Exploration of Construction Waste Treatment and Management Practice in the Zero Waste Cities of China

Take Shenzhen City as an Example

Cong Peng and Zhengquan Liu(✉)

Department of Civil Engineering, Guangxi Vocational College of Water Resource and Electric Power, Nanning 530000, China
liuzhengquan9027@hotmail.com

Abstract. Zero waste cities will become the model of sustainable cities in China in the future. In order to build a smart and low-carbon city and promote the construction of a zero waste city, Shenzhen city of China has adopted the platform of intelligent construction waste management system to collect and monitor construction waste, which is based on the NB-IoT waste monitoring system, remote Sensing Technology, GIS technology, CEMS and built environmental assessment system are used to assess and early-warning the construction waste stock, and effectively improve the level of construction waste management in cities.

Keywords: Zero waste city · Construction waste · Waste management of low-carbon city

1 Introduction

"Zero waste city" is a new and sustainable model of city, which takes the new development concept of innovation, coordination, green, openness, and sharing as its leader, and promoting the formation of green development and lifestyle, continuously promotes the source reduction and resource utilization of solid waste, minimizes the amount of landfill, and minimizes the environmental impact of solid waste. It is also an advanced city management concept [1].

On April 30th, 2019, the Ministry of Ecology and Environment of the People's Republic of China announced the pilot construction of 11 "Zero waste cities". The 11 pilot cities are Shenzhen of Guangdong Province, Baotou of Inner Mongolia Autonomous Region, Tongling of Shaanxi Province, Weihai of Shandong Province, Chongqing city, Shaoxing of Zhejiang Province, Sanya of Hainan Province, Xuchang of Henan Province, Xuzhou of Jiangsu Province, Panjin of Liaoning Province, and Xining of Qinghai Province. Among these cities, Shenzhen as a pilot city of Zero waste cities with technological innovation, has built the Shenzhen Construction Waste Intelligent supervision System platform, based on the advantages of IoT, automobile electronic technology, and other

N. Akhtar et al. (Eds.): PMIS 2023, AHIS 8, pp. 288–295, 2023.
https://doi.org/10.2991/978-94-6463-200-2_31

fields of science and technology with urban data collection, and play an exemplary role in the process of China's Smart City for the disposal of construction waste [2].

Construction waste refers to the residual soil, waste soil, waste material, mud, and other wastes generated during the construction, laying, demolition, and repair of various buildings, structures, and pipe networks by organizations or individuals who refer to construction [3]. Europe and the United States and other developed countries found the harm of construction waste earlier, and took positive measures to establish a relatively complete construction waste treatment system, such as the construction waste system of "Hierarchical management" and "Four management" in the United States. Japan has the mature law system for construction waste. And Germany has the advanced recycling technology of construction waste [4]. Many scholars have carried out in-depth research on the causes, quantities and types of construction waste [5, 6]. These results provide a reference for the basic research of zero waste city's construction and construction waste treatment in China.

Many factors will affect the construction of zero waste cities in China, such as waste treatment technology and management system [7]. In the first batch of the zero waste city pilot, Shenzhen city made full use of the deep foundation of scientific and technological innovation, and used information technology to monitor and manage construction waste in the whole process, which provided a reference template for the construction waste treatment under the construction of zero waste city.

2 Current Status of Zero Waste City Construction and Construction Waste Disposal in China

2.1 Solid Waste and Construction Waste Disposal in China

At present, China is one of the largest solid waste-producing countries in the world. China adds more than 10 billion tons of solid waste every year, and has a total historical storage of 60 billion to 70 billion tons. The phenomenon of garbage siege in some areas is very prominent in China. Promoting the construction of "Zero waste city" will guide the whole society to reduce the generation of solid waste, improve the level of urban solid waste management, and accelerate the solution of the long-standing problem of solid waste pollution. The zero waste city will take benefits in different area, just like environmental, economic and social etc.[8].

China's current solid waste mainly originates from industrial waste, domestic waste and rural waste. For urban management, industrial waste and domestic waste are particularly serious. Zero waste city is helpful to recycle the solid waste produced in production and life through circular economy, so as to achieve the goal of the carbon cycle and carbon neutralization. "Zero waste city" is not the absence of solid waste generation, nor does it mean that solid waste can be fully recycled, but rather an advanced urban management concept, aiming to finally achieve the goal of minimum solid waste production, full resource utilization and safe disposal in the whole city, which requires long-term exploration and practice [9].

By 2020, China's total construction waste production will reach 2.6 billion tons. From the perspective of resource utilization, the overall resource recovery rate of Chinese

construction waste is less than 10%, far lower than 90% of European and American countries and 95% of Japan and South Korea. The Pilot Work Plan for the Construction of "Zero waste Cities", proposes to carry out construction waste treatment, promote resource utilization in areas where conditions permit, improve the quality of construction waste recycling products, and provideing an opportunity for the resource utilization of construction waste.

Construction waste is generally produced during the construction process and in the maintenance and demolition of old buildings. Despite the contents of various components being different, the basic components of garbage produced by different structural types of buildings are the same, including soil, muck, scattered mortar and concrete, masonry and concrete fragments produced by chiseling, reinforced concrete pile heads cut by piling, metal, etc. According to the relevant data, the rough statistics of the construction material loss of brick and mortar structures, fully cast-in-place structures and frame structures, and other buildings, in the construction process of each square meter of building, only construction waste residue will produce 500 tons to 600 tons. According to the relevant data, China's annual construction and construction waste is generated and discharged to 40 million tons [10].

2.2 Taking Shenzhen City of China as an Example

Shenzhen produces more than 100 million cubic meters of construction waste every year. With such a large amount of construction waste, achieving the tracking management of the "generation-transportation-disposal" whole process is very difficult. To realize the supervision of solid waste, the Shenzhen housing bureau relying on the city public safety institute, the development and construction of "Shenzhen construction waste wisdom supervision system", the project through the ministry of science and technology demonstration project acceptance, the system not only multiple innovations, but its achievements have been in Shenzhen construction waste discharge, transportation, transit, and disposal business application, significant social and economic benefits, has important demonstration and promotion value.

"Intelligent supervision system of construction waste in Shenzhen city" is based on the mud truck GPS positioning system, through the electronic sheet to the city's construction waste discharge, transportation, transit, backfill, acceptance, utilization process, all-weather wisdom supervision, implementation from the production of the source of construction waste, transportation route, end disposal of "two-line" closed-loop management, truly achieve "every ton of construction waste processing to trace". Meanwhile, it also realizes dynamic monitoring and automatic early warning of the safety of the receiving field, which is through monitoring the receiving field, as well as real-time online monitoring of rainfall, surface displacement, deep displacement, pore water pressure, soil water content, etc. of the dam body and landfill of the receiving field. The intelligent supervision system can cover regulatory departments, construction units, receiving units, and vehicle transportation units at all levels, such as housing and construction, transportation, water affairs, traffic police, to realize multi-departmental data sharing, interoperability. Figures 1 and 2 show the login interface and structure of Shenzhen Construction Waste Intelligent Supervision System Platform:

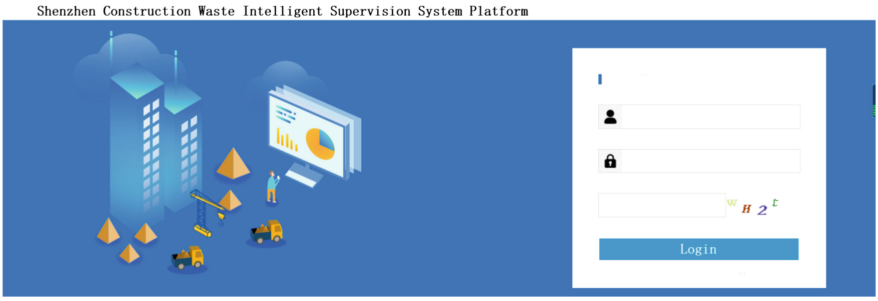

Fig. 1. Login interface of Shenzhen construction waste Intelligent supervision platform

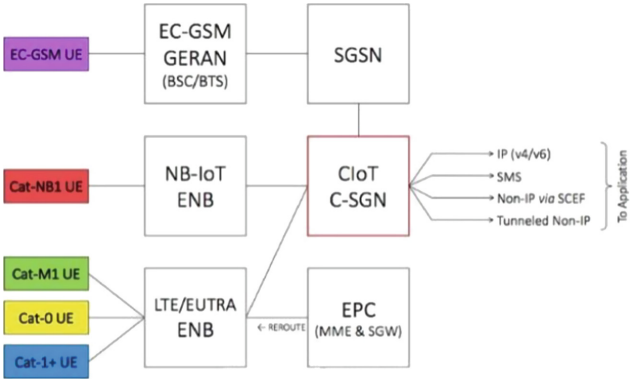

Fig. 2. Structure of Shenzhen Construction Waste Intelligent Supervision System Platform

Analyzing the structure of the intelligent supervision system of construction waste in Shenzhen city, which is according to the intelligent management and control platform and various types of hardware terminal to design, and the intelligent management and control platform is composed of remote data acquisition and communication, information integration platform and customer service management module.

2.2.1 Remote Data Acquisition and Communication

The system mainly collects and analyzes the data of the vehicle driving behavior, sets up the relevant data collection terminal in the vehicle, and feeds back the relevant information of the vehicle in real-time and transmits it to the information integration platform. At present, the commonly used means are GIS, GPS, wireless communication, real-time monitoring and so on.

2.2.2 Information Integration Platform

Similar to the function of the human brain, becomes the building waste intelligent monitoring system platform of the central system, to collect all the real-time feedback of all the information and data analysis to further decisions. Shenzhen Construction Waste

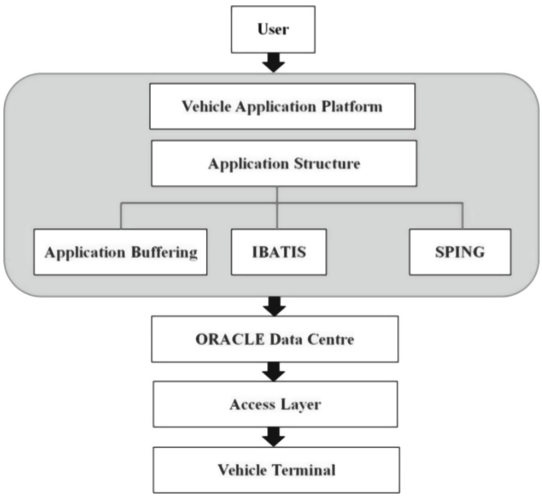

Fig. 3. Structure of Information Integration Platform

Intelligent Supervision System Platform can collect construction waste information from multiple channels, which is a set of intelligent supervision of construction waste from discharge to reuse of the whole process of the information system. The system can carry out real-time monitoring of construction sites, transport vehicles, and receiving fields, and carry out statistical analysis on monitoring data. Its beneficial effect is that it can effectively curb the phenomena of construction waste transport vehicles that do not comply with traffic signals, overloading, and speeding, unclean vehicle capacity, stealing and dumping, etc. At the same time, it provides the basis and decision-making for relevant departments to scientific management of construction waste, provides decision-making support for emergency command, and ensures the environmental reuse of construction waste. Figure 3 show the structure of information integration platform:

The platform provides the basis for multiple types of data collection and analysis. The comprehensive supervision database of construction waste based on the source detection database, transportation process database, receiving site detection database and recycling tracking database is constructed, which provides data support for the analysis and decision-making of the government and relevant enterprises and institutions.

2.2.3 Customer Service Management

Receive customer feedback and various needs, and for Information Integration Platform Statistics and analysis of data results of customer analysis, two-way coordination, to achieve efficient customer service management, and for the macro-level of intelligent management and control to provide room for continuous improvement.

From the perspective of strengthening the management of construction waste, the Shenzhen city will continue to accelerate the construction of “Shenzhen construction waste wisdom supervision platform”, the pilot implementation of electronic joint management and gradually promote the city’s construction waste discharge, transportation,

transit, backfill, acceptance, use and other processes for the whole process, all-weather "wisdom regulation".

The different departments of government can share data through the system, and the level of monitoring and disposal of construction in Shenzhen has been greatly improved, and the traditional dump trucks (13,000) have been completely cleared away, 7,714 new transport vehicles with intelligent control, (including 410 new energy waste transport vehicles). With the closed loop of whole process of transport chain and development of solid waste industrial chain, at present, the disposal rate of industrial solid waste in Shenzhen has been increased to about 90%, and the transportation and disposal rate of hazardous solid waste has been increased by 30%. It shows that the system play an important role in the Zero waste city, and the technology of smart city promotes the construction of Zero waste city.

3 Conclusion and Suggestions

Zero waste city is a low-carbon and sustainable model of city, and smart city is also an significant content of Zero waste city. The construction of Zero waste city rely on the key information technology of government management, and innovation of smart city is helpful for construction of zero waste city. Some suggestions as follows:

3.1 Establish a Scientific System

To support the construction of Zero waste cities, we need to establish four systems, namely the institutional system, technology system, market system, and regulatory system. For the possible solid waste generated by the new construction industry, we should adapt to the development trend of the industry, pay attention to technological innovation, management innovation, and digital transformation, and build innovation-driven development drivers in an all-around way. Breakthroughs in wet waste treatment technology after dry and wet waste separation, miniaturization of waste incineration, and multi-source waste collaborative treatment technology will be emphasized in terms of technological innovation.

3.2 Seek Institutional Innovation

With the constant updating of the city face, the construction process and the obsolete part of the building will produce construction wastes stably in the process of construction and dismantling. Based on this, construction waste treatment enterprises should communication with government departments actively, and the absorbed the construction waste timely. After transforming the construction waste to sustainable recycling materials for the construction of new buildings, that will be stable commercial business model and take huge economic benefits. This mode can give full play to the respective advantages of the government and the market, stimulate enterprises to develop the potential value of construction waste, form the "construction waste-construction waste processing, renewable construction products" industrial chain, improve the utilization of construction waste, out of a "government-led, market operation, franchise, recycling" of recycling road.

Based on the characteristics of non-toxic or low toxicity, state policies are mostly to encourage use without mandatory recycling. It is necessary to consider not only the sufficient stability of raw materials, but also the high quality and cost performance of products. After all, the resource utilization of construction waste is different from the traditional utilization of domestic waste and kitchen waste. At present, there are few specialized large enterprises engaged in the comprehensive utilization of construction waste, and most of them are in a state of loss. The main reason is the lack of a stable supply of raw materials, followed by the product quality and cost performance are not close, or both. Only by taking the "two ends" of raw material supply + product utilization as the starting point, innovating the business model combined with the local actual situation, and playing the leading position of the market can we truly promote the standardization and industrialization of construction waste resource utilization.

3.3 Technical Innovation

Construction waste resource utilization needs to be taken measures according to local conditions and technological innovation. Since the 90s, China has started the basic research on construction waste recycling, including construction waste resource utilization technology, recycling technology, recycled concrete high-performance utilization technology, etc., and completed the system structure of the construction waste industrial chain technology, which provides a lot of basic data and theoretical support for construction waste recycling and reuse. As the construction structure and building material requirements vary greatly in different parts of China, higher requirements for construction waste resource utilization technology and products are put forward. For local utilization, reasonable transportation, comprehensive disposal, modification, and other aspects of technological innovation according to local conditions, research, and development of cost-effective equipment is the foundation of the construction waste resource utilization guarantee.

Carrying out the pilot construction of a "Zero waste city" is a specific action to deeply implement the decisions and arrangements of the CPC Central Committee and the State Council. As a powerful starting point for deepening the reform of comprehensive solid waste management and promoting the construction of a "Zero waste society" at the overall level of the city, it is also an important measure to improve ecological civilization and build a beautiful China. The promotion of "Zero waste city" construction to enhance the level of integrated solid waste management and promote urban supply-side reform. The organic integration of government and management will accelerate the formation of a spatial pattern that saves resources and protects the the urban ecological environment. At the same time, for the development of urban economy, the industrial structure and agricultural production mode and consumption mode of the city will also turn to the direction of green development and improve the level of sustainable development of the city.

Acknowledgment. This study was financially supported by The Basic Competence Improvement Project for Middle and Young Teachers in the Universities and Colleges of Guangxi (2021)-Application and research of DMBP building intelligent construction technology in Guangxi region (Grant No. 2021KY1098).

References

1. Bahl M et al.(2021) Don't Transfer Waste, Transform Waste: A Sustainable Approach Towards Zero Waste Events Initiative During Hockey World Cup in Bhubaneshwar, India.IOP Conference Series: Earth and Environmental Science,795(1).
2. Wu Hao, Liu Hongbo, Cai Hongying, Zhou Qi, Zhou Yanchuan, Tian Shulei.(2021) General industrial solid waste management countermeasures under the construction background of "zero waste city" construction —— takes the main urban area of Chongqing as an example. The Environment and Sustainability, 46(04):119-122.
3. Hongping Yuan, Linyin Shen.(2011) Trend of the research on construction and demolition waste management[J]. Waste Management, (3):670-679.
4. Lu, M., Poon, C.S., Wong, L.C.(2006). Application framework for mapping and simulation of waste handling processes in construction[J]. Journal of Construction Engineering and Management, 132 (11), 1212–1221.
5. Zygouras, M., Karagiannidis, A., Malamakis, A.(2009) Construction and demolition waste processing in Athens, Greece: a pilot demonstration[J]. International Journal of Environment and Waste Management, 3:177-192.
6. Hao J L., Hills M., Huang T.(2007) A simulation model using system dynamic method for construction and demolition waste management in Hong Kong[J]. Construction Innovation, 7(1):7-21.
7. Elshaboury N., Al-Sakkaf A., Abdelkader E M., et al.(2022) Construction and Demolition Waste Management Research: A Science Mapping Analysis[J].Int. J. Environ. Res. Public Health,19(8): 4496.
8. Tian Xi et al.(2021) Design and simulation of a secondary resource recycling system: A case study of lead-acid batteries.Waste Management, 126:78–88.
9. Dugenje.(2019)Main problems existing in China's bulk industrial solid waste industry [J].Resource regeneration,11:34–36.
10. Lina Yu, Jingjie Teng, Huabo Duan, Linlin Guo.(2021) Study on "Full treatment"of construction and demolition wastes based on "zero waste city" concept[J].Environment and Sustainable Development,46(03):203–208.