 & 1 & 2 & 1/2 & 3 & 1 \end{bmatrix}$$

$$R_1 = \begin{bmatrix} 1 & 1/2 & 1/7 & 1/3 & 1 \\ 2 & 1 & 1/3 & 2 & 3 \\ 7 & 3 & 1 & 5 & 7 \\ 3 & 1/2 & 1/5 & 1 & 3 \\ 1 & 1/3 & 1/7 & 1/3 & 1 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 1 & 1/5 & 1/2 & 1/3 & 1/2 \\ 5 & 1 & 3 & 1/2 & 1 \\ 2 & 1/3 & 1 & 1/2 & 1/3 \\ 3 & 2 & 2 & 1 & 1 \\ 2 & 1 & 3 & 1 & 1 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 1 & 2 & 1 \\ 1/2 & 1 & 1/2 \\ 1 & 2 & 1 \end{bmatrix}$$

$$R_4 = \begin{bmatrix} 1 & 1/3 & 2 & 2 & 1/3 \\ 3 & 1 & 4 & 3 & 2 \\ 1/2 & 1/4 & 1 & 2 & 1/3 \\ 1/2 & 1/3 & 1/2 & 1 & 1/3 \\ 3 & 1/2 & 3 & 3 & 1 \end{bmatrix}$$

$$R_5 = \begin{bmatrix} 1 & 1/2 \\ 2 & 1 \end{bmatrix}$$

$$R_6 = \begin{bmatrix} 1 & 1/2 & 1/3 & 1/2 \\ 2 & 1 & 1/2 & 1/2 \\ 3 & 2 & 1 & 2 \\ 2 & 2 & 1/2 & 1 \end{bmatrix}$$

Then, the consistency of each judgment matrix is tested to ensure the consistency of the results of single ranking and total ranking. According to the calculation by analytic hierarchy Process, the consistency ratio *C.R.* of the above judgment matrix is less than 0.1, so the judgment matrix has reached the satisfactory consistency index. For the specific calculation process, please refer to Reference [11]. See Table 1 for the weight calculation results of each second-level indicator and the score of each first-level indicator.

Table 1. Competitiveness evaluation index system of Foshan ceramic industrial cluster.

Target layer	Primary indicators	Secondary indicators	Index weight	Score
Foshan ceramic industry cluster competitiveness	Resources R ₁	Natural resources	8.9043	6.8223
		Capital resources	7.1320	
		Human resources	6.3930	
		Technical resources	7.1973	
		Information resources	6.4798	
	Facilities R ₂	Infrastructure	7.9655	7.6027
		Government policy	8.4110	
		Service level of Trade Association	7.2265	
		Business environment (fair competition in enterprise market, etc.)	8.1070	
	Suppliers/Support industry R ₃	Research environment (universities, research institutions)	6.2358	7.4623
		Number and strength of suppliers	7.6038	
		Professional level of auxiliary industry (logistics, product testing, etc.)	7.4623	
	Enterprise structure, strategy and competition R ₄	Professional level of related industries (wholesale market, raw material market, etc.)	7.3208	7.6812
		Governance structure	7.8395	
		Enterprise innovation ability	7.6510	
		Cooperation degree of enterprises in cluster	7.6038	
		Competition degree of enterprises in cluster	7.2735	
	Local market R ₅	Enterprise brand building	7.7925	7.5252
		Domestic market prospect	7.3680	
		Domestic market share of products	7.6038	
Foreign market R ₆	Prospect of international market	7.3443	7.7555	
	International market share of products	7.0850		
	Total export earnings	8.5000		
		Barriers to products entering the international market	7.2500	

According to the GEM model's industrial cluster competitiveness calculation formula, firstly calculate the "factor pair" score of Foshan ceramic industry cluster, and then calculate the total score of the industrial cluster, the specific calculation results are as follows:

$$\text{Groundings: PAIR SCORE (Resources, Facilities)} = (R_1+R_2)/2 = (6.8223+7.6027)/2=7.2125$$

$$\text{Enterprises: PAIR SCORE (Suppliers/Support industry, Enterprise structure, strategy and competition)} = (R_3+R_4)/2 = (7.4623+7.6812)/2=7.5718$$

$$\text{Markets: PAIR SCORE (Local market, Foreign market)} = (R_5+R_6)/2 = (7.5252+7.7555)/2=7.6404$$

$$\text{GEM} = 2.5 \times [(6.8223+7.6027) \times (7.4623+7.6812) \times (7.5252+7.7555)]/3 = 558$$

Analysis and calculation results: The GEM score of Foshan ceramic industry cluster is 558, indicating that Foshan ceramic industry cluster has strong competitiveness in China, but there is still a certain gap from the leading position, indicating that there is still a large space for improvement.

Then, the results of factor pair score are analyzed. First, from the "market factor pair" score, Foshan "foreign market" factor score is the highest in GEM model six factors, 7.7555, a considerable performance, while the "local market" score is 7.5252, a general performance, which is consistent with Foshan's ceramic industry market positioning. The degree of localization of ceramic products of Foshan ceramic enterprises is insufficient. Foshan ceramic industry cluster is export-oriented and enjoys obvious export market advantages. Since 2000, the export of architectural ceramics has been growing rapidly year by year, and Foshan ceramics export has covered more than 150 countries and regions in the world, which has become an important growth point of Foshan's foreign economic and trade development^[14].

In the "enterprise factor pair", the factor of "enterprise structure, strategy and competition" scored a high score of 7.6812, showing a good performance. It shows that the enterprises in Foshan ceramics industry cluster have strong market competition, enterprise brand awareness and innovation ability. The score of "supplier and support industry" in Foshan ceramic industrial cluster is 7.4623, showing a weak performance. This indicates that suppliers and related supporting industries in Foshan ceramics industry cluster need to be further improved. The construction of perfect supplier and related supply chain system support is an industrial cluster to form competitive advantages and transformation and upgrading of the internal demand. While developing the ceramic industry in Foshan, the industrial chain is constantly deepened and extended, which drives the development of other industries, and promotes the upgrading of talents and the improvement of product research and development capabilities. Foshan has become China and even the world ceramic management and one of the most concentrated area of professional and technical personnel, have for the development of the ceramic industry has a complete industrial chain system, has the production, logistics, advertising, planning and other related enterprises and institutions, formed the specialization, industrialization of collaboration, good pattern for the development of the cluster. Therefore, the vigorous development of Foshan ceramic industry cannot be separated from the cooperation of related support industries, and

the improvement of competitiveness of Foshan ceramic industry cannot be separated from the optimization and upgrading of suppliers and related support industries.

In the "pair of grounding factors", the score of "resource" factor is 6.8223. The reasons are as follows: Although Foshan has regional advantages such as a long history of porcelain making, abundant ceramic raw material resources and a large number of ceramic workers, the factors such as high-quality human resources and core technical resources that affect the competitiveness of the ceramic industry are at a relatively low level. With the continuous development of the ceramic industry, the bottleneck of talents and science and technology is increasingly prominent, mainly in the lack of composite, cutting-edge talents and talents in emerging fields, especially in the new ceramic materials, ceramic high-tech, capital operation, e-commerce and other fields of talent demand is still very large. International and high-level r & d and design teams are relatively lacking, and the independent innovation ability is weak.

The score of "facilities" factor is 7.6027, showing a good performance. Foshan ceramic industry cluster has received policy support from national and regional government departments, and relevant infrastructure construction has provided strong help for the development of ceramic industry. A series of supportive measures have been introduced, including incentives for ceramic enterprises, the establishment of ceramic industry promotion association, youth chamber of commerce, etc., which have played a good role in helping the development of Foshan ceramic enterprises. Foshan city planning includes the world's advanced ceramic production lines and equipment manufacture "China ceramics manufacturing 2025" demonstration garden, the park will gather at home and abroad advanced ceramic equipment enterprises, to create the world's leading ceramic equipment manufacturing base, to develop Chinese ceramics manufacturing blueprint, eventually to Foshan, Guangdong and even the national ceramics industry transformation and upgrading to provide support and guide.

4 Path selection of competitiveness promotion

Evaluation analysis found that "foreign market, enterprise structure, competition and strategy, facilities" score is higher, and the supplier, the local market, the resources and the supporting business "score is low, particularly in the" resource "factor score 7 points below, as well as the industry vulnerability and risk, suggest that these factors of Foshan ceramics industry cluster competitiveness must hinder ascension, It deserves the high attention of all sectors of society. The relevant path selection is as follows:^[15]

(1) Adjusting the industrial structure and transforming the development model. As the "world factory" of ceramic production, Foshan building ceramics consumes more energy and resources, and at the same time leads to poor compatibility between economic development and ecological environment. Environmental protection costs continue to rise, and there is an urgent need to change the growth power from "factor driven" to "innovation-driven". Therefore, the development of Foshan ceramic industry should pay attention to technological innovation, grasp the ownership of technolo-

gy, break through the bottleneck of research and development, and step into the world first-class ceramic manufacturing. On the one hand, the introduction of foreign advanced technology on the basis of re-innovation, the formation of independent intellectual property rights of new technology; On the other hand, in the aspect of research and development, we should pay attention to technological re-innovation, carry out technological breakthroughs and master the ownership of core technologies. In addition, traditional ceramic enterprises in Foshan are supported to realize cross-border integration with Internet enterprises, and enterprises are encouraged to promote accurate docking between market demand and production supply by transforming production technology and business process, so as to realize "Foshan Smart manufacturing".^{[16][17]}

(2) Improve the mechanism of talent training and introduction. Foshan ceramics industry should establish the introduction mechanism of high-level talents and applied talents and perfect the incentive mechanism of talent innovation. Foshan ceramics industry should carry out comprehensive cooperation with universities to establish the cultivation system of high-precision professional talents integrating production, education and research. Combined with the innovation needs of enterprises, the establishment of a high-level innovation team, to maximize the integration and integration of internal and external innovation elements of the ceramic industry, forming a cluster innovation network, and promoting the transformation and upgrading of Foshan ceramic industry.

(3) Industrial risk and vulnerability protection. Foshan ceramic industry should establish the identification, early warning, prevention and control system of resource, technology, economy, policy and ecology related industry vulnerability and risk.^[18] Foshan Municipal government and industry measures should play an important guiding role. Through the establishment of ceramic industry demonstration area, so that the enterprise relocation and technical transformation in one step; We will strengthen management of energy conservation, energy consumption and emissions reduction in accordance with the law, gradually establish a scientific supervision and management system, and promote resource recycling and comprehensive utilization of energy through government subsidies and other incentive policies.

5 Conclusion

This paper evaluates the competitiveness of Foshan ceramic industry based on GEM and AHP model, and puts forward solutions to the problems according to the evaluation results, which has strong guiding significance and application value for preventing and avoiding the internal risks of industrial clusters. However, because the factors affecting the development of Foshan ceramic industry are in the process of dynamic and uncertain changes, the study of this problem is a complex system engineering, the study of this paper is only a new attempt, there are many problems worth further exploration.

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