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Research on Industrial Upgrading under the Concept of Green Development

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Abstract: In recent years, the emergence of green development has had a significant influence on China's industrial upgrading. Through a comprehensive literature review, this paper explores the impact of green development and identifies three primary mechanisms by which it drives industrial upgrading: green technology, industrial clustering, and the industrial value chain. Moreover, the paper outlines five major challenges currently encountered in integrating green development with industrial upgrading. A case study of the Yangtze River Delta region is included to illustrate the practical application of these mechanisms. Based on the analysis of relevant data and theories, the paper proposes policy recommendations to guide future efforts in promoting green industrial upgrading. In conclusion, the study summarizes key findings and discusses their implications for future development. Through thorough analysis, this research aims to provide valuable insights and serve as a reference for related fields.

Keywords: Green development, Industrial upgrading, Industrial upgrading

1. Introduction

In recent years, with the intensification of global climate change and the frequent occurrence of climate disasters, influential countries in the world have begun to participate in actions to mitigate the climate crisis. As an influential country, China has adopted green development as one of its five development concepts since 2015, aiming to promote comprehensive green transformation of its economy and society. Industrial upgrading refers to the improvement of production factors, structural changes, improvement of production efficiency and product quality, also with upgrading of the industrial chain, which increases the added value of products. In the Catalogue for the Guidance of Industrial Restructuring, China mentions that it will promote high-end, intelligent and green manufacturing. In the field of industrial transformation and upgrading, China has been proposing policies to encourage green industrial transformation, and has made seven major achievements, including accelerating the high-end industrial structure and making remarkable achievements in low-carbon energy consumption [1]. It is also suggested in the 14th Five-Year Plan to accelerate the development of a manufacturing and quality power and to concentrate on the real economy in economic development. Nonetheless, a sizable percentage of China's economy is made up of traditional industries, which face issues like an energy system that is biased toward coal, severe

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environmental pollution, and a lack of innovation capacity. The contradiction of resource and environment constraints has intensified, and traditional industries are facing great pressure of transformation [2].

2. Literature Review

2.1. About Industrial upgrading

Under the background of the development of social productivity and the further deepening of the "dual carbon" goal, China's economy is currently transforming from high-speed growth to high-quality development, which is in a critical period. In the in-depth development stage of urbanization, it is faced with the problems of low energy utilization rate and intensified contradiction between resources and environment. Therefore, it is urgent to solve the problem of promoting the industry to the middle and high level of the global value chain and how to take the leading position in the international competition to achieve the green and low-carbon transformation of the industry [3]. Under the guidance of relevant policies, China's industrial transformation has indeed made relevant achievements, for example, in the coal industry, there are now talent-and technology-intensive industries driven by emerging industries [4]. The further construction of smart cities, which is regarded as the fundamental way out for urban green and low-carbon transformation, has more than 800 pilot cities related to smart cities in China, providing an effective strategy for the construction of a new development pattern [5]. Moreover, the optimization of the industrial structure of resource-based cities is on the rise, which to some extent reflects the trend of the overall industrial diversification of resource-based cities [6].

2.2. About green industry upgrading

With the corresponding achievements, if we want to further promote the industrial transformation and development, we should further refine the measures related to specific industries and implement the policies into production and life. In China, green development has been combined with reality, gradually forming a unique development model with two cores: greening the economy and green economy. Through multi-dimensional linkage and improved governance, China has continuously promoted the process of green development [7]. The contradiction between economy and ecological environment is the root of green development, and economic green development is its key. Since its participation in the United Nations Conference on the Human Environment in 1972, China's green development has gone through an exploratory period, an embryonic period and an accelerated period. To achieve green economic development, China needs to give full play to its institutional advantages, utilize environmental resources, stimulate market vitality, and promote scientific and technological innovation, industrial upgrading and energy structure transformation [8]. In order to achieve this goal, green taxation should be carried out. The linkage mechanism of investment and demand should be constructed to ensure the sustainable and balanced development of green industry upgrading. At the same time, we should pay attention to the optimization and adjustment of regional coordination mechanism, match the regional differences between green taxation and industrial upgrading, and finally achieve the goal of promoting green industrial development and successful industrial transformation and upgrading [9]. Providing financial guarantee for industrial transformation [10].

Secondly, green development focuses on the synergy between economy and ecology, emphasizes reducing resource consumption and environmental damage, achieving sustainable economic growth, and strengthening environmental governance through legal, policy and technological means. Green scientific and technological innovation is the key to improving the efficiency of environmental governance [11]. Environmental governance is a part of green development, and it is necessary to improve governance efficiency through laws, policies and market mechanisms, promote green

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technology and industrial structure adjustment, and achieve the goal of green economy and environmental protection [12].

Under the green development goal, smart cities improve carbon emission efficiency through green technology innovation, and cities with high carbon emissions have higher demand for smart city policies, which is conducive to promoting environmental governance and coping with the climate crisis [13]. In addition, China has made remarkable achievements in green technology innovation and industrial transformation. Through a series of policies and measures, the Chinese government has actively promoted the R&D and application of green technologies, which has achieved remarkable results. Specifically, China's technological innovation in solar photovoltaic, wind power, electric vehicles and other fields not only meets the needs of the domestic market, but also occupies an important position in the global market. However, China's green industrial transformation still faces many challenges [14]. For example, the lack of technological innovation capacity in some regions leads to poor promotion and application of green technologies. In addition, the resistance of some interest groups in traditional industries to green technologies also hinders the transformation and upgrading of industries. Therefore, in the future, China needs to take more powerful measures in terms of policy support, technological innovation and market promotion to promote the comprehensive deepening of green industrial transformation [15]. Green supply chain management (GSCM) refers to the introduction of environmental protection concepts in all links of the supply chain to achieve sustainable development of the whole supply chain by optimizing resource allocation and reducing environmental load. Walmart, an American retail giant, has also implemented a sustainability program in its supply chain, requiring suppliers to improve energy efficiency, reduce carbon emissions, and prioritize sourcing renewable resources. These measures not only improve the overall efficiency of the supply chain, but also significantly reduce the environmental impact. As a global manufacturing power, China has also been actively promoting green supply chain management in recent years. The Chinese government has issued policy documents such as the Green Manufacturing Project Implementation Guide (2016-2020) to encourage enterprises to implement green supply chain management and promote the ecological transformation of the industry. However, due to the complex industrial structure and unbalanced regional development in China, the promotion of green supply chain management still faces many difficulties. For example, some small and medium-sized enterprises face great pressure in implementing green supply chain management due to their low technical level and lack of funds. Therefore, in the future, China needs to further strengthen policy support in promoting green supply chain management, promote technological innovation and cooperation, and promote enterprises to achieve sustainable development.

The existing literature has highlighted the significance of green technology innovation and policy support in promoting industrial upgrading through green development. However, most studies focus on single factors using empirical or case analysis methods, with limited attention to the integration of various green development pathways for industrial upgrading. A review of current research shows that scholars primarily use empirical methods or case studies to explore the factors driving industrial upgrading, while few address how different green development strategies contribute to this process. Therefore, this paper adopts a literature review approach, analyzing a wide range of studies on industrial upgrading and green development to outline the ways in which green development fosters industrial upgrading.

The structure of this paper is as follows: the second section presents the research content and case analysis, while the final section provides conclusions and policy recommendations.

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3. Main Research Content

3.1. The influence mechanism of green development concept on industrial upgrading

The Opinion of the CPC Central Committee and the State Council on Accelerating the Comprehensive Green Transformation of the Economy and Society proposes strengthening scientific and technological innovation and business model innovation to support green and low-carbon technological revolution. Developing more environmentally friendly production technologies, management methods, and products, such as developing green technologies with high resource utilization rates to reduce resource waste in production processes, can help improve production efficiency and product quality. Improving resource utilization rates also means reducing ecological pressure, such as new energy-saving and carbon reduction technologies can fully tap the energy-saving potential of existing capacity by improving production processes and equipment, reducing energy consumption and waste generation, and thus achieving effective resource utilization. It also ensures national resource security and reduces the rate of use of the country's non-renewable resources. Improving resource utilization rates also prompts enterprises to adopt new technologies, production processes, and management methods, more effectively utilizing production factors, reducing production costs, and enhancing product value [16].

People's utilization of land and other resources has undergone a transition from rough to intensive use, as resources are limited, scarce, and diminishing, leading to an escalating contradiction between unlimited demand for resource development and its limited supply, ultimately leading to the emergence of intensive development [17]. There are two categories of modes of economic growth exist: The expansion of production components is the primary means of attaining economic growth in the context of the intensive growth model. The intense growth model primarily focuses on maximizing the distribution of production variables, enhancing their quality, and boosting their efficiency in order to achieve economic growth [18]. The intensive development mode makes the industrial production mode more advanced, continuously enhances the role of science and technology in rapid growth, and makes various production factors converge, coordinate, and optimize, ultimately realizing the update of industrial production mode. Green development emphasizes the sustainable utilization of resources, driven by technological innovation, to promote the transformation of industrial structures toward higher value-added and lower energy consumption. It also stresses industrial collaboration and resource sharing across regions. These goals can promote enterprises to improve their production efficiency, and the green development concept runs through all production links. Enterprises can improve their technical level and management efficiency and enhance the comprehensive utilization rate of resources within the region. All of the above development can drive the industry towards intensive and efficient development.

At present, China has not yet achieved the advantage of a manufacturing powerhouse, and is still constrained in some core areas or causes significant environmental damage [19]. The modern green and low-carbon development of industrial and supply chains integrates green concepts across all stages, including green supply chain management, production, and transportation, facilitating the overall green upgrading of industries. This is evident in practices such as green procurement and supplier selection within supply chain management. Companies will be more inclined to choose environmentally friendly materials and renewable resources for production. The introduction of high resource utilization rate and energy saving and emission reduction models during production makes the green transformation of the industry continue to develop. Green transportation and intelligent management reduce unnecessary pollution during transportation. This transformation and development of the industrial chain drive each industry to actively or passively carry out green upgrading. The market-oriented green technology innovation system has greatly increased the innovation capacity of enterprises, thus generating many new business forms and modes[20].

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Secondly, the green transformation of industrial concentration has made upstream and downstream enterprises able to share resources, technologies, and information, ultimately forming the overall upgrading advantage of the industry.

3.2. Analysis of the Dilemmas of Industrial Upgrading in the Context of Green Development

Industrial upgrading often requires companies to adopt environmentally friendly technologies and improve production processes, which means a substantial initial investment is needed. In the decision-making process, companies usually weigh the trade-off between their investment and expected returns. However, the economic benefits of implementing green technologies often take a long time to materialize. In the short term, the additional costs of industrial upgrading mainly come from equipment updates, process improvements, and R&D expenditures.

Although introducing pollution control technologies and sustainable environmental measures can significantly reduce emissions and improve energy efficiency, these initial stages often come with an increase in production costs and a narrowing of profit margins. The sudden increase in costs, coupled with the lag in short-term returns, constitutes a significant barrier to companies implementing green transformations. Therefore, immediate financial pressure may make companies unwilling to pursue sustainable practices, as they are more focused on maintaining profitability rather than long-term ecological responsibility.

Green development necessitates technological innovation by companies to boost resource efficiency and cut pollution. However, the practical deployment and advancement of green technologies encounter multiple hurdles. While technological innovation is crucial for industrial upgrading, the technological advancement across various sectors is uneven, with many traditional industries lacking mature environmental technologies. Integrating these green technologies into existing production systems often demands significant modifications, introducing uncertainties and potential temporary drops in production efficiency. Additionally, technological standards and patent constraints make it challenging for many developing countries or less developed regions to access advanced green technologies, compounding their difficulties in achieving green industrial upgrades. This innovation gap may impair the ability of these enterprises to adopt eco-friendly practices, reinforcing existing habits detrimental to sustainable development.

The successful rise of the green industry not only depends on supply-side technological innovation and policy support, but also requires strong market demand. However, at present, global demand for green products remains insufficient, which constitutes a major challenge. Price is an important factor affecting market demand; green products are often priced higher due to their higher production costs, which limits consumer purchasing willingness. Under this background, the market acceptance of green products is low, making it difficult for enterprises to achieve the scale effect that can usually lower production costs. This situation creates a two-way constraint on supply and demand, and the lack of consumer enthusiasm further weakens market growth. In addition, due to the fact that the application of green technologies is usually unable to significantly improve product performance or reduce prices in the short term, consumers' willingness to replace traditional products is low, further restricting the market's expansion potential.

The global shift towards green development is gradually eroding the comparative advantages of traditional industries. Nations should focus their resources on products where they have a relative strength. However, the stringent environmental regulations promoted by green development present significant challenges for countries dependent on resource-intensive or labor-intensive sectors. Many developing nations have historically leveraged low-cost labor and plentiful natural resources to compete in the global market. Yet, with the increasing demands for green development, these countries must adhere to stricter environmental standards during production, leading to higher costs and weakening their previous competitive edge. Consequently, green trade barriers in the global

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market might jeopardize these countries' standing in the international industrial chain. As competition grows fiercer, those unable to transition effectively to eco-friendlier production methods may find their market positions increasingly threatened by more innovative, environmentally sustainable competitors.

The evolution of industries, particularly through automation and technological advancements, inevitably alters the employment landscape. Technological advancements might cause structural unemployment by reducing certain roles in traditional sectors before new technical positions are fully established. This shift can intensify unemployment issues in the short term, particularly for low-skilled workers who find it challenging to swiftly adapt to technological changes. The resulting mismatch between labor supply and demand poses a significant challenge, as workers frequently lack the skills necessary to transition to new roles.

In summary, this analysis reveals the multiple challenges faced in industrial upgrading under the framework of green development. Solving these dilemmas requires a comprehensive approach, including joint efforts from government, enterprises, and various sectors of society to drive sustainable and economically feasible industrial evolution. By promoting collaboration and innovation, stakeholders can work together to overcome the barriers to green transformation and ensure that environmental factors become an important part of industrial strategies.

3.3. Research on industrial upgrading under the concept of green development:the Yangtze River Delta

Since the Fifth Plenary Session of the 18th CPC Central Committee in 2015, the concept of green development has been a core element of the new development concept, which aims to solve the problem of harmonious coexistence between human beings and nature. In view of global climate change and China's new journey towards building a modern socialist country, it is crucial to firmly establish and practice the concept that "lucid water and lush mountains are invaluable assets" to promote high-quality economic development in China. To achieve this, it is crucial to promote green and low-carbon technology innovation, accelerate green productivity and transformation, and incorporate these into the broader economic and social framework, ensuring that green development becomes the central principle guiding enterprise reform and innovation. However, China is still in the process of development in the historical stage of industrialization and urbanization. There is still much to be done to achieve a more balanced urban energy structure, improve energy utilization and address other problems [2].

To achieve this goal, we must promote industrial transformation and upgrading of regions, enterprises and other topics with a plan. The Yangtze River Delta region is undoubtedly one of the most active, open and innovative regions in China. It plays a pivotal role in the country's modernisation and all-round opening pattern. The 14th Five-Year Plan is the first five-year plan for China to start a new journey to build a modernised socialist country in an all-round manner and to enter into the construction of a beautiful China in an all-round manner. This is based on the recommendations of the 14th Five-Year Plan and the 2035 Vision designated by the Fifth Plenary Session of the 19th CPC Central Committee. The Yangtze River Delta is an important birthplace of Xi Jinping's ecological civilisation thought. It must adhere to the guidance of the green development concept to promote industrial transformation, optimisation and upgrading without delay.

The Yangtze River Delta boasts a well-developed water network, a rich variety of ecosystems and a robust ecological carrying capacity. However, the region also faces significant challenges. The dense population, high level of urbanisation and high intensity of resource extraction have resulted in insufficient systematic protection of river basins. Furthermore, the chemical industry along the river has resulted in prominent environmental risk hazards. Additionally, the region experiences high levels of resource and energy consumption, as well as total pollutant emissions[21].The ecological

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environment is a crucial foundation for the high-quality development of the Yangtze River Delta integration. Green development is the fundamental solution to address the outstanding ecological and environmental problems in the Yangtze River Delta region and achieve sustainable, high-quality development.

The concept of green development provides crucial guidance for the industrial transformation and upgrading of the Yangtze River Delta region. In the context of global climate change and China's modernization process, green low-carbon technological innovation, productivity enhancement, and industrial greenification have become core elements in driving high-quality economic development. Despite the region's rich ecological resources and strong environmental capacity, it faces challenges such as high resource consumption and environmental pollution. By implementing green development strategies, the Yangtze River Delta is gradually achieving a balance between ecological protection and economic growth. Moving forward, the region should continue to uphold the the concept of green development, address resource and environmental constraints, and promote sustainable, high-quality development. This experience can serve as a valuable reference for green development not only across China but also globally.

With the further development of China's productivity level, according to the data of China Statistical Yearbook, the gross regional product of the Yangtze River Economic Belt was 17.71 trillion yuan in 2010 and 47.15 trillion yuan in 2020, with an average annual growth rate of 16.6% during the ten years, and the urbanisation rate of the resident population increased from 48.7% in 2010 to 64% in 2020/so it shows that the economy and urbanisation of the Yangtze River Economic Belt have developed significantly[22]. However, if we want to further realise green-led industrial transformation and upgrading, the Yangtze River Delta region should also rely on the background of a strong sense of local reform and innovation, a developed economy and strong scientific research, and use technological innovation, digital economy and financial policies to promote it.

The General Programme for the Yangtze River Delta Eco-Green Integrated Development Demonstration Zone was released in November 2019, which clarifies the strategic positioning of the Yangtze River Delta Demonstration Zone (comprising Qingpu District in Shanghai, Wujiang District in Suzhou City, Jiangsu Prov, and Jiashan District in Jiaxing City, Zhejiang Province) as a new benchmark for the transformation of ecological advantages, a new high point for green innovation and development, a testing ground for integration system innovation and a new paradigm for harmonious coexistence of human beings and nature. Demonstration areas that prioritise ecological and environmental governance and through governance, the region's water quality in the lakes in advance to meet the standards, while the good ecological environment also has a spillover effect, the region's new energy industry, high-tech industries, such as "settled" to create a benchmark of low-carbon environmental protection. Meanwhile, the construction of an integrated market, relying on the demonstration zone within the universities, high-quality talents gathered, the advantages of strong innovation capacity, Tongji University Yangtze River Delta Sustainable Development Research Department brings together Fudan University, Nanjing University, Zhejiang University and other 8 universities talents, the sustainable development of technology programme in this integration and transformation of the nearest. 2023 July 31, the first inter-provincial high-tech industrial development zones in the demonstration area in the country. will be established. The integration effect has been enhanced through systematic innovations such as full linkage and mutual articulation, with the average annual growth rate of the GDP of the demonstration zone at 7.4% and the average annual growth rate of 10.9% in the total industrial output value above the scale [23].

In 2023, there were 23 cities in the YRD region whose tertiary sector accounts for more than 50% of the regional GDP, among which Shanghai's tertiary industry accounted for as much as 75.2%, which was the city with the highest tertiary industry output value, while its primary industry accounted for only 0.22%: Jiaxing's secondary sector accounts for about 53 % of output. Jiaxing's

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secondary industry output value accounted for about 53.5% of regional GDP, and it was the only city where the secondary sector accounts for more than 50% of output; Suzhou was the only city among the cities whose secondary industry output value accounted for more than 50%. It is not difficult to find that the 41 cities in the Yangtze River Delta region have basically formed an industrial gradient pattern of 'three, two, one', but the proportion of tertiary industry in Jiangsu Province is slightly lower than that in Zhejiang Province [24]. At the same time, the impact of the green development concept is that when the economic development has a certain foundation, the green development can be more through industrial adjustment, to the collection of high-value tertiary industry, to promote industrial upgrading; but when the economic foundation is relatively weak, the green development is manifested in the pursuit of environmental protection, so that the development of low-grade industries, and the upgrading of the goal of industry is contrary to the road [25].The Yangtze River Delta region is promoting economic development through the use of green finance. Experiments have proved that the development of financial technology contributes to the upgrading of industrial structure. In the Yangtze River Delta region, fintech can influence the upgrading of the industrial structure through the channel of green credit, but there is the phenomenon of imbalance between escalate of the industrial structure and the development of fintech among regions, and there are differences in its role in promoting the upgrading of the industrial structure. The analysis shows that the role is greater for the upstream region than for the middle and downstream regions [21].

The method of industrial upgrading guided by the concept of green development in the Yangtze River Delta region is worthy of reference for other regions in China. It is necessary to integrate the concept of green development into local construction planning, practise the concept of "green water and green mountains are golden silver mountains", and achieve high-quality economic development under the premise of harmonious coexistence between man and nature.

The further promotion of the Yangtze River Delta should be: (1) the establishment of a comprehensive ecological environmental protection coordination mechanism; strengthen regional cooperation based on pollution prevention and create a new situation of regional joint prevention and control.(2) Improve the market and economic mechanism for ecological environment; improve the ecological compensation mechanism, promote the participation of more social capital, improve and enhance regional carbon trading market, and put into full play to Shanghai's advantages in financial resources, and vigorously develop green credit, insurance and investment. (3) Play a leading role in innovation, exploring new mechanisms for the conversion of scientific and technological achievements in environmental protection, and fully develop environmental protection industries. (4) Strengthen the integrated supervision of the regional ecological environment [22].

4. Conclusion

The green development concept, as the key guiding principle for economic transformation in the new era, has significantly influenced the paths of industrial upgrading across various sectors in China. With the increasing pressures of resource scarcity and environmental challenges, the traditional model of high consumption and pollution is no longer viable, making green transformation and industry upgrading an irreversible trend. Through fostering technological innovation, optimizing industrial structures, and enhancing environmental protection, China is paving a path toward industrial advancement focused on development. Supported by the green development concept, businesses are shifting from extensive growth to a more refined, innovation-driven and low-carbon transformation. The advancement and use of green technologies have not only boosted production efficiency but also led to breakthroughs in energy and material utilization, significantly reducing environmental pollution and ecological damage. At the same time, green industries, as a new growth point, injected strong momentum into the economy and further optimized the industrial structure, promoting the rise of high-value-added, high-technology-content industries and driving overall high-quality economic

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development. Government policies played a crucial role in guiding and supporting the process, by formulating green development incentive mechanisms and implementing environmental supervision, enterprises' enthusiasm for green transformation was greatly enhanced. The green development concept is not only the intrinsic driving force for industrial upgrading, but also an important guarantee for achieving high-quality economic development. In the future, with the continuous strengthening of technological progress and policy support, China will continue to promote deep industrial transformation under the guidance of the green development concept, achieving coordinated development of economy, society, and the environment and walking a sustainable development path with Chinese characteristics. This study provides a theoretical basis for further in-depth discussions on the interactive mechanisms between green development and industrial upgrading and provides reference for policy formulation and practical operation. Based on the above research conclusions, the following policy recommendations are proposed.

4.1. Policy Recommendations

To alleviate cost pressures and the conflict between long-term investments and short-term profits, governments should implement targeted subsidies and tax reductions for businesses in transition. These financial incentives will help offset the costs of adopting environmentally friendly technologies. Additionally, creating a supportive regulatory environment and providing technical assistance for companies prioritizing sustainability will promote the widespread adoption of green technologies.

To overcome technical barriers and encourage innovation, government funding for green technology research and development should be substantially increased. Creating dedicated sustainable innovation funds and encouraging collaboration among industry, academia, and research institutions will boost technological capabilities and support the transition from research to practical applications.

To combat insufficient market demand for green products, the government should introduce green consumption subsidies and incentives for eco-friendly products. These initiatives can encourage consumers to choose sustainable options. Awareness campaigns to educate the public about the benefits of green consumption will further enhance consumer willingness and drive demand for environmentally friendly goods.

To counter the erosion of comparative advantages and increased international competition, the government should encourage domestic enterprises to engage in international cooperation. Facilitating knowledge exchange with global partners will enhance companies' technological capabilities. Strengthening policies to support the competitiveness of green products in international markets is essential for maintaining a competitive edge.

To address employment challenges from industrial upgrading, the government should provide vocational training and re-employment support for displaced workers. Investing in skill development and aligning training programs with labor market demands will prepare workers for new roles in the green economy and encourage the creation of new job opportunities in sustainable sectors.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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