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Exploring the Construction Path of "Zero-Waste City" in China under the Perspective of Circular Economy

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Abstract: The total amount of solid waste generated globally is on the rise, and China is vigorously promoting the construction of "Zero-Waste City" to cope with the increasingly serious environmental problems of solid waste. The construction of "Zero-Waste City" is a vital initiative to enhance ecological civilization and build a beautiful China, and the concept of circular economy provides support for "Zero-Waste City". This study explores the development and implementation of China's "Zero-Waste City" initiative, a crucial effort for enhancing ecological sustainability and addressing solid waste challenges. It examines the concept's origins, current research, pilot projects, and identifies challenges faced by "Zero-Waste City" construction, particularly in policy, systems, technology, and industry. The study offers recommendations for improving policies, technological approaches, and industrial practices, integrating the principles of the circular economy to support the successful realization of China's "Zero-Waste City" vision. The study also highlights the importance of public awareness and participation, emphasizing the need for collaborative efforts between government, industry, and citizens to ensure the long-term sustainability of the "Zero-Waste City" initiative.

Keywords: "Zero-Waste City", Circular economy, Solid waste, Construction path.

1. Introduction

1.1. Background and Significance of the Study

For a long time, the development of most cities in the world has been based on a linear development model where products are produced, utilized and then discarded in pursuit of maximizing economic benefits [1]. In this rough development process not only consumes a large number of resources, but also produces a lot of solid waste that the environment cannot sustain. The random dumping or unregulated disposal of these solid wastes seriously damages the ecological environment and human health and leads to increasingly high management costs. In this context "Zero-Waste City" has emerged and is being promoted by more and more countries, organizations and individuals [2].

Reducing the consumption of natural resources and deriving economic benefits from them and balancing the relationship between economic construction and environmental and resource protection are the aims of the circular economy model [3]. The construction of a "Zero-Waste City" cannot be achieved without the support of the concept of circular economy. At a time when resources are becoming more and more depleted, promoting the construction of "Zero-Waste City" under the

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perspective of circular economy is an important step for China to achieve ecological civilization and green sustainable development.

1.2. Domestic and International Research Status

"Zero-waste" was first used by Paul Palmer in 1973. Nowadays, "Zero-waste" and Circular Economy have been adopted as one of the national and regional strategies in most developed countries [4]. For example, as early as 2015, Singapore put forward the Sustainable Singapore Blueprint 2015, through the reduction, reuse and recycling of all materials to give the second life to all materials through reduction, reuse and recycling, making Singapore a "Zero-waste" country [5].

China has inherited and developed international waste-free concepts and practical experience, but started late and the gap is significant [6]. In 2018, the General Office of the State Council issued the Pilot Work Program for the Construction of “Zero-Waste City". In this program, the connotation of "Zero-Waste City" is defined as: with the new development concept of innovation, coordination, green, openness and sharing as the lead, by promoting the formation of a green development mode and lifestyle, continuously promoting the reduction of solid waste at source and the utilization of resources. The General Office of the State Council issued the Pilot Program for the Construction of "Zero-Waste City", in which the connotation of "Zero-Waste City" is positioned as a city development model that minimizes the environmental impact of solid waste by promoting the formation of a green mode of development and way of life, continuously promoting the reduction of solid waste at source and resource utilization, and maximizing the reduction of the amount of landfill. In early 2019, the first 11+5 "Zero-Waste City" pilot list was announced for construction [7]. Pilot construction has achieved a stage-by-stage success, initially constructing a solid waste classification and resource utilization system, but there are still problems in the management mechanism, technical level and other aspects. In conclusion, China still needs to make a lot of efforts to realize the "Zero-Waste City".

1.3. Purpose and Method of the Study

1.3.1. Purpose of the Study

It will fill the gap in China's relevant theoretical research, provide theoretical support for the enhancement of ecological civilization and accelerating the realization of a beautiful China. With the help, "Zero-Waste City" can achieve a more efficient, synergistic and sustainable system of waste management and resource utilization, make urban development more sustainable. Finalizing a win-win situation for resources, environment, economy and society.

1.3.2. Research Method

(1) Literature analysis method: Screening and organizing the collected literature related to "Zero-Waste City" and circular economy, analyzing and interpreting the key contents, obtaining the information and data needed for the research, and improving the quality and reliability of the research results.

(2) Case study method: The construction of Shenzhen, the pilot city of China's "Zero-Waste City", was selected to analyze and summarize the experience and lessons learned.

1.4. Structure

Firstly, raise the question: Introducing the research background of the rough development, and in this context, raising the question of how to build a “waste-free city” under the perspective of circular economy. Then explore the significance of building a "Zero-Waste City" in China, analyze the status

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of domestic and international research, and define the purpose and methodology of the study. The following section explore the significance of "Zero-Waste City" in China and analyzes the status of related research at China and abroad to determine the purpose and methodology of the study.

Secondly, research cases: Shenzhen, a typical city of China's "Zero-Waste City" construction, is chosen as the research object to understand the basic situation and specific practice of its construction and explore the application of the concept of circular economy in it. Then, analyze the problems: analyze the problems of promoting "Zero-Waste City" in China from various perspectives, and analyze with case studies. After that, raise suggestions: Based on the above study, recommendations are made that are in line with China's national conditions and provide specific improvement measures for Shenzhen. Finally, leads to a conclusion: Summarize the current situation of promoting "Zero-Waste City" in China and the important role of circular economy in the program. Emphasize the feasibility and relevance of the pathways and recommendations presented in this paper and offer a bright outlook for the future.

2. Case Description

2.1. Case Selection

In April 2019, the Ministry of Ecology and Environment (MOE) identified 11 cities, including Shenzhen, Baotou and Weihai, and 5 special cases, including Xiong'an New Area in Hebei, Beijing Economic and Technological Development Area and Sino-Singapore Tianjin Eco-city, as pilot projects for the construction of a "Zero-Waste City". In these pilot cities, China explored four major systems (institutional, technological, market and regulatory) until March 2021, when the evaluation and summary of the pilot work will be completed. By March 2021, the evaluation and summarization of the pilot work will be completed. In this study, Shenzhen, a city with outstanding construction effect in the pilot program, is selected as a case study for analysis.

Shenzhen is a seaside city in southern China, neighboring Hong Kong and located in the southern part of Guangdong Province. As one of the top ten cities in China, Shenzhen has always attracted a lot of attention. As a pioneer and pathfinder of China's reform and opening up, it has demonstrated unlimited vitality and inexhaustible innovation, and has become an excellent choice for China to implement the pilot project of “Waste-Free City”.

2.2. Current Situation of the Construction of a "Zero-Waste City" in Shenzhen

Based on the actual situation, Shenzhen adheres to the international standard, and in accordance with the idea of "starting, following, running parallel and leading", it creates the "Shenzhen model" of solid waste management with "four synergies" (reduction, resource utilization, harmlessness and low carbonization in an all-round way. Solid waste treatment and disposal capacity has grown significantly in recent years. The local utilization and disposal capacity has been increased by 54%, successfully reaching 273,000 tons per day. With the tremendous efforts of Shenzhen, all types of solid waste being effectively disposed of[8]. The pilot task of initial exploring "Zero-Waste City" has been completed perfectly on schedule, and the pilot work has achieved remarkable results.

2.3. Application of Circular Economy in Shenzhen

In the process of exploring the solid waste management model for mega cities, Shenzhen adopts a large number of methods to vigorously implement the theory of circular economy. The government set up special funds for the development of energy-saving industries during the pilot period. And the Treasury invests 500 million yuan annually to support energy-saving industries, energizing the development of green industry. With unremitting efforts, Shenzhen's low-carbon and recycling

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development has reached the world's leading level, and the total area of green buildings ranks first in the country. More than 16,000 low-end enterprises have been eliminated and transformed, and the city has taken the lead in realizing 100% pure electrification of buses. Energy consumption per unit of industrial added value has dropped by nearly 60% in the past 10 years, and the carbon emission level of 10,000-yuan GDP is at the lowest level of large cities in China [9]. Circular economy is showing a vigorous development in Shenzhen.

3. Problem analysis

3.1. Policy and Institutional Level Issues

Policies and institutions in developed countries have been in place for a long time. Many developed countries have formulated medium- and long-term plans, specifying strategic objectives, implementation road maps and specific action plans for the next 10 to 30 years. For example, in 2016, the Netherlands formulated the "Circular Economy 2050 Blueprint", which proposes to achieve the phased goal of halving the use of major raw materials by 2030 and realizing 100% recycling of waste by 2050. However, at the national level, China has not yet clearly defined the overall goal, timetable and roadmap for "Zero-Waste City" in the medium and long term and lacks systematic top-level design and development planning [10].

In addition, China's legal system for the circular economy started late, and has successively enacted and implemented the Cleaner Production Promotion Law, the Energy Conservation Law, the Circular Economy Promotion Law, the Renewable Energy Law, and relevant supporting regulations, which together have constructed China's circular economy legal system, and these laws and regulations have played an important role in the development of circular economy in China. However, with China's dual-carbon goal and the elevation of ecological civilization construction to the level of national strategy, China's circular economy legal system can no longer meet the urgent need of achieve further economic and social development [11]. The relevant laws, regulations and standards for "Zero-Waste City" are not yet sound, and do not cover all key aspects of the whole life cycle.

3.2. Technological and Industrial Level Issues

As the overall economic efficiency of the solid waste recycling industry is not high, the level of intensification and standardization is low, and some of the technologies and projects still have the problem of being recycled but not economic or low-carbon, the comprehensive cost-benefit advantage of technology transformation is not obvious, and the endogenous motivation of enterprises to participate in technology transformation is insufficient. In addition, due to the low entry threshold of the solid waste comprehensive utilization industry, as well as China's current stage of the relevant intellectual property protection is not yet perfect, it is difficult to define the scope of infringement, resulting in some mastery of innovative solid waste high-value resource utilization technology enterprises are reluctant to apply for a technology patent, but rather, advanced technology solutions as a trade secret, only in the internal use of the enterprise on a small scale. In addition, some places have solid waste comprehensive utilization of scientific and technological achievements transformation platform, but favours technology evaluation, technology promotion and application of insufficient. The existence of these problems is not conducive to the exchange of advanced technology and industrialization of the promotion and application, seriously hindering the industry's high value, large-scale, high-quality development [10].

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3.3. Problems of Public Awareness and Social Participation

The public is an important participant in municipal solid waste management, playing a huge role as the broadest and most powerful social force. Nowadays, in order to increase the rate of public participation in the achievement of "Zero-Waste City", many relevant policies have been introduced in various places. However, due to living habits and lack of awareness, residents have not been able to fulfill their obligations effectively, and the degree of participation is not high. Excessive packaging, overconsumption and e-commerce have brought challenges to urban waste disposal. Disposal of solid waste is government-led, and the lack of public participation in the planning of related environmental protection projects has led to some projects becoming "not in my backyard".

3.4. Problems and Challenges in Shenzhen

Since being selected as a pilot for the construction of a national "Zero-Waste City", Shenzhen has explored the solid waste management model of a mega-city and has been listed by the Ministry of Ecology and Environment as a typical case of advanced "Zero-Waste City" construction. Unfortunately, there are still many problems and challenges for Shenzhen to realize further development and provide reference for other cities.

Firstly, there is insufficient reduction at source. In Germany, the basic law on circular economy "Circular Economy and Waste Management Act" puts forward that reduction at source is the optimal choice, followed by recycling and final waste disposal [12,13]. However, Shenzhen pays more attention to the treatment and disposal of various types of solid wastes after they are generated, focusing on the later treatment of solid wastes rather than reduction at the source. At the organizational and management level, it is mainly promoted by the departments of ecology and environment, urban management and law enforcement, which are responsible for the supervision and management of municipal solid waste. Due to the current management system and division of responsibilities among departments, the construction practice focuses more on environmental supervision, pollution control and risk prevention, and is not sufficiently capable of integrating the reduction the source [10].

Secondly, there is a lack of key technologies and equipment for the harmless and resourceful utilization of solid wastes. Such as waste incineration fly ash resource utilization technology is relatively scarce, at present mainly to safe landfills, mature and can be promoted, the cost of appropriate technology is very lack of; low-value wastes, such as waste salt, waste acid, disposal technology is more difficult, research and development strength is seriously insufficient [6].

4. Suggestion

4.1. Improve Policies and Regulations

The first thing that should be emphasized is systematic top-level design. Formulate a good medium- and long-term plan, specifying the strategic objectives, implementation roadmap and specific action plans for the next 10-30 years and beyond, so as to make the development more planned. Secondly, the construction of relevant laws, regulations and standard systems. Establish a good legal framework for the circular economy and build a mechanism to promote economic law for "Zero-Waste City". Through legislation oriented towards "zero-waste", the implementation of laws related to the circular economy will be promoted, and the efficiency of waste resource utilization will be further enhanced.

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4.2. Promote Technological Innovation and Industrial Upgrading

Strengthen technological innovation and break through key technological bottlenecks. Classify industrial by-products, rationalize the formulation of technical standards for products such as industrial by-products and products for the efficient utilization of resources, increase investment in weak aspects of research, in-depth implementation of the Ministry of Science and Technology issued a "solid waste resource utilization" key special action to make the dream of utilizing almost all industrial solid waste in a comprehensive manner a reality [13].

To formulate a development plan for the waste-free industry, cultivate the market, grow the industry, encourage intelligence, and support and attract enterprises of various forms of ownership to enter the waste-free industry. Realize the coordination between the government's macro-guidance and market resource allocation and cultivate the endogenous power of the industrial market. Explore the establishment of feasible intellectual property protection mechanisms in response to the characteristics of the solid waste comprehensive utilization industry, such as the low threshold of some technologies, the difficulty of technology trading, and the difficulty of defining and distinguishing the use of patents.

4.3. Increase Public Awareness and Participation

Improve the system of national action for a "Zero-Waste City", improve public supervision and reporting and feedback mechanisms, and raise citizens' environmental literacy. Actively carry out various forms of publicity and education on garbage classification and resource and environmental awareness, make comprehensive use of traditional and new media, advocate green and healthy lifestyles, strengthen national education, sensitize society as a whole to the benefits of "Zero-Waste City", and make citizens consciously and voluntarily join in the great cause of comprehensive building the "Zero-Waste City".

4.4. Improve the Construction of a "Zero-Waste City" in Shenzhen

First of all, the overall coordination and leadership of people's governments at all levels should be strengthened, and a cross-sectoral and coordinated comprehensive management system for "Zero-Waste City" should be established, so as to enhance the ability to coordinate the reduction of solid waste at production chain. And then, the laws, regulations and standard systems related to reduction at source also need to be strengthened, mainly to reinforce the legal regulation of product design, material selection, production, distribution and consumption at source, and to clarify the legal responsibilities, obligations, rewards and punishment mechanisms of enterprises, individuals and other relevant subjects.

The other is to strengthen in-depth communication and collaboration with countries around the world in the field of municipal waste management. While vigorously promoting technological innovation, we should draw on the advanced technologies and experience of developed countries and regions, master key technologies and equipment for the harmless and resourceful utilization of solid waste, and strengthen the interconnection of technologies, standards and models for exploring the path to the "Zero-Waste City" in China with those abroad.

5. Conclusion

As the country with the largest amount of solid waste in the world, China has been exploring and practicing the correct path of circular economy in line with its own national conditions and has made great efforts. The construction of "Zero-Waste City" under the support of the concept of circular economy has become a powerful hand in promoting the construction of China's ecological civilization

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and realizing the green and circular development of cities. Nowadays, the exploration of "Zero-Waste City" in China has gone through the conceptualization, strategic research and pilot construction, and has accumulated initial experience in the institutional system, market system, regulatory system and other aspects, and is on the right track step by step.

Through relevant theories and case studies, to explore the comprehensive construction path of "Zero-Waste City" under the perspective of circular economy, "Zero-Waste City" will realize a more efficient, synergistic and sustainable system of waste management and resource utilization and promote the sustainable development of the city and the protection of the environment. The "Zero-Waste City" will realize a more efficient, synergistic and sustainable waste management and resource utilization system, promoting sustainable urban development and environmental protection.

Ecological civilization construction and green development cannot be separated from the practice of circular economy and "Zero-Waste City". This is relevant to the country, society and even the individual, and everyone will be rewarded for their efforts. Despite the challenges and difficulties, the vision will become a reality in China through policy enhancement, scientific and technological progress and social participation. The future of "Zero-Waste City" is bright and promising.

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