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Romanian Academy, Romania

*CORRESPONDENCE
Yue Cheng,
616225194@qq.com

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Multiple paths of green and low-carbon development in industrial parks: group analysis based on the TOE framework

Xin Meng[1], Yue Cheng[2]* and Yuanhua Xuan[3]

[1]Party and Government Office, Guangxi Health Science College, Nanning, China, [2]School of Public Administration, Guangxi University, Nanning, China, [3]School of Intelligence and Information Engineering, Guangxi Economic and Trade Vocational Institute, Nanning, China

The green and low-carbon development of industrial parks plays an important role in promoting industrial and technological agglomeration, How to optimise their green and low-carbon development pathways is an important management question to be answered, requiring the examination of multiple path based on a histological perspective. Based on the technology–organisation–environment framework, this study selected 29 state-level economic and technological development zones (ETDZs) in China as research objects, and explored multiple sets of paths using fuzzy set qualitative comparison and necessity-contribution analysis. The study found that: 1) four promotion paths can be adopted for green low-carbon development of the zones: endogenous drive, balanced promotion, core support drive and comprehensive drive; 2) single environmental factor does not constitute a bottleneck hindering the green low-carbon development of the zones, which should be combined with the actual situation of the zones, and the balanced enhancement of the effectiveness of green and low-carbon should be realised through measures such as industrial policy, environmental risk prevention, and performance assessment of green policies. Finally, the study proposes the following policy recommendations: industrial parks should focus on the key role of environmental risk prevention, apply a combination of measures in accordance with their own realities, and appropriate external pressure can help promote green and low-carbon development.

KEYWORDS

green low-carbon development, group analysis, industrial park, multiple path, TOE framework

1 Introduction

Industrial parks are crucial to the advancing regional industrial and technological clusters, enhancing economic growth and fortifying global supply chains, but they also create growing problems of resource depletion and environmental pollution (Mathews et al., 2018). Under the principles of green and low-carbon development, the implementation of green and low-carbon practices must be fostered within industrial parks. This process entails cultivating an “inclusive economy” that combines economic growth with environmental protection. By ensuring the sustainable provision of diverse resources and services from natural assets, industrial parks can overcome their developmental challenges and effectively contribute to regional economic and social progress. However, given the complexity of the explanatory mechanism of industrial parks to promote green and low-carbon development and the influence of multiple factors, theoretical research has not kept pace with the actual progress.

The world's major developed and developing countries have carried out useful explorations in recent years. US has launched a pilot programme of eco-industrial parks to finance the design and development of eco-industrial parks in Maryland and other regions, so as to change the structure of industrial development in industrial parks. Japan has begun pilot projects in Hokkaido and other areas through the construction of intravenous industrial parks, the adoption of resource recycling and waste treatment technologies, and the development of environmental industries and intravenous industries to promote the reduction of carbon emissions in industrial parks (Chen et al., 2021). Developing countries such as Indonesia, Turkey and Brazil have also carried out a great deal of practical exploratory work to promote the transformation of the industrial structure of their industrial parks in the direction of green and low-carbon (Bank, 2019).

China is the world's largest industrialised country and the largest carbon emitter, with carbon emissions reaching 11.477 billion tonnes by 2022. On 22 September 2020, at the 75th United Nations General Assembly, China formally proposed the goal of achieving peak carbon by 2030 and carbon neutrality by 2060. In order to achieve this goal, China has adopted large-scale construction of a carbon market for trading (Wang and Lyu, 2024), promoted the green transformation of its industrial structure (Wang and Zhou, 2023), and established ecological civilization demonstration zones in an effort to honour its goal of carbon neutrality (Zhang and Fu, 2023), and has achieved significant results: China's carbon emissions are expected to fall to 249 megatonnes by 2024 and it will peak carbon ahead of schedule by 2030. Achievements in promoting green and low-carbon development in industrial parks provide a key impetus and an important guarantee for achieving this goal. Since their establishment in 1984, China's national-level economic and technological development zones (ETDZs) have emerged as a key pillar driving China's economic development. However, early stages of their development witnessed resource overexploitation, reliance on a linear growth model, and uncontrolled industrial expansion, leading to resource scarcity and environmental degradation in host regions (Mathews and Tan, 2016). In response, the Chinese government has prioritised the promotion of green and low-carbon development within industrial parks. Since 2017, annual lists of 'green industrial parks' have been compiled, and industrial parks that are awarded the national green park status are offered support. This approach aims to foster the growth of green industrial parks, improve their development environment and stimulate neighbouring regions to enhance their own level of green development. The green industrial parks established in China have witnessed substantial advancements, with significant improvements in industry safety and green development. Green industrial parks now boast an average solid waste disposal utilisation rate exceeding 95% whilst strengthening their green supply capacity (CCID, 2023). Moreover, China's formal proposal during the 75th United Nations General Assembly on 22 September 2020, i.e., to achieve carbon peaking by 2030 and carbon neutrality by 2060, has received substantial impetus and a vital guarantee from the achievements made in promoting green and low-carbon development in industrial parks. Therefore, research on the green and low-carbon development path of China's industrial parks will not only help to explore the experience of how the world's most carbon-emitting countries promote the green and low-carbon development of their industrial structure, but also help to provide new perspectives on the green and low-carbon development of developing countries in global policymaking and to provide lessons learned from their experience.

Current research on promoting green and low-carbon development in industrial parks primarily focuses on the macroeconomic level, encompassing areas, such as the development of indicator systems and assessment methods for measuring green and low-carbon progress (Zeng and Shang, 2017), the adoption and implementation of green technology innovations (Sacirovic et al., 2019), and the assessment of environmental benefits achieved (He and An, 2019). However, these studies often examine the influence of individual factors on green and low-carbon development in industrial parks independently, overlooking the integrated nature and complex interactions of the associated mechanisms (Murray et al., 2017). Therefore, exploring further the multiple modes of operation of industrial parks to promote green and low-carbon development from a configuration perspective is a key breakthrough in exploring their complex mechanisms.

This study focuses on the following two major questions: 1) From the perspective of group analysis, what are the mechanisms and factors influencing the green and low-carbon development of industrial parks? 2) How do different factors synergistically contribute to green and low-carbon development? To address the aforementioned issues, this study opts for industrial parks in China, recognized as the world's foremost industrial powerhouse and the leading contributor to global carbon emissions, as the primary research sample. The focal point is an examination of "China's performance in a global context," specifically emphasizing how industrial parks operating within the framework of the "China model" can achieve both management innovation and advancements in the green economy. Selecting China's national ETDZs as samples, we constructed a model of the influencing factors on the green and low-carbon development of industrial parks from the perspective of the technology–organisation–environment (TOE) framework. Then, we combined the necessity–contribution analysis (NCA) method and the fuzzy-set qualitative comparison analysis (fsQCA) method to explore the multiple influencing paths to gain an in-depth understanding of which resource factor configurations can affect the effectiveness of the green and low-carbon development of industrial parks. Thus, this study can provide theoretical basis and practical guidance for industrial parks to implement efficient synergistic innovations and promote green and low-carbon development.

The innovation and possible contribution of this study to existing research is twofold:

The first aspect is innovation in the combination of research object and research method. Academic research on regional green and low-carbon development paths are mostly concentrated in provinces (states), cities and counties and other traditional local administrative areas, while there are very few cases in which industrial parks, which have special administrative competence and a high degree of concentration of industrial development factors and a more urgent need for green development, have been the object of research, Moreover, most of them use quantitative methods such as correlation analysis and regression analysis, thus ignoring the complex and variable combination of factors that influence them. In view of this, the article creatively takes industrial parks as the entry point, combines the QCA method and NCA method, and systematically analyses the improvement paths of the green and low-carbon development effectiveness of industrial parks driven by a variety of factors through different equivalent paths, which makes up for the research gaps on the paths and grouping theories of green and low-carbon development.

Most of the previous studies explored the policy path of green and low-carbon development from a single perspective, such as environmental protection and industrial transformation. This study used the TOE framework to construct a framework of influencing factors, the framework addresses the limitation of analysing single factors in isolation and neglecting the joint influence of multiple complex factors. It also enriches the existing research field from the perspective of technology adoption and innovation. The results of the study can provide policymakers and managers of industrial parks with suggestions on the use of a combination of policy tools to promote the effectiveness of green and low-carbon development management in industrial parks.

Focusing on the above discussion, this paper intends to carry out the research in accordance with the following process: firstly, through combing and analysing the academic literature, the analytical framework of influencing the green and low-carbon development of industrial parks under the perspective of technology adoption and innovation is determined. Subsequent steps involved the identification and categorization of condition and outcome variables, followed by their respective value assignments. A comprehensive analysis ensued, employing a combination of NCA and QCA methods to explore both individual variables and combinations of conditions. Through this approach, the study aimed to delineate pathways characterized by high-performance as well as those exhibiting non high-performance, with a particular emphasis on the robustness testing of the outcomes. Finally, the collation draws conclusions and suggests policy path responses.

2 Literature review and research framework

The behaviour of industrial parks in promoting green and low carbon is a phenomenon of interaction and interactions between different subjects, and is a kind of technological adoption and innovation behaviour, which may be influenced by technological characteristics, internal factors of the organisation and external environmental conditions (Shipan and Volden, 2008). Introduced by Tornatizky and Fleischer, the TOE framework provides a comprehensive analytical framework that focuses on the factors influencing technology adoption and innovation across technological, organisational and environmental dimensions. It offers insights into organisations' behaviours related to technology integration and adoption (Tornatzky and Flelscher, 1991). The TOE framework not only fits the actual situation of the complex multifactorial role of green and low-carbon development in industrial parks but also effectively identifies how different factors play a role and constructs a framework idea for group analysis. The next section further explores the factors influencing the green and low-carbon development of regions and industrial parks from the perspective of technology adoption and innovation.

2.1 Impact of technology adoption and innovation on regional green and low-carbon development

Empirical studies have shown that the majority of regional green and low-carbon development behaviours have technological, organisational and environmental dimensions. Firstly, at the level of technological conditions, enterprises, as the key body to achieve carbon emission reduction targets, can gain green advantages through green innovation and its spillover effects to improve energy use efficiency and reduce carbon emission intensity (Liang and Luo, 2022); it can also reduce carbon emissions from the source by driving the transformation of traditional industries in the direction of greening and promote the overall effectiveness of green and low-carbon development in the region where it is located (Chen and Zhang, 2023). Secondly, at the organisational level, the achievement of green and low-carbon development in a region is also influenced by governmental administrative interventions. By effectively allocating resources, the government can assume the risks associated with technological innovation and emission reduction in relevant industries. This approach facilitates the transition of high-carbon industries within the jurisdiction to a low-carbon development trajectory, stimulating a clustering effect and fostering a cohesive force for carbon emission reduction (Liang et al., 2022). Lastly, the environmental conditions at the regional level can also impact the success of green and low-carbon development. Factors, such as environmental regulations and industrial restructuring, are crucial. Moreover, variations in environmental characteristics, such as the imposition of carbon taxes, the allocation of energy tax revenue and the contribution of the tertiary industry, can significantly foster the advancement of green and low-carbon practices (Zhao et al., 2022).

2.2 Pathways to green and low-carbon development in industrial parks

2.2.1 Elements for green and low-carbon development of industrial parks

China's Green and Low Carbon Development Path for Industrial Parks primarily centres around policy and system formulation, innovative management mechanisms, environmental risk management and control and the establishment of a performance assessment system for green development. In terms of policy system formulation, the implementation of green industrial policies by managers of industrial parks can trigger adaptive cyclic interactions between enterprises and its stakeholders and improve the green total factor productivity of the region (Cheng et al., 2021); Clearly define the direction of green and low-carbon development in the formulation of policies at the overall level, and realise the green development of industrial parks through the implementation of policy tools such as encouraging industrial restructuring, supporting the clean energy industry, and strengthening environmental regulation (He and Li, 2023). In terms of management mechanism innovation, a good management system innovation can regulate the production behaviour of enterprises, obtain a new competitive advantage in green development with the supply of high-quality and exclusive public products (Wang, 2015). or change a single management system for industrial development, and integrate the environmental protection management system, the EIA management system, the engineering management system and the development and construction system to promote the enhancement of the green effectiveness (Cai, 2014). In terms of environmental risk control, the construction of the environmental performance evaluation index system, the strengthening of the coprocessing of enterprise organic waste and the monitoring of pollutant emissions, the establishment of the industrial parks' enterprise pollutant prevention appraisal system and the development of the Green Investment Promotion Evaluation Indicator System not only serve as the driving force for the green and low-carbon development of industrial parks but also play a positive role in promoting the effectiveness of the green development of industrial parks (Xiao et al., 2023). Lastly, enhancing the inclusion of ecological environmental protection and green low-carbon development in the performance appraisal system of industrial parks can effectively encourage the enforcement of environmental regulations by the governing department. The resulting pressure from the environmental performance appraisal serves as a catalyst for promoting green innovation amongst enterprises within industrial parks, leading to overall improvements in the parks'green development performance (Guan et al., 2023).

2.2.2 Empirical research on the relationship between factors and green and low-carbon development paths

Well-crafted green industrial policies play a pivotal role in fostering the positive impact of industrial parks on green and low-carbon development. Zhou and Zhang conducted a comprehensive analysis of the emotional preferences associated with green industrial policies implemented in industrial parks within China's Yangtze River Delta region from 2010 to 2019. The findings underscore that a judiciously designed content for green industrial policies significantly contributes to enhancing the effectiveness of carbon emission reduction efforts and overall impact (Zhou and Zhang, 2023). The results of empirical research on the Suzhou Industrial Park in China and some industrial parks in the western region of China point out that: the innovation of the management system can be adopted to stimulate the synergy of the government, enterprises, universities, the public and other innovation bodies (Zhang and Xing, 2023); or the top-level design can be clear about the "zero-carbon strategy" of low-carbon development and intensive expansion, and based on this, the cultivation of green and low-carbon development paths can be carried out in accordance with the functional forms and development stages of different types of industrial parks (Zheng et al., 2023). Designing a multi-level superimposed and interlocking environmental risk prevention and control system, such as a system for preventing and controlling water pollution emergencies, can significantly enhance the environmental risk prevention and control capacity and green sustainable development of industrial parks (Chen.Y et al., 2023; Chen et al., 2023 and others point out in their empirical study of industrial parks in China's Yangtze River Economic Zone that the implementation of dynamic management of environmental risk grading in the parks and the establishment of a working mechanism for dealing with emergencies and accidents can help to prevent, control and dissolve the environmental risks of industrial parks in a systematic way and to achieve green and low-carbon development (Zhang et al., 2022).

2.3 Review of research

The above studies have made many useful explorations, but there are still the following areas that need to be strengthened: firstly, the existing empirical analysis of the literature mainly explores the single value of a number of potential elements, i.e., based on regression analysis, correlation analysis and other ways to test the correlation effect of a single element, neglecting the integration of the analysis of the driving mechanism of the green and low-carbon industrial parks, organisational processes and the institutional environment, and the lack of synergistic effects of the synergies between the multiple conditions of the system. Secondly, the existing research predominantly targets provinces (states), cities, counties, and other conventional local administrative areas. Although there are studies focusing on the administrative bodies of industrial parks, the majority of qualitative research tends to gravitate towards single-case studies or single-factor quantitative research, often delving into environmental protection and institutional design. The research landscape lacks a robust exploration of industrial parks as the central subject, specifically in unraveling the complex interplay of factors influencing the efficacy of green and low-carbon construction. Strengthening efforts in understanding the multifactorial dynamics contributing to the role of industrial parks is imperative. Therefore, it is necessary to integrate the formation of a composite framework that influences the common role of multiple factors in the green and low-carbon development of industrial parks based on the framework of technology adoption and innovation, and to further explore the construction of multiple paths in combination with the group theory.

2.4 Research framework design

We embeds the TOE framework into the context of green and low-carbon development of industrial parks in China to explore its path mechanism in a multifaceted and systematic way.

2.4.1 Theoretical analysis of factors influencing green and low-carbon development in industrial parks from the perspective of technology adoption and innovation

In the TOE framework, the technological condition pertains to the characteristics of the technology itself and its alignment with the organisation. This aspect emphasises whether the technology is compatible with the structural attributes and application capabilities of the organisation, as well as its potential benefits for the organisation (Tan et al., 2019). The technological condition is further delineated into three subcategories: the establishment of recycling industries, mitigation of environmental risks and evaluation of green policy performance. Strategically rationalising and proactively adjusting the industrial structure in industrial parks can significantly improve the efficiency of green and low-carbon development. Notably, the implementation of recycling industries not only optimises the composition of industries but also alleviates resource demand by enhancing the economic, resource and environmental benefits of industrial parks (Qi, 2013). China's National Development and Reform Commission and the Ministry of Finance have announced and released six batches of national parks' recycling demonstration pilot park lists from year 2012–2017, using selection criteria, including whether industrial parks have a complete recycling industry layout plan, land-use assessment for project entry into the parks, measures for environmental supervision and enforcement and pollutant management programmes. Drawing from national standards, Chinese provinces have incorporated provincial-level pilot recycling demonstration parks as part of their assessment protocols to measure the effectiveness of recycling initiatives within industrial parks. Given the concentrated nature of industrial parks, the implementation of appropriate environmental regulations can effectively incentivise enterprises to adopt technological innovations. This proactive approach helps prevent environmental pollution and promotes the greening of industries within the park, ultimately achieving sustainability objectives (Yin et al., 2023). By developing an environmental performance evaluation index system, enhancing financial investment in environmental protection and supervision, and intensifying environmental oversight, enterprises can be encouraged to regulate their high-energy-consuming and highly polluting production practices (Shang and Zeng, 2015). A reliable risk monitoring and early warning system serves not only as a crucial reference for industrial parks in formulating effective management measures but also assists in determining the threshold of resource and environmental carrying capacity within a specified timeframe. Such information can guide the scope, intensity, and scale of economic development (Jia et al., 2018). China's industrial parks have been given varying degrees of administrative power by local government agencies, and it is crucial to implement a performance evaluation system, including effectiveness evaluation and appraisal of leading cadres (Han et al., 2015). In the context of China's sectional system, the performance appraisal of local officials serves as an important motivator. By increasing the proportion of green appraisal within comprehensive evaluations, regional environmental pollution can be reduced (Han and Zhang, 2018). The establishment of local regulations to mandate green performance appraisal and linking the use of park funds to green performance requirements (Jiang, 2014) further strengthen the foundation of industrial parks and ensure green growth.

2.4.2 Organisational condition: institutional measures support

Technology has the potential to re-engineer organisations; however, organisations can also exert influence and even shape technology in the opposite direction (Mergel and Desouza, 2013). Factors, such as an organisation's resource capacity, the level of centralisation in its structure and interorganisational pressures amongst others, significantly influence the trajectory of technology (Grimmelikhuijsen and Feeney, 2017). This study specifically examines the role of institutional measures support. In China's hierarchical administrative system, decision-makers within industrial parks possess significant political decision-making power. When considering the adoption and promotion of green and low-carbon policies, they consider the economic situation and resource mobilisation capacity of their jurisdiction (Rogers, 2003). Moreover, decision-makers provide financial support to industrial parks in areas, such as eco-environmental management, green technological innovation, energy technological innovation and industrial restructuring and upgrading, through targeted financial expenditures (Zhang and Yang, 2019). In addition, complete institutional measures support for green and low-carbon development is closely related to whether the administrative body has sufficient capacity to implement the programme rules and regulations; this relationship helps ensure the implementation of the measures in accordance with the correct direction and accurate technical guidelines to enhance the implementation of the region's policy strength and effectiveness (Huang and Li, 2023). This support will have a significant impact on the green and low-carbon activities of industrial parks.

2.4.3 Environmental conditions: policy signals and competition from neighbouring regions

Environmental conditions, including factors, such as the market structure and external government regulations, play a significant role in shaping an organisation's ability to adopt and implement new technologies effectively (Oliveira and Martins, 2011). As administrative pressure operates within a hierarchical system, the implementation of policies driven by higher levels of government, as well as the signalling of policy intentions, can prompt lower levels of government to adopt a more conscientious and proactive approach (Zhang et al., 2022). China's industrial parks are considered local "quasiadministrative organisations"; hence, the "policy signals" imposed by higher-level authorities to promote green and low-carbon development affect the macroexternal environment of industrial park development and become one of the motivating factors for them to promote green and low-carbon development. The competition amongst industrial parks also affects the external environment, given that administrative entities at the same level are subject to the jurisdiction of a common superior administrative subject. Consequently, competition and imitation amongst neighbouring administrative subjects arise as they adopt new policies (Xufeng and Hui, 2018). This process leads to the diffusion of policy innovations and in turn, generates competition amongst neighbouring regions. Therefore, the existence of similar administrative entities in the neighbourhood of industrial parks that have achieved good results in green and low-carbon development may have a positive impact on the formulation of measures to promote green development in industrial parks.

In summary, the constructed TOE framework for green and low-carbon development in industrial parks encompasses six secondary conditions that supplement the primary conditions of technology–organisation–environment (Figure 1).

3 Research design

3.1 Research methodology for fsQCA combined with NCA

This paper proposed to use Fuzzy-Set Qualitative Comparative Analysis (fsQCA) to carry out the empirical test. Based on the multiple path, fsQCA approach uses Boolean operations and set relations to conduct comparative analyses at the case level, focusing on exploring the relationship between antecedent complexity and causal asymmetry; moreover, it can fully tap into the complex interactions and synergistic effects amongst multiple elements (Du and Jia, 2017), Compared to quantitative studies based on regression analyses and qualitative studies based on case analyses, the advantage of the QCA methodology is that it allows for the identification of conditional groupings with equivalent results through cross-case comparisons across samples such as large, medium and small (Equifinality), It helps researchers to understand the differentiated driving mechanisms that lead to the outcomes in different case scenarios and the fit and substitution relationships between the conditions discussed, broadening the dimensions of theoretical explanations for specific research questions (Tan et al., 2019). In addition, the use of the fsQCA methodology fits with the problem studied in this paper: Firstly, the green and low-carbon construction of industrial parks results from the synergistic linkage and joint action of external and internal factors. However, traditional linear regression analysis hardly explores the influence of multiple factors on the outcome variables. By contrast, fsQCA can analyse interactions amongst elements whilst tapping into the nonlinear relationship between different combinations of elements. Secondly, the fsQCA method integrates the strengths of qualitative and quantitative analyses and is suitable for medium-sized samples of approximately 10–50 (Du et al., 2020). Hence, the number of industrial parks selected for this study (i.e. 29) is compatible with fsQCA, and the depth and uniqueness of the case study can be considered. Finally, fsQCA can be used to identify the typical cases covered by each equivalent grouping accurately (Zhang and Du, 2019). It can also analyse the differences in the green and low-carbon development paths of different industrial parks, making it easy to summarise and generalise the efficient strategies that can be replicated. Finally, in recent years, the fsQCA method has been widely used in empirical studies in the fields of strategic management and technology application in organisations (Huang and Gui, 2009; Hao et al., 2017; Wang et al., 2014; Wang and Wang, 2018; Fan et al., 2018), which is in line with the logic of the TOE framework's technology-adoption-innovation (TIAI) analysis used in the present study, which has strengthened the scientific validity and reasonableness of the results of the analyses.

The Analysis of necessary conditions(NCA) is an analytical approach introduced by Professor Dul (Dul, 2020). It can be used specifically to analyse how necessary relationships and antecedent conditions constitute necessary conditions for outcomes. The reason for the combination of NCA and fsQCA methods in this study is that the QCA method focuses on qualitatively identifying the necessary conditions for the sufficiency analysis, The NCA method can analyse the degree of necessity of antecedent conditions from a quantitative point of view,

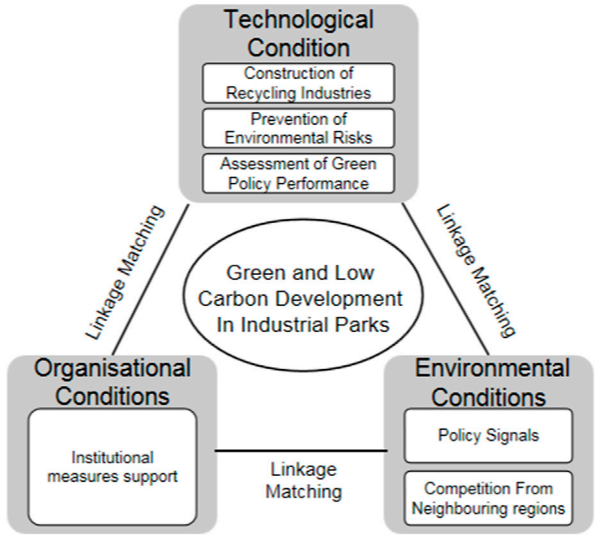

FIGURE 1
Analysis framework.

thus representing the degree of necessity more accurately and effectively compensating for the shortcomings of the fsQCA method in the process of analysing the necessary conditions, The NCA method enables a quantitative analysis of the necessity degree of antecedent conditions, thereby providing a more accurate representation of necessity. This quantitative perspective effectively compensates for the deficiencies observed in the fsQCA method during the analysis of necessary conditions, contributing to an improved understanding of the subject matter, The combination of the two methods is more valuable and the results of the analyses are more scientifically sound (Du et al., 2020; Vis and Dul, 2018). Therefore, this study firstly adopts the NCA method to analyse the necessity relationship between the influencing factors and the effectiveness of green low-carbon development; then, the QCA method is used to test the robustness of the necessity analysis results and to analyse the adequacy relationship between the influencing factors and the effectiveness of green low-carbon development, so as to further understand the complexity of promoting the green low-carbon development in industrial parks.

3.2 Selection of case samples and data sources

To ensure the scientific nature of the case samples, this study selected the top 30 national-level economic development zones amongst the 230 national-level economic development zones in China in the "2019 Comprehensive Assessment and Evaluation Results of National-level Economic Development Zones" as the case samples. However, the Caohejing Economic Development Zone in Shanghai was excluded because it is a "market subject" (i.e., managed by a state-owned enterprise according to the entrepreneurial market-oriented management) and not a "regional subject". Thus, a total of 29 case samples were included. These 29 national-level economic development zones all belong to the "first level" of China's industrial park development, and their levels of economic development do not significantly vary; the case samples are distributed in the eastern, central and western parts of China, which can compensate for the shortcomings of comparability caused by geographical differences and meets the requirements of the selection of homogeneous and diversified research cases.

The empirical data for this study were sourced primarily from policy documents: one is to find relevant policy documents in the official website of the Chinese government, and to judge whether the variables exist or not through the government documents and interpretations; the other is to search for keyword terms on mainstream search engines such as Google and Baidu. In this study, a team consisting of three members who are often engaged in text mining and text quantification research was set up to combine the two approaches mentioned above, adopting the methods of proofreading, identifying, giving opinions and revising each other by the three persons, and repeatedly checking and revising in order to improve the accuracy of the selection of policy texts. Excluding the policy texts that do not involve variable observation content, a total of 56 policy texts with valid variable observation content, such as the "13th Five-Year Plan for the Economic and Social Development of Industrial Park" and the "13th Five-Year Plan for the Green and Low-Carbon Development of Industrial Park", have been collected.

3.3 Data measurement and calibration

3.3.1 Outcome variables

This study focused on the assessment of green manufacturing system construction by China's National Ministry of Industry and Information Technology during the period of 2017–2021. The outcome variable used in this study was whether industrial parks are designated as national green parks. These assessments were considered authoritative and scientifically rigorous, providing a comprehensive reflection of the effectiveness of China's industrial parks in green and low-carbon development. In this study, the 29 industrial parks were assigned values of 1 or 0 based on their inclusion in the five batches of national green parks. Given the time lag of 2–4 years in policy implementation, a lag period was incorporated, with the outcome variable adopting data from year 2017–2021.

3.3.2 Conditional variables

Policy signals (PS). This variable primarily assesses whether industrial parks receive administrative pressure and PS from higher authorities. Textual indicators, such as 'implementing the spirit of instructions from higher authorities' or 'formulated in accordance with documents from higher authorities', in the locally formulated policies promoting green and low-carbon development by industrial parks determine the assignment of values. If these indicators are present, the value is 1; otherwise, the value is 0.

Competition from neighbouring regions (NR). It is mainly based on whether another industrial park in the jurisdiction of the city has been awarded a national green park before the sample is assessed. If there is one, the value is 1, with the value increasing by 1 for each additional park awarded; otherwise, the value assigned is 0.

Institutional measures support (MS). The promotion of green and low-carbon development policies at the industrial park level relies on three fundamental criteria: the provision of financial support, effective organisational leadership and the formulation of a comprehensive green development preparation programme. Each criterion, when met, is assigned a value of 1. Moreover, the cumulative presence of multiple criteria increases the assigned value. Conversely, if none of the criteria is met, the value designated is 0.

Construction of recycling industries (RI). The promotion of green and low-carbon development policies at the industrial park level is primarily based on three key elements: financial support, effective organisational leadership and the formulation of a comprehensive green development preparation programme. Each aspect, when present, contributes a value of 1. Additionally, if multiple elements are satisfied, the value increases accordingly. Conversely, if none of the elements are fulfilled, the value assigned is 0.

Prevention of environmental risks (ER). Assessment largely hinges on the existence of a policy within industrial parks that explicitly outlines the establishment of an environmental monitoring and early warning mechanism. If such a policy has been implemented, it is assigned a value of 1; otherwise, a value of 0 is given.

Assessment of green policy performance (GP): This variable is based on whether industrial parks incorporate green development into the comprehensive performance appraisal and supervision system at this level. If it does, the value is 1; otherwise, it is 0.

The antecedent conditions were analysed using data from year 2013–2019, in consideration of the 2–4 years time lag in the introduction of the policy and the fact that the outcome variable uses data for the period 2017–2021.

3.3.3 Data calibration

According to the analytical steps of the qualitative comparison analysis (QCA) method, three nonclear dichotomous variables, i.e., NR, MS and RI, must be conditionally calibrated. In accordance with Tan and Du et al. (Tan et al., 2019; Du et al., 2020), the raw data were calibrated using the direct calibration method by setting the three calibration anchors to be the 90% quartile (full affiliation), the median (crossover point) and the 10% quartile (no affiliation at all) of the descriptive statistics of the case data, with the advantage of using the median, which is less sensitive to outliers compared with the mean (Greckhamer and Gur, 2021). Calibration anchors and descriptive statistics for the antecedent conditions are shown in Table 1.

4 Analysis of results

4.1 Univariate sufficiency–necessity analysis

4.1.1 NCA

The determination of the necessary conditions in the NCA method must simultaneously satisfy two conditions: 1) the effect size (d) is not less than 0.1, and 2) the Monte Carlo simulation replacement test results show that the effect size is significant (Dul et al., 2020). The effect size ranges from 0 to 1, with 0–0.1 indicating a low level of impact, 0.1–0.3 indicating a medium level of impact

TABLE 1 Calibration and descriptive statistics of data.

Sets	Fuzzy set calibration			Descriptive analysis			
	Full affiliation	Intersection	Fully unaffiliated	Mean	Standard deviation	Minimum value	Maximum value
PS	\	\	\	0.586	0.493	0	1
NR	0.98	0.02	0.02	0.655	1.026	0	4
MS	0.98	0.98	0.02	0.759	0.567	0	2
RI	1	0.98	0.02	0.965	0.928	0	2
ER	\	\	\	0.655	0.475	0	1
GP	\	\	\	0.586	0.493	0	1

Remarks: PS, RI, and GP, are denoted by '\' because they do not need calibration.

TABLE 2 Analysis of necessary conditions for green and low-carbon development of industrial parks based on NCA.

Conditional variable(1)	Method	Precision (%)	Upper limit area	Range	Effect size	p-value(2)
PS	CR	100	0.000	1	0.000	1.000
	CE	100	0.000	1	0.000	1.000
NR	CR	100	0.000	0.98	0.000	1.000
	CE	100	0.000	0.98	0.000	1.000
MS	CR	100	0.000	0.98	0.000	1.000
	CE	100	0.000	0.98	0.000	1.000
RI	CR	100	0.000	0.98	0.000	1.000
	CE	100	0.000	0.98	0.000	1.000
ER	CR	100	0.000	1	0.000	1.000
	CE	100	0.000	1	0.000	1.000
GP	CR	100	0.000	1	0.000	1.000
	CE	100	0.000	1	0.000	1.000

Remarks: 1) Calibrated fuzzy set affiliation values were used; 2) permutation test method was used with the number of repetitive samples = 10,000.

and 0.3–0.5 indicating a high level of impact. In this study, we used the NCA software in R software for the NCA method, the effect sizes of the six conditioning variables were analysed using two estimation methods: cap regression analysis (CR) and cap envelopment analysis (CE). The results are shown in Table 2.

The results in Table 2 show that the effect sizes of the six conditional variables are not significant, suggesting that these conditions individually do not constitute a necessary condition for industrial parks to achieve green and low-carbon development. Thus, the combined impact effects of these conditions should be further analysed.

4.1.2 QCA

The necessity analysis within the QCA method is utilised to determine the dependence of the results on a specific variable. This determination is commonly derived from two primary indicators: consistency and coverage. An indicator value exceeding 0.9 for consistency indicates the essential nature of the conditional variable. Furthermore, coverage primarily depicts the explanatory power of the conditional variable on the outcome variable. In this study, fsQCA 3.0 software was used to calculate the "sufficiency–necessity" results of individual explanatory variables for high-performance and nonhigh-performance data, respectively, as shown in Table 3.

The results show that except for the consistency of ER, which is above 0.9 in the high effectiveness results, and the lack of coverage of ~ER, which is above 0.9 in the low effectiveness results, the remaining variables fail to reach the desired level of 0.9 as necessary conditions for the outcome variables. The rest of the variables do not reach the desired level of 0.9 and cannot be considered necessary conditions for the outcome variables. The above results also confirm that the realisation of green development in industrial parks requires the interaction of all variables with each other; therefore, different combinations of conditional variables must be analysed further to explore the multiple paths of influence on the green development of industrial parks.

TABLE 3 "Sufficiency–necessity" analysis results of univariate.

Conditional variable	High-performance		Conditional variable	Nonhigh-performance	
	Consistency	Coverage		Consistency	Coverage
PS	0.583333	0.411765	~PS	0.411765	0.583333
NR	0.340000	0.311450	~NR	0.469412	0.501887
MS	0.823333	0.498486	~MS	0.415294	0.769063
RI	0.830000	0.615575	~RI	0.634118	0.840874
ER	**0.916667**	0.578947	~ER	0.529412	**0.900000**
GP	0.750000	0.529412	~GP	0.529412	0.750000

Remarks: Calculations based on fsQCA3.0 software. As the value of these two data exceeds 0.8, which is high compared to other variables, to a certain extent, it indicates that these indicators have a high degree of influence on the outcome variables, which should be focused on and reflected as important explanatory variables of the outcome variables of all the cases in the path analyses below. Therefore, we have bolded these two data here.

4.2 Conditional portfolio analysis

Conditional combination analysis can reveal the effect of combinations of conditions on the results, in general, the level of consistency of the combination of sufficient conditions should not be less than 0.75(Schneider, C. Q and Wagemann, C, 2012). On the basis of the truth table constructed in the previous section and in accordance with the steps of QCA, the consistency threshold and frequency threshold must be determined. Given the small sample size of this study, we referred to the study of Zhang et al. (2019); hence, the frequency threshold was set to 1, and the consistency threshold was set to 0.8. The setting of the 'PRI consistency threshold' can avoid the simultaneous subset relationship of a certain grouping in the result and the result negation, and generally its threshold should not be lower than 0.5, according to Patala et al., 2021, who set it to 0.6.

The standard analysis in QCA is considered to produce higher confidence analyses due to the inclusion of counterfactual analyses. Thus, standard analysis was used in this study to calculate the results of high and nonhigh effectiveness separately. The parsimonious solution, complex solution and intermediate solution are obtained through operations. According to Fiss (2011), the conditions appearing in the simple solution are categorised as core conditions, and the conditions appearing in the intermediate solution but not in the simple solution are categorised as auxiliary conditions, which are presented in a table and categorised in accordance with the core conditions. Amongst them are four high-performance paths and more nonhigh-performance paths to facilitate the analysis of the original coverage of the four paths selected for analysis to avoid the coverage of small paths to interfere with the analysis of the results, the results are shown in Table 4.

4.2.1 High-performance paths

The results in Table 4 reveal four paths to high green and low-carbon development effectiveness ("*" denotes "and").

(1) Internal drive type path—Group 1 "Policy signals*Construction of recycling industries*Prevention of environmental risks". In which the elements of each dimension do not exist as core conditions and there is no serious lack of them; moreover only the elements of NR and other external factors belong to the missing state, indicating that although the external influencing factors are missing, the high effectiveness of the green development of industrial parks can still be achieved through MS, RI and other types of internal factors. This result shows that despite the absence of external factors, the high effectiveness of green development in industrial parks can still be achieved through MS, RI and other types of internal factors that complement and synergise with each other. Industrial parks with such a combination of elements, regardless of whether their superiors have released PS to them or there is no NR, can help enhance the effectiveness of green and low-carbon development by creating a good policy guarantee for green and low-carbon development and an environment with a good industrial structure, This paper therefore names such paths "Internal drive type path". Typical cases, such as the Tianjin, Dalian and Zhenjiang Economic Development Zones, whose higher authorities have not released specific PS for green and low-carbon development and lack the competition from neighbouring green zones, have developed complete institutional measures for green and low-carbon development and have achieved outstanding results in the construction of recycling industries. Moreover, the prevention of environmental risks has been stipulated in a separate chapter in the 5-year economic and social development plan. The above industrial parks reveal that under the influence of more complete internal factors, high green and low-carbon effectiveness can still be achieved despite missing core elements and the influence of external factors.

(2) Balanced promotion type path—Group 2 "Policy signals*Institutional measures support*Prevention of environmental risks*Assessment of green policy performance". The conditions it possesses are all auxiliary conditions, with all external and internal factors distributed. Moreover, no case of missing core or auxiliary conditions is noted. This path shows that industrial parks mainly focus on their own positioning and industrial development and promote green development in a balanced and steady manner. The industrial park actively responds to the policy signals of the higher authorities and puts them into practice,

TABLE 4 Condition configuration for high and nonhigh performance cases.

Conditional variable	High-performance paths				Nonhigh-performance paths			
	Group 1	Group 2	Group 3	Group 4	Group 1	Group 2	Group 3	
							Group 3a	Group 3b
Policy signals		▲	▲	■	▲	▲		▲
Competition from neighbouring regions	△		□	■		■	△	▲
Institutional measures support	▲	▲	■			▲	▲	▲
Construction of recycling industries	▲		▲	▲	□	□	▲	
Prevention of environmental risks	▲	▲		■	□		□	□
Assessment of green policy performance		▲	□	■	□	□	■	■
Consistency	0.973941	0.995	0.942308	0.990196	0.994924	0.990196	1	1
Raw coverage	0.498333	0.331667	0.163333	0.168333	0.230588	0.118824	0.116471	0.116471
Unique coverage	0.328333	0.163333	0.081667	0.080000	0.169412	0.056470	0.114118	0.115294
Solution coverage	0.903333				0.922353			
Solution consistency	0.978339				0.99115			

Remarks: ■ indicates that the core condition exists, □ indicates that the core condition does not exist. ▲ indicates that the auxiliary condition exists, △ indicates that the auxiliary condition does not exist. A blank space indicates that the condition may or may not be present.

and pays attention to system support and industrial safety, recycling to carry out the structural optimisation of the original industry, and formulates a complete mechanism to prevent all kinds of risks and hidden dangers, and ensures the implementation of green and low-carbon transformation. This paper therefore names such paths “Balanced promotion type path”. Typical cases include the Suzhou Industrial Park and the Hefei and Guangzhou Economic Development Zones. These three industrial parks are all located in the metropolitan area of developed regions along the eastern coast of China. The cities in which they are located have a strong demand for the implementation of green and low-carbon development, and all of them have conveyed PS in their policy documents, thus forming the influence of external factors. In addition, the areas in which these industrial parks are located are densely populated, and the requirements for the prevention of environmental risks are high; hence, these industrial parks have been separately listed in their respective 5-year plans for economic and social development and have formulated in detail systems for preventive measures, emergency response and accountability, thus maximising the safety and security of industrial construction. Although the resource advantages in other aspects are not too prominent, the green and orderly development of industries through the creation of a balanced green and low-carbon environment can enhance the effectiveness of development.

(3) Core support drive type path—Group 3 “Policy signals*Institutional measures support(core condition) *Construction of recycling industries”. The core condition is MS, and the supporting conditions are PS and RI. The focus of industrial parks is on the overall institutional measures support (including the complete design of the green and low-carbon construction programme), the full support of human and financial resources and the active promotion of the construction of recycling industries, despite the absence of competition from neighbouring regions and assessment of recycling industries. NR and GP are two core conditions but can still achieve high effectiveness of green and low-carbon development. Examples include the Beijing and Nanjing Economic Development Zones. Both have issued the document “Establishment of the Leading Group for Promoting Green Parks”; set up the leading organisation for promoting green development at their own level; and clearly defined the working mechanism for regular consultation, on-site promotion, supervision and accountability, annual assessment, etc., forming a relatively complete overall mechanism design for promoting green and low-carbon development. On this basis, the introduction of recycling industries, the original high energy-consuming and high-polluting industries to carry out recycling transformation and other tasks and a clear division of labour, and actively cultivate several green manufacturing system benchmark enterprises, This paper therefore names such paths “Core support drive type path”, of which the Beijing Economic Development Zone for the national recycling transformation demonstration parks, Nanjing Economic Development Zone, the effectiveness of the construction of the green manufacturing system ranked at the forefront of Nanjing City. With its own good institutional measures support and the support for industrial development, a high level of effectiveness in green development can be achieved despite the lack of competitive pressure from the proximity of similar green industrial parks.

(4) All-round drive type path—Group 4 “Policy signals*Competition from neighbouring regions*Construction of recycling industries*Prevention of environmental risks*Assessment of green policy

performance" (All core conditions). This pathway highlights the importance of industrial parks not only prioritising their own green and low-carbon development but also considering the influence of external PS. They should respond enthusia. They should respond enthusiastically to higher-level policies concerning green and low-carbon development whilst ensuring synchronisation with their own industrial construction and factor guarantee, This paper therefore names such paths "All-round drive type path". Typical cases include the Chengdu and Xuzhou Economic Development Zones, which are located in western China and are subject to a stronger degree of influence by the local government's administrative factors compared with developed regions in eastern and central China. They are also subject to the competitive influence of the Jintang Industrial Concentration and Development Zone (national-level green park) under the jurisdiction of Chengdu City. Furthermore, its own risk prevention and green performance construction results are good, and it achieves a higher green development effectiveness even though it lacks institutional measures support. Another example is the Xuzhou Economic Development Zone. On the basis of better park construction, its competent Xuzhou Municipal Government in Xuzhou City, to promote the green development of the policy text clearly requires: "Promote Xuzhou Economic Development Zone to improve the degree of industrial relevance to promote the park's green, low-carbon and recycling development". The Pizhou Economic Development Zone under the jurisdiction of the Xuzhou Municipality was also recognised as a national green park 2 years earlier than the Xuzhou Economic Development Zone. The demonstration effect has invariably deepened the competition amongst various development zones in Xuzhou City and formed the pressure of competition from neighbouring regions, which is in line with the all-round drive to achieve a high degree of green and low-carbon development. In addition, combining the previous NCA analysis and the univariate necessity analysis of QCA, ER appeared as a core condition in one pathway and as a secondary condition in two pathways, suggesting that this element of industrial parks plays a more important role in promoting high effectiveness in the process of promoting green and low-carbon development in the combination of governance.

4.2.1 Nonhigh-performance paths

Given the asymmetry of cause and effect, this study also analyses the grouping pathways that generate nonhigh green and low-carbon development effectiveness, as shown in Table 3. It also summarises three types of driving pathways: RI*ER*GP, RI*GP and ER (inhibition paths). The first pathway, consisting of Group 1, suggests that lower RI effects, ER, and shortfalls in GP combine to inhibit the industrial parks to produce high levels of green and low-carbon development. The second pathway consists of Group 2, which suggests that the lack of RI and GP are not conducive to green low-carbon development. The third pathway, consisting of Groups 3a and 3b, suggests that the absence of ER is not conducive to high green and low-carbon performance. By combining the previous NCA analysis and the univariate necessity analysis of QCA, the absence of ER is also found in the two paths of the nonhigh-performance group, and both of them are missing the core condition, indicating that any path of the industrial park grouping without this element will have a greater inhibitory effect on the generation of high-performance green and low-carbon development.

4.3 Robustness test

The robustness test in QCA analysis is an important basis for judging whether the results are stable or not. Drawing on the existing research practices of Shipan and Volden, 2008, Cheng et al., 2021, Cheng and Wang, 2022 and other studies on evaluating result stability, we firstly adjusted the value of the consistency domain to 0.85, the frequency number was kept at 1, and the two groupings of high-efficacy and nonhigh-efficacy products were basically the same as that of the existing groupings. The solution coverage and solution consistency are small. Secondly, a high-effectiveness and low-effectiveness case, i.e., Shanghai Jinqiao Economic Development Zone (municipalities directly under the central government) and Dalian Economic Development Zone (cities with separate municipalities under the central government), respectively were deleted after comparison with the analysis of the groups, and carried out the analyses of the high-effectiveness and low-effectiveness. The results showed that the group solutions were the same, and the differences in the solution coverage and solution consistency were negligible. The above test shows that the results of this study are relatively robust.

5 Conclusion and policy implications

5.1 Research conclusion

Taking 29 national development zones in China as case studies and using a combination of the QCA and NCA methods, this study analyses the complex causal relationship between urban talent ecosystem and scientific and technological talent agglomeration from a group perspective. The following conclusions are drawn:

Firstly, individual environmental factors are not necessary for high green and low-carbon development in industrial parks, but strengthening the prevention of environmental risks plays a pervasive role in generating high levels of green and low-carbon development, reflecting the need to continue to optimise the safety environment in development zones to promote green and low-carbon development in industrial parks. Secondly, this study finds four kinds of grouping paths for industrial parks to generate a high level of green and low-carbon development. They reflect the multiple paths that different industrial parks have taken to achieve green and low-carbon development based on their own environments through internal drive, balanced promotion, core support drive and all-round drive. They also reflect that the development and different driving mechanisms for green and low-carbon development in China's industrial parks undergo different stages. Three pathways inhibit the high effectiveness of green and lo-carbon development in industrial parks, and they are asymmetrically related to the pathways that drive high effectiveness.

The absence of prevention of environmental risks plays an important role in the inhibition pathways. Finally, the effective green and low-carbon development of industrial parks is closely related to the degree of economic and social development of the region in which they are located. Highly effective industrial parks are mainly clustered in the Yangtze River Delta Region, Guangdong–Hong Kong–Macao Greater Bay Area, the Beijing–Tianjin–Hebei Economic Circle and other eastern coastal urban agglomerations, suggesting that an increase in the level of economic development of the city is related to the improvement of the level of green and low-carbon development of the industrial parks.

5.2 Insights and policy implications

5.2.1 Theoretical implications

Firstly, based on the fact that the green low-carbon development of industrial parks is a comprehensive and complex system, this paper adopts the TOE framework and the group perspective to analyse the complex causal relationships among the influencing elements from a finer granularity. The results support the complex system view that there are multiple paths rather than a single optimal path for green low-carbon development in industrial parks. The results of the study reveal multiple modes of regional green low-carbon development under the perspective of complex system and provide a positive theoretical basis.

Second, this study responds to the complex systems view's call for "combinatorial" methodologies. The complex systems view argues that economic systems include multiple factors that are interdependent and require new methodologies such as "combinatorial" mathematics (Arthur, W. B, 2018). This paper analyses the complex relationship between the elements that interact with each other, describes what kind of combination of green development elements (ecological) promotes or hinders the achievement of effective green and low-carbon development in industrial parks, and provides new ideas and methods for researching complex systemic issues.

5.2.2 Policy implications

Firstly, we focus on the key role of prevention of environmental risks. Different industrial parks should consider the stage of economic development of the region and the leading industries to optimise the rule of law to ensure environmental protection in industrial parks; accelerate the construction of environmental protection, risk prevention and other policies and regulations; and create a safe production environment in line with the region' s own endowment. Secondly, it is necessary to improve and perfect the early warning mechanism and supervision system of environmental risk prevention, industrial parks can establish the mechanism of environmental quality analysis meeting for the linkage of various management functions, and the target assessment mechanism of environmental management and pollution prevention and control, etc., so as to strengthen the capacity of ecological and environmental risk prevention and enhance the effectiveness of the synergistic management of the ecological and environmental environment.

Secondly, various measures must be combined with their own actual situation to promote the balanced promotion of green and low-carbon performance of industrial parks. 1) First, for industrial parks that lack external policy signals and neighbourhood competition effects, we should focus on our own institutional support, recycling industry construction and environmental risk prevention, accelerate the establishment of a full-time green low-carbon development executive team, and prepare a complete implementation plan for promoting green development, so as to improve the synergy of the work of synergistic promotion; in addition, we should pay attention to the formulation of recycling and transformation type of industrial policies and the creation of a safe production environment, and promote synergy between industrial policies and environmental policies. 2) Industrial parks with relatively weak resource endowments should focus on building essential elements like environmental risk prevention and green performance appraisal. It is crucial to timely optimize and enhance the "green performance" appraisal mechanism. In the performance appraisal target system for the park's management team, additional targets and indices should be incorporated in the areas of risk prevention, resource utilization, environmental protection, and green manufacturing to ensure the effective implementation of green and low-carbon measures.

Thirdly, appropriate external pressure can help promote the green and low-carbon development of industrial parks. Industrial parks should respond to the signals from higher authorities or market players in a timely manner whilst paying attention to the experiences of neighbouring regions in the creation of green industrial parks. They should also organise regular meetings and exchanges, exchange staff and collate experiences and promotions to enhance the mechanism of exchanges and communication and promote the complementation of strengths and weaknesses so as to avoid falling behind or being overtaken by other industrial parks.

5.3 Research shortcomings and prospects

This study suffers from the following shortcomings that must be improved in future studies. Firstly, the theoretical model constructed is limited to grouping and analysing the antecedent conditions of industrial parks to promote green and low-carbon development; these are generally discussed in the existing literature. In the future, it can be considered based on the relevant theoretical basis, and matching analysis with the pilot factors of the national low-carbon industrial parks and eco-industrial demonstration park policy in the existing research. Secondly, given the availability of data on industrial parks, only 29 industrial parks were selected as cases. The sample can be further expanded in the future to improve the generalisability and replicability of the conclusions. Finally, only static data were used to explore the complex relationship between green and low-carbon development in industrial parks; in the future, data can be collected from multiple industrial parks over time, and the dynamic QCA methodology can be selected to investigate the impact mechanisms further. Effectiveness of construction.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

XM: Writing–original draft. YC: Writing–review and editing. YX: Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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