

# High-Quality Development of Ceramic Industry Clusters in Guangdong-Hong Kong-Macao Greater Bay Area Based on Green Innovation

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**Abstract:** In the past ten years, the ceramic industry which, belongs to the manufacturing industry, has formed an industrial cluster advantage in the Guangdong-Hong Kong-Macao Greater Bay Area in China. However, the continuous economic downturn in the international market, coupled with anti-dumping and other trade barriers, and the domestic overcapacity and environmental pollution pressure has impeded the export of ceramic industry products. The internal and external problems are restricting the improvement of green innovation performance of the ceramic industry cluster in the Guangdong-Hong Kong-Macao Greater Bay Area under the high-quality development. This project divides green innovation into several stages and levels for analysis, and establishes an evaluation index system in three dimensions: green economic benefits, technological innovation, and green development. Data on the factors affecting the high-quality development of the ceramic industry in the Guangdong-Hong Kong-Macao Greater Bay Area were extracted from databases such as CSMAR, WIND, RESSET, and CCER, followed by empirical tests. Finally, the specific improvement path for the high-quality development of the ceramic industry in the Guangdong-Hong Kong-Macao Greater Bay Area is obtained, and lastly the policy recommendations is proposed in the paper.

**Keywords:** Ceramic industry; Green economy; Technological innovation; Green development

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## 1. Introduction

The Guangdong-Hong Kong-Macao Greater Bay Area will undergo green and low-carbon development with four innovations<sup>[1]</sup>. High-quality development of the manufacturing sector is the core competitiveness of Guangdong-Hong Kong-Macao to build a world-class Bay area<sup>[2]</sup>. In the past ten years, the ceramic industry, which belongs to the manufacturing industry, has formed an industrial cluster advantage in the Guangdong-Hong Kong-Macao Greater Bay Area. Its ceramic production and export have a heavyweight position worldwide, including in China<sup>[3,4]</sup>. These economic mosaics are not only the growth points of the regional economy, but also dominate the country's competitive advantage<sup>[5]</sup>. Based on the above background, this project will build an evaluation index system which is suitable for the green innovation performance of ceramic industry clusters through small sample testing, analysis, and exploration of existing data, subsequently proposed path selection and policy for green development of ceramic industry clusters. As an important part of the national economy, the ceramic industry has a high energy consumption, pollution, and emission industry. Its green innovation performance often showed the characteristics of

multi-level and multi-influencing factors; therefore, it cannot be evaluated by a single index at a single level [6-8]. High-quality development is an essentially green development, and innovation has become the primary driving force, while green innovation has become the common form of development [9-11]. Based on the green innovation performance of the ceramic industry cluster, the path selection and policy suggestions for improving the green innovation performance of the ceramic industry cluster in the Guangdong-Hong Kong-Macao Greater Bay Area are given to guide the practice of high-quality development.

## 2. Research on high quality development of manufacturing industry and industrial cluster

The high quality of the manufacturing industry is a combination of breaking and standing development. In terms of measures to promote the high-quality development of the manufacturing industry, it is essential to reduce inefficiency and ineffective output, enhance technological innovation capabilities, encourage innovation and entrepreneurship, accelerate industrial integration, and also promote the quality, the efficiency, and the power changes of manufacturing development [12-14]. Manufacturing can achieve the high quality if it has the seven characteristics of quality, efficiency, power, coordination, greenness, openness, and sharing [15,16]. In the process of promoting the high-quality development of the manufacturing industry, elements such as innovation, capital, and human capital play an irreplaceable role. Among them, innovation is the first driving force for the manufacturing industry to move towards the high-quality development [17]. Industrial clusters are the core and foundation for realizing industrial chain reconstruction [18]. A sound and complete industrial chain and industrial clusters are the major advantage in China's development process, and as an important cornerstone for China to become a powerful manufacturing country [19]. Therefore, the ceramic industry clusters play a significant role in improving innovation capabilities [20].

## 3. Empirical test of green innovation performance of ceramic industry cluster under high quality development

### 3.1. Index weight analysis based on analytic hierarchy process

Analytic Hierarchy Process is a decision-making method that decomposes decision-related issues and related factors into the target, criterion, and program layer, followed by qualitative and quantitative analysis. By determining the subjective weights of the three dimensions of green economy, technological innovation, and the green development, and analyzing these weights, this project can more objectively by analyzing the influencing factors of the green innovation performance of the ceramic industry cluster.

According to the entropy method, a judgment matrix is constructed for the green economy, technological innovation, and green development, followed by calculation of the weight vector of the judgment matrix. Finally, the consistency test is conducted on the judgment matrix,  $CR < 0.1$ , and the consistency test is passed to ensure the rationality of the data. The weight of each index is shown in **Table 1**.

**Table 1.** Index weight

First-level indicator	Weights	Secondary indicators	Weights
Green economy	0.7380	GDP	0.4920
		GDP per capita	0.2460
Technological innovation	0.1676	R&D activities staff	0.0838
		R&D expenses	0.0838
ECO development	0.0944	Urban sewage treatment rate	0.0472
		Harmless treatment rate of municipal solid waste	0.0472

According to **Table 1**, under the first-level indicators, green economy has the largest weight, followed by technological innovation, and green development, and the weight of the green economy is far greater than the other two indicators, indicating that the green economy is the most important factor affecting the Guangdong-Hong Kong-Macao Greater Bay Area. Meanwhile, the important factor in the green innovation performance of the ceramic industry cluster in the district. From the two indicators of Gross domestic product (GDP) and per capita GDP, it is demonstrated that the economy has a greater impact on the ceramic industry.

### 3.2. Index weight analysis based on entropy method

The law of entropy value is a method to determine the weight by combining the information value provided by the entropy value. The weights are analyzed, and the factors affecting the green innovation and development of the ceramic industry cluster in the Guangdong-Hong Kong-Macao Greater Bay Area are obtained.

**Table 2.** The weight table of each index under the entropy method

First-level indicator	Weights	Secondary indicators	Weights
Green economy	0.2834	GDP	0.1650
		GDP per capita	0.1184
Technological innovation	0.5744	R&D activities staff	0.2879
		R&D expenses	0.2865
ECO development	0.1422	Urban sewage treatment rate	0.1001
		Harmless treatment rate of municipal solid waste	0.0421

According to **Table 2**, under the first-level indicators, technological innovation has the largest weight, followed by green economy, and green development, and the weight of technological innovation is significantly different from the other two indicators, indicating that technological innovation has a significant impact on the Guangdong, Hong Kong and Macao. Meanwhile, the impact of green innovation in the ceramic industry cluster in the Greater Bay Area is more obvious. The Guangdong-Hong Kong-Macao Greater Bay Area has formed the advantages of industrial clusters, however, there are still problems such as overcapacity and environmental pollution pressure, and the above-mentioned indicators, weight ratios, which clearly show that technological innovation has a greater impact on the ceramic industry in the Guangdong-Hong Kong-Macao Greater Bay Area.

### 3.3. Comprehensive weight analysis based on AHP and entropy method

Based on analytic hierarchy process and entropy method, the influencing factors of the green innovation and development of the ceramic industry cluster in the Guangdong-Hong Kong-Macao Greater Bay Area was analyzed, and subsequently the comprehensive scores were obtained and ranked.

**Table 3.** Comprehensive score sheet

Index	Overall ratings	Rank
Green economy	0.5107	1
Technological innovation	0.3710	2
ECO development	0.1183	3

**Table 3** showed that the green economy has the most obvious impact on the green innovation and development of the ceramic industry cluster in the Guangdong-Hong Kong-Macao Greater Bay Area, followed by technological innovation, and green development, however, the impact of green development is lower. This suggests that the high-quality development of the ceramic industry in Guangdong, Hong Kong and Macao requires attention to the development of green economic indicators. The ceramic industry is an industry with high energy consumption, pollution and emissions. Therefore, the traditional model is no longer suitable for the development of modern society, thereby a rapid economic development should be conducted on the basis of green innovation.

#### **4. Improvement paths and policy suggestions for green innovation of ceramic industry clusters in Guangdong-Hong Kong-Macao Greater Bay Area under high-quality development**

With the development of the ceramic industry cluster, the shortcomings of the ceramic industry's technological innovation mechanism have not been perfected, and the lack of awareness of green environmental protection has gradually been exposed, and the institutional innovation should provide a scientific basis.

##### **4.1. Improve the top-level design of the economic system, and promote high-quality economic development**

China's social and economic development is in a transition period from high-speed to high-quality development. Affected by factors such as economic downturn, novel coronavirus pneumonia, Sino-US trade friction, and the tightening of coal-to-gas, environmental protection policies, the development of the ceramic industry has become slow. Based on the development difficulties, such as low entry threshold, high energy consumption, high pollution, and slow green innovation transformation and upgrading of ceramic enterprises, the government should continuously improve and optimize the top-level design of the economic system to provide a solid guarantee for the economic development of the Greater Bay Area.

##### **4.2. Improve the contribution rate of economic growth, and increase the output of technological innovation**

Investment in the scientific and technological research and development of ceramics should be increased, continuously improve the independent research and development capabilities of ceramic enterprises, focus on the research and development of key technologies of ceramic enterprises, use advanced ceramic technology to develop more high-end ceramic products, and increase the added value of ceramic products. Additionally, utilize the excellent educational resources in the region and rely on the technical resources of local universities to promote the establishment of long-term and stable relations between ceramic enterprises and scientific research units of local universities, thereby promote the integration of production and education, school-enterprise cooperation, and give attention to the university's own scientific research advantages and enterprise resources. Further, together introduce high-level talents.

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### **Disclosure statement**

The authors declare no conflict of interest.

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