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Research on the Development Pathways for Low-Carbon City Construction from a Multi-Stakeholder Collaborative Perspective—A Case Study of Xiamen, a Pilot Low-Carbon City in China

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Abstract

The construction of low-carbon cities is crucial for sustainable urban development. This paper investigates the developmental pathways for low-carbon city construction based on the theory of collaboration, analyzing the stakeholders involved in the construction of low-carbon cities. Using Xiamen, a pilot low-carbon city in China, as a case study, the research analyzes the main practices of various stakeholders. Finally, it offers strategic recommendations for low-carbon city construction from multiple dimensions including government, residents, businesses, and media. This study enriches the field of low-carbon city construction and provides theoretical guidance to accelerate the global advancement of low-carbon cities.

Keywords

Multi-Stakeholder Collaboration, Low-Carbon Cities, Developmental Pathways

1. Introduction

In the context of global climate change, building low-carbon cities has become a critical strategy worldwide for addressing climate change and promoting sustainable development. With rapid urbanization, most population growth and economic activities are concentrated in urban areas, leading to significant energy consumption (Sharma, 2011; Wang et al., 2016). Thus, cities play a pivotal role

in achieving greenhouse gas reduction targets. Establishing low-carbon cities is considered key to a low-carbon future (Yang & Li, 2013). Urban low-carbon development is a multi-objective issue that involves not only reducing greenhouse gas emissions but also ensuring economic growth and quality of life (Fu, Liu, & Wang, 2010). The construction of low-carbon cities is a complex and multidimensional process, involving economic development, population concentration, technological advancement, energy structure, and environmental protection (Su et al., 2016). Therefore, exploring effective pathways for promoting urban low-carbon development is crucial.

Existing literature on the development pathways of low-carbon cities in China has yielded certain insights. Xing (2017) studied eight low-carbon city pilot cases and suggested that the government should organically integrate elements such as low carbon, green, energy-saving, environmental protection, ecology, and intelligence. Zhou et al. (2018) identified development obstacles and characteristics from the development trajectories of Shenzhen Special Economic Zone, Pudong New Area, and Binhai New Area, providing recommendations for the low-carbon development of Xiong'an New Area. Yang (2022) proposed relevant pathways to promote low-carbon city construction in China from the two-dimensional perspective of industry and transportation. However, previous studies have not approached the development of low-carbon cities from a systemic perspective, considering specific pathways from a multi-stakeholder collaborative viewpoint. A single entity is less capable of coping with various societal risks, while multiple stakeholders have greater adaptability to the evolving external environment and align better with current development trends. Therefore, low-carbon city development requires various stakeholders to collaborate, leveraging their respective strengths and advantages, to establish a collaborative mechanism that meets the needs of low-carbon city construction. This research aims to explore the development pathways for low-carbon cities from the perspective of multi-stakeholder collaboration, with the pilot low-carbon city of Xiamen, China as a case study. It analyzes how governments, businesses, the public, and media can work together to achieve low-carbon development goals. Adopting a multi-stakeholder collaborative theory as the theoretical framework, this paper examines the practical experiences of Xiamen in building a low-carbon city, exploring how different stakeholders can cooperate to create value and strategies for low-carbon development. This study not only broadens the perspective of low-carbon city development research but also enriches the theoretical and practical knowledge of low-carbon city construction. Additionally, it provides other cities with strategies and practical examples for low-carbon transformation, offering significant theoretical and practical value. Through an in-depth analysis of the Xiamen case, this paper aims to provide a specific research framework to guide future cities in achieving effective multi-stakeholder collaboration on the path to low-carbon development, thereby promoting sustainable development in society overall.

2. Research Design

2.1. Theoretical Foundation

This paper bases its analysis of the "Xiamen low-carbon city construction" case study on the theory of collaboration. Introduced by Haken (2012), collaboration theory suggests that synergy occurs when various components of a system work together, producing a collective or holistic effect greater than the sum of their individual actions, achieving an effect where 1 + 1 > 2. It includes two fundamental viewpoints: the first is "collaboration leads to order." The composition of social systems is complex and diverse, with various social actors operating smoothly in their respective tracks and playing positive roles in real-time. However, if one actor "derails," the consequences affect not only that actor but also disrupt the normal operation of other organizations. The second viewpoint is "self-organization," where, in the absence of external directives, the internal subsystems can form a certain structure according to specific rules.

Low-carbon city construction from a multi-stakeholder collaborative perspective involves not only the government but also various stakeholders, including enterprises, residents, and the media. Stakeholder theory (Freeman, 1984) posits that achieving organizational goals involves multiple stakeholders, each playing different roles. Low-carbon city construction is precisely the result of joint participation and interaction among different stakeholders. The government, as a guide, directs low-carbon development through policy-making and regulation; enterprises, as key participants, contribute to low-carbon city construction through innovation and sustainable production; residents, as a fundamental force, support city development through green consumption and low-carbon behavior; the media, as a coordinator, promotes low-carbon awareness and policy implementation through advocacy, education, and supervision. Through collaboration and cooperation among these stakeholders, low-carbon city development is effectively advanced (see **Figure 1**).

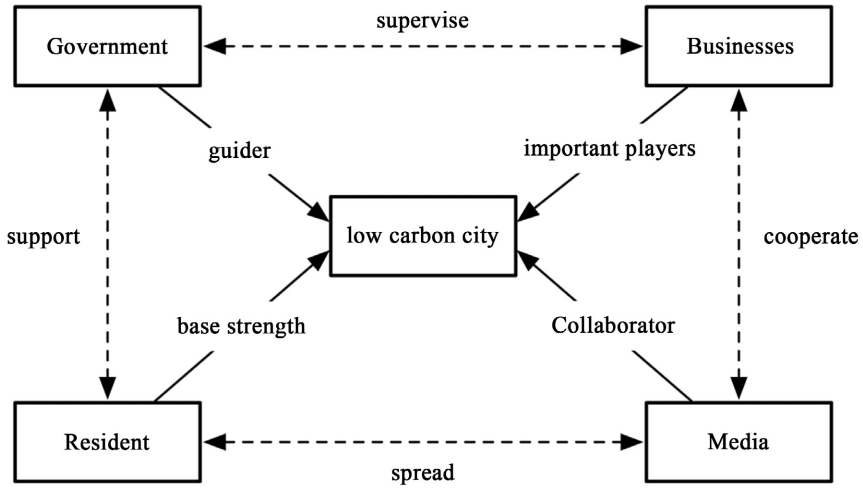

Figure 1. Mechanisms of Low-Carbon city construction from a Multi-Stakeholder collaborative perspective.

2.2. Methods and Data

In theoretical construction, case studies have become increasingly popular and form the foundation for extensive research (Eisenhardt & Graebner, 2007). Case studies are often regarded as a valuable tool for exploratory research projects, capable of describing the essence of phenomena and exploring their overall evolution. They are particularly suited to new or relatively underdeveloped research areas or for detailed investigations of specific complex cases in the real world (Rowley, 2002; Yin, 2013). Given the complex relationships among stakeholders involved in low-carbon city construction, the case study method is an appropriate choice for this research. In this specific study, we employ a descriptive single-case study approach, providing a detailed description of practical activities in Xiamen to illustrate the process of low-carbon development, derive theoretical generalizations, and propose strategies for low-carbon development applicable to other cities.

The materials used to construct the case study primarily include field interviews and research, academic papers, media reports, and information published on the official websites of city governments. According to the "triangulation" thinking model (Denzin, 2017), we compare information from different sources to achieve mutual verification between data and logical information, thereby significantly enhancing the credibility of the research.

2.3. Case Introduction

Xiamen, located on the southeast coast of China, is one of the economic and cultural centers of Fujian Province and one of China's earliest four special economic zones. As a national low-carbon city pilot, Xiamen is committed to advancing green, low-carbon development strategies. Through the implementation of a series of innovative policies and measures, the city demonstrates its determination and practice in areas such as energy utilization, urban planning, transportation, and architectural design. Xiamen's low-carbon practices not only include enhancing energy efficiency and developing a green transportation system but also promoting the use of renewable energy and enhancing public environmental awareness. These measures collectively foster Xiamen's exploration and practice on the path of low-carbon development, providing valuable experiences and references for other cities. Through these efforts, Xiamen aims to build a modern international city that is environmentally friendly and resource-conserving, showcasing the positive outcomes and forward-thinking layout of China's low-carbon city pilot projects. In 2023, Xiamen was recognized as an "Excellent National Low-Carbon City Pilot" in the "National Low-Carbon City Pilot Work Progress Evaluation Report," earning significant accolades in the field of ecological environment construction and showing remarkable success in low-carbon city construction.

3. Case Analysis

Based on multi-stakeholder collaborative theory, this paper analyzes the partici-

pation of various stakeholders in the "Xiamen Low-Carbon City Construction" case. Stakeholders such as governments, businesses, media, and residents collectively participate in low-carbon city construction, achieving multi-stakeholder collaboration and advancing the construction of low-carbon cities.

3.1. Government

Climate change impacts the global governance structure of governments. International experience shows that the government plays a crucial role in the development of low-carbon cities. First, the government acts as a regulator, setting goals and potential measures for low-carbon development through legislative and policy innovation. Second, the government acts as a provider, offering conditions and support for low-carbon development through fiscal budgets and effective means. Third, the government acts as a promoter, facilitating other sectors of society, including various local governments, social institutions, and businesses-citizens, to drive the development of low-carbon cities. The Xiamen city government comprehensively implements new development concepts, carries out peak carbon and carbon neutrality work, and has formulated a series of low-carbon development policies and plans. It innovatively explores and develops a "dual carbon economy" model, with multiple low-carbon pilot projects being vigorously constructed, rapidly forming a comprehensive, multi-level low-carbon pilot system. These policies and plans have played a vital role in guiding the construction of a low-carbon city in Xiamen.

The Xiamen government has also developed comprehensive planning documents such as the "Xiamen City Peak Carbon Action Plan" and the "Xiamen City Peak Carbon and Carbon Neutrality '1 + N' Policy System," among others. Furthermore, it has released several low-carbon technical standards, including the "Xiamen City Low-Carbon Community Acceptance Technical Specification (Trial)" and the "Xiamen City Zero-Carbon Scenic Area Pilot Demonstration Project Acceptance Technical Specification (Trial)." These initiatives significantly guide the city's efforts towards building a low-carbon urban environment.

3.2. Businesses

Green and low-carbon development is not only a prerequisite for building corporate core competitiveness and accelerating the creation of world-class enterprises but is also essential for corporate survival. Businesses in Xiamen have played a crucial role in promoting the city's low-carbon construction, with several exemplary cases emerging. The Xiamen Property Exchange Center, together with Industrial Bank and Xiamen Airlines, launched the nation's first "carbon-neutral air ticket," becoming a classic example of green air travel for individuals nationwide. Xiamen Port Logistics Co., Ltd., has integrated the concept of carbon neutrality in planning, construction, management, and operations, precisely accounting for and setting carbon-neutral targets and paths, and achieving an energy-efficient transformation through intelligent management.

The Yuhu Comprehensive Bonded Zone has managed to become self-sufficient in green electric energy within the zone, establishing a leading "energy self-balancing zero-carbon park" in China. Xiamen Port's Haitian Terminal has integrated low-carbon concepts into its systems, becoming the first in Fujian Province to complete the electrification of docks, automation of operations, and intelligent transformation of management, continuously improving and enhancing the port's energy-saving and environmental management capabilities. This has provided a "Xiamen solution" for the intelligent upgrade of traditional container terminals. These practices have significantly contributed to promoting low-carbon city construction in Xiamen.

3.3. Residents

Green and low-carbon living is not just an idea but a responsibility. It represents the residents' care and respect for the environment and is also for leaving a better future for our descendants. Adopting a green and low-carbon lifestyle helps reduce air pollution and global warming while improving people's quality of life. In their daily lives, people change traditional lifestyles, making green eating, green travel, and green living conscious actions, which are crucial for building a low-carbon city. In 2022, the National Energy Saving Publicity Week was officially launched in Haicang District of Xiamen, and the "Youth Energy Saving Challenge" mini-program was officially launched on WeChat. In 2023, the Xiamen Marathon achieved carbon neutrality in collaboration with Ant Forest, mobilizing a million participants to donate carbon credits, with the entire population of Xiamen participating in energy saving, forming a trend of green, low-carbon, civilized, and healthy living.

3.4. Media

In the era of strong national advocacy for a low-carbon economy and the implementation of green strategies, the media plays an indispensable role. Only media that prioritize social responsibility can better serve the country's economic transformation and possess broader credibility, influence, and vitality. The media in Xiamen promote green and low-carbon ideas both online and offline, creating a social atmosphere and practicing green development principles. Platforms such as Xiamen Daily, Xiamen Mobile TV, and the subway integrate content from the Energy Saving Publicity Week, guiding the general public to practice simple, moderate, green, low-carbon, and healthy living through energy-saving, green consumption, and other aspects, fostering a strong culture of energy conservation among the populace.

4. Strategic Recommendations for the Development Pathways of Low-Carbon Cities in China from a Multi-Stakeholder Collaborative Perspective

Based on collaborative theory, this paper presents strategic recommendations for

advancing the construction of low-carbon cities from multiple dimensions including government, businesses, residents, and media.

4.1. Government

Governments should lead the construction of low-carbon cities by developing and enforcing stricter environmental regulations and policies. For instance, governments could set higher carbon emission standards, mandating businesses to reduce their carbon footprints. Additionally, there should be increased financial and policy support for clean energy projects, such as providing subsidies and tax incentives for the development of renewable energy sources like wind and solar power.

Governments should also invest in smart city infrastructure, including smart grids, energy-efficient public lighting, and traffic management systems, all of which are effective means to reduce urban carbon emissions. Furthermore, governments could encourage citizens to reduce reliance on private vehicles by establishing favorable policies for public transport and expanding bicycle lane networks, thereby lowering the city's overall carbon emissions.

Fiscal incentives are also key to promoting low-carbon behaviors, such as offering tax breaks to households and businesses that install energy-saving devices or use green building materials. Moreover, governments could establish a dedicated low-carbon development fund to support the research and commercial application of various low-carbon technologies.

4.2. Businesses

As pillars of the urban economy and major sources of carbon emissions, businesses play a crucial role in the construction of low-carbon cities. Businesses should actively respond to government policies by voluntarily reducing energy consumption and waste emissions during production. Specific measures include optimizing production processes, improving resource efficiency, using environmentally friendly materials and technologies, and reducing resource consumption through the establishment of circular economy models.

Businesses should also increase their investment in renewable energy and low-carbon technologies, such as projects utilizing solar and wind energy, and exploring carbon capture and storage technologies. Additionally, businesses can promote the green transformation of the entire industry by strengthening cooperation with upstream and downstream supply chains.

Corporate social responsibility also includes enhancing communication and cooperation with governments, social organizations, and residents, jointly participating in the city's low-carbon planning and implementation processes, ensuring that business activities align with urban sustainable development goals.

4.3. Residents

Residents are the foundational force in urban low-carbon construction. They can

reduce energy consumption and carbon emissions by changing daily habits. For example, reducing the use of heating and air conditioning, optimizing home energy management, using energy-saving devices and lighting, and increasing the use of renewable energy.

Residents can also opt for low-carbon transportation methods such as public transit, cycling, or walking, reducing the use of private cars. In terms of consumption choices, supporting local and organic foods can reduce the overall carbon footprint from production to consumption. Moreover, residents should actively participate in community greening projects, such as planting trees and flowers, which not only beautify the living environment but also improve the urban microclimate and enhance biodiversity.

Through these everyday practices, residents can not only contribute to the city's low-carbon development but also enhance their own quality of life. Governments and social organizations should provide necessary information and resources to help residents understand and implement these low-carbon measures, such as offering discounts on energy-saving equipment through community centers and organizing educational activities about sustainable lifestyles.

4.4. Media

The media plays a critical role in disseminating information and educating the public in the construction of low-carbon cities. They should actively report on environmental protection and low-carbon living news, raising public awareness about the importance of climate change and low-carbon lifestyles through various media platforms. For instance, the media can host or report on environmental-themed programs and activities, showcasing practical applications of low-carbon technologies and lifestyles, inspiring public interest and participation.

The media should also take on a monitoring role, fairly reporting on the progress and challenges of government and business efforts in environmental protection and low-carbon construction. Through continuous attention and reporting, the media can encourage governments and businesses to adopt more transparent and responsible attitudes, ensuring the effective implementation of low-carbon policies.

Moreover, the media can serve as a collective voice for various stakeholders, fostering dialogue and collaboration among different parties. By hosting forums and roundtable discussions, the media can help build a strong collaborative force for society-wide participation in low-carbon construction.

5. Research Conclusion and Limitations

This paper, adopting a multi-stakeholder collaborative perspective, explores how cities can achieve low-carbon development. In a highly developed modern society, traditional studies on urban low-carbon development no longer meet current needs. Therefore, through an analysis of the Xiamen city case, this paper has

highlighted the importance of the involvement and collaborative development of various stakeholders (government, businesses, residents, media) in the process of urban low-carbon development, as well as the collaborative pathways for different roles in urban low-carbon progress. Based on the case analysis, this paper proposes strategic recommendations for fostering low-carbon city construction.

It should be noted that this study is limited to the case of Xiamen's low-carbon development. Future research should delve into more urban low-carbon development cases to validate and enrich the theories and strategies proposed in this paper. It is hoped that this research will provide useful insights for the field of urban low-carbon development and contribute to the enhancement and development of urban sustainability and environmental protection.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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