Discussion on Management-and-Control Mode for Precise Disposal of Construction and Demolition Waste

Qiyun Peng1*, Chenggang Xi1, Ning Wang2 and Fumin Ren2

1 RIOH High Science and Technology Group, Beijing, China
2 School of Civil Engineering, Beijing Jiaotong University, Beijing, China
Email: pqy277@qq.com

Abstract. Faced with the severe challenges brought by construction and demolition waste (CDW), it is urgent to explore a more reasonable and effective management-and-control mode to dispose CDW. By analyzing the current situation of CDW disposal in China, it is found that the extant measures are mainly for the purpose of during- and post-event supervision, and the key factor to improve the status of CDW disposal is the government’s pre-planning for recycling purpose. In view of this, a government-led management-and-control mode for precise disposal of CDW is proposed. The mode is implemented by the government in advance to determine the target value of CDW recycling, and optimize the allocation of CDW generation-transport-disposal chain on the basis of meeting the requirements of resource compliance, with three characteristics (precise classification recycling and quantitative prediction, precise control of transportation quantity, and precise planning for resource allocation) and two operating modes (“target limit of mandatory recycling + optimal distribution” and “target limit of mandatory recycling + free decision”). To achieve this mode, a series of countermeasures are proposed from the aspects of formulating policies, planning aims, setting up institutions, and building a supporting system.

1. Introduction

Because of continuing industrialization and urbanization, construction and demolition waste (CDW) is expected to grow significantly in the near future, which makes CDW disposal as a global challenge [1, 2]. In China, about 30%-40% of the total municipal waste is CDW [3]. If there is a more effective mode for CDW disposal, it will reduce considerable environmental burdens and also bring economic benefits.

To propose a potentially effective mode for CDW disposal in China, there are several important suggestions from previous studies. First, the government’s involvement should be strengthened to actively mediate the CDW disposal by establishing policies [4]. Second, interests of all stakeholders in CDW disposal (e.g., government, clients, contractors, and suppliers, etc.) should be well balanced [5, 6]. Third, information-based system that allows precise CDW disposal is required to achieve the optimal strategy [7]. On the practical level, China has gradually strengthened the control of CDW in recent years and listed CDW recycling into the national “13th Five-Year Plan”. And 35 cities across the country have been established as pilot cities to explore suitable mode of CDW disposal. Based on these scientific studies and practical experiences, the current study analyses status and problems of CDW disposal in China and makes efforts to propose a MC mode for precise disposal of CDW, aiming at providing an instructive idea to reduce, reuse and recycle CDW comprehensively.
2. The Status and Problems of Management and Control about CDW in China

2.1. Management-and-Control Status
Through field visits and literature surveys, the status of CDW disposal in China is investigated, including policies, measures and disposal technologies. In recent years, CDW-related management regulations have been successively introduced and continuously improved in many Chinese cities, resulting in operable implementation plans as a guide to effectively carry out CDW disposal. Together, the main management measures are as follows.

2.1.1. Source Management. First, an approval system of CDW disposal is implemented. Transportation enterprises, transportation vehicles, consumption sites and project constructions need to apply for a license certificate. Second, the construction site management is strengthened. Specific regulations are used to supervise facilities and measures at the construction site to protect the environment such as dust suppression and noise reduction and the entry and exit of transportation vehicles of CDW. Third, on-site CDW is classified according to the source of generation, such as engineering slag, engineering mud, engineering waste, demolition waste and decoration waste. Fourth, reduction and reuse of CDW at the construction site are encouraged.

2.1.2. Transportation Management. First, a market access-and-exit system is implemented for companies and vehicles to transport CDW. Second, a joint management system is implemented for CDW transportation. Third, a standardized management of transport vehicles is used, including unified modifications of CDW transport vehicles within administrative areas, which require color uniformity, confinement and GPS real-time positioning. Fourth, monitoring platform is used in the transportation process to achieve real-time monitoring of the entire path of CDW from transportation to consumption, using the vehicle-mounted positioning system networked with the monitoring platform.

2.1.3. End Management. For consumption and disposal, the major management is to supervise the standardization, environmental protection and safety measures about the settings, acceptance amount and acceptance behavior of consumption sites. For resource utilization, most measures are used to encourage the construction side are to reuse CDW and cooperate with resource enterprises in a franchise mode. Raw materials are generally distributed and adjusted nearby. Resource management usually focuses on the recycling direction of CDW.

2.2. Problem Analysis
By analysing the status of management and control of CDW in China, the current mode is for the purpose of governance, focusing on during-event and post-event supervisions, mainly for the process management of generation, transportation and disposal about CDW. For example, to supervise whether the CDW generated during the construction process is temporarily stored as required, whether there is a leakage problem in the CDW transportation, whether the CDW is transported to the designated disposal site, whether the consumption site properly disposes the CDW in accordance with regulations, and whether illegal disposal is appropriately punished. This management-and-control mode has achieved good results in terms of managing CDW stock, standardizing disposal procedures of CDW, reducing environmental pollution of CDW, and removing hidden dangers of CDW. However, management-and-control measures of the government are not effective about reduction, reuse and recycling of the CDW from the source. CDW is mainly disposed by simple landflling, and recycling is still at a low level. The on-site classification management is chaotic, and the reduction and reuse rely on “voluntary behaviour”. There are no clear resource indexes. In places where supervision is not strong, the leakage phenomenon still exists, and producers, transporters and disposers of CDW do not perform well in recycling.
According to the current study, the Chinese management-and-control mode of CDW lacks a comprehensive planning in advance for the purpose of resource utilization. The “production-transportation-disposal” chain spontaneously formed by the market is a behavior mode that seeks to maximize profits. Thus, it is difficult for the government to achieve optimal deployment of resource utilization only through administrative supervision. As a management party, the government should mediate planning and control to transform the process of generation-transportation-disposal of CDW into an ecologically and economically beneficial process. Therefore, this study proposes a government-led management-and-control mode for precise disposal of CDW in order to reduce, reuse and recycle CDW.

3. Government-Led Management-and-Control Mode for Precise Disposal of CDW

3.1. The Connotation of Government-Led Precise Disposal

Government-led precise disposal refers to that the government uses measures, including legal enforcement, policy guidance, economic intervention, administrative constraints and technical support, to guide, plan and supervise the entire life cycle of CDW from generation, storage, transportation, resource utilization; accurately controls and monitors the type, quantity and attributes of CDW in all steps; achieves the optimal configuration of various types of CDW transportation and disposal methods; and attains the purpose to maximal utilization of resources.

3.2. Management-and-Control Mode of Precise Disposal

3.2.1. Mode 1: The Target Limit of Mandatory Recycling + Optimal Distribution. This mode refers to that the government establishes the target limit of mandatory recycling of CDW, distributes tasks to producers, transporters, recyclers and disposers of CDW, and achieves the best interests of all parties. The specific operations are as follows. The production side of CDW reports the basic data of the project on the disposal-system platform, which performs quantitative classification and prediction of the CDW based on precise disposal with the target limit of mandatory recycling, including reduction, recycling, consumption and transportation. For recyclable CDW, the system distributes tasks to enterprises for recycling, consuming and transporting on the basis of optimal dispositions to maximize the interests of production side, transportation side and disposition side. Such distribution aims at allowing enterprises to “maximize the use of processing capacity”. If the disposal capacity is still not enough to reach the mandatory limit, a temporary storage plan should be formulated. The producer, transporter, recycler and consumer are responsible to dispose CDW according to the disposal plan. The costs of transportation and disposal should be paid in advance, that is, the transportation and disposal fee should be paid in advance by the producer according to the disposal plan, and returned to the producer after the treatment reaches the standard.

3.2.2. Mode 2: The Target Limit of Mandatory Recycling + Free Decision. This mode refers to that the government establishes target limits of mandatory recycling of CDW and the producers can freely choose legal transporters, recyclers and disposers if the limits can be achieved. The specific operations are as follows. the producers fill in the basic data of the project on the platform of CDW disposal system. The system performs quantitative classification and prediction of the CDW based on the project type, combines the target limits to generate the optimal configuration schemes of CDW utilization, including reduction, resource utilization, consumption and transportation schemes, and pushes to the producer. At the same time, the system publishes the information such as the type and quantity of CDW generated by the project, and the recyclers, consumers, and transporters can submit a disposal application based on their own processing capabilities. The producer can dispose CDW in accordance with the system's optimal configuration plan, or independently choose the transportation and disposal organizations. The producer needs to provide the management side with a disposal plan when making its own decisions. The reduction and resource utilization rate of the disposal plan must
not be lower than the mandatory target limits. The management side enforces mandatory control according to the target limits.

3.2.3. The Differences of Both Modes. The two modes above can achieve precise management and control of CDW disposal with the goal of resource utilization. The difference is described as follows. The first mode is completely supervised by the government and limits the flexibility in the development of market-oriented disposal of CDW, but it can be used as a transitional approach considering the current status of CDW disposal in China. The second mode can allow free market decisions under the government's mandatory supervision. When the economic measures such as fees, punishments and subsidies are reasonable and the public's awareness of resource utilization is improved, it will be conducive to the healthy development of the marketization behavior of the whole process of CDW disposal chain and reduce the pressure of government supervision. This mode can be used as a future development trend.

3.3. Characteristics of Government-led Management-and-Control Mode for Precise Disposal of CDW

3.3.1. Precise Classification and Quantitative Prediction of Resource Utilization. At present, the classification of CDW in China is mainly divided into five categories, such as engineering slag, engineering mud, construction waste, decoration waste, and demolition waste. The estimation of the amount of production is limited to the total amount. This classification and statistical method are mainly used for the statistical level of the competent departments. The classification of resource utilization is based on the final utilization direction of CDW. Such classification and quantity prediction are more conducive to targeted and precise disposal of resource utilization in the later stage.

3.3.2. Precise Control of Transportation Quantity. At present, the settlement method of CDW transportation costs is mainly based on contract-system resource settlement. That is, the waste producer signs a contract with the transporter to settle the transportation costs. The transporter transports the generated CDW to the end-use disposal site for weighing. This method of source settlement and terminal measure cannot guarantee that the transporter will consciously transport to the designated site for disposal. In contrast, there are two advantages in the method of end settlement by using advanced technology to upload the end measurement results to the management-and-control system in real time for settlement. On the one hand, the transporter will actively and adequately transport for the benefit of revenue. On the other hand, it is also convenient for the management side to simultaneously achieve precise supervision of the amount of transportation and consumption.

3.3.3. Precise Planning of Resource Allocation. To achieve precise planning of resource allocation, it is necessary to balance the interests of all parties. The demands of producers, transporters and disposers of CDW are mainly for the pursuit of maximizing commercial benefits, while the government, as the manager, needs to achieve the maximum recycling and reduction of CDW and the effective disposal of all CDW. The premise of balancing the needs of all parties is to reach the target limit of recycling set by the management party, and then configuration of transportation and disposal of CDW can be optimized according to the type and quantity of CDW, the relationship between the producer and the disposer, the capacity of the disposer and the requirements for the type of CDW.

4. Implementations of Government-Led Management-and-Control Mode for CDW Precise Disposal

4.1. Formulate Legal Policies and Adopt Incentives
The first is to develop a legal and regulatory guidance system for CDW classification with clear responsibilities and operability. With reference to CDW management modes in other countries, the
classification management of CDW should be upgraded to the legal level, by establishing and improving a legal system of classification management of CDW, formulating a detailed and operable classification method, and clarifying respective responsibilities and obligations of producers, transporters, recyclers and consumers. It should be enforced to achieve fine classification-and-stacking and on-site reduction-and-reuse of CDW. The second is to use economic methods that combine rewards and punishments at reasonable costs. In accordance with the requirements of laws and regulations, the classification, reuse and recycling of CDW are compulsory; otherwise, punitive measures such as fines should be adopted. It should be reasonable to set up consumption-and-landfill disposal fees and recycling disposal fees. The price difference between the two disposal fees should be used to promote the producers to form the initiative of resource utilization. To increase the enthusiasm of enterprises to optimize resource utilization, there should be corresponding credit tax incentives, financial incentives and other measures.

4.2. Target, Plan and Enforce the Management and Control for CDW Disposal
Local governments at all levels should reasonably determine the limits of resource utilization targets within their respective administrative areas in accordance with their respective capacity and level of disposal of CDW, punish the producers who fail to meet the standards and reward the producers who overfulfill their tasks. At the same time, the goal of restricting the recycling of CDW should be incorporated into the urban development plan, or a special CDW management plan.

4.3. Establish a Special Agency or Department Responsible for CDW Precise Disposal
The specialized agency or department of CDW management should recruit professional scientific research teams and engineering teams. On the one hand, they are responsible for establishing, maintaining, and operating the precise management-and-control system of CDW. On the other hand, they will study new issues that have arisen during the implementation of precise management and control, modify or develop new management-and-control systems, continuously improve the efficiency of the management-and-control system, and ensure the comprehensive and efficient realization of precise disposal and management of CDW in the jurisdiction.

4.4. Construct a Supporting System with Quantitative Prediction and Intelligent Decision
At present, the efforts to establish the management-and-control system for CDW mostly stay at the database level in China, which do not reflect the classification prediction and intelligent decision-making function about disposal planning of CDW. The ideal system should have the following functions. First, the database function. Participants such as producers, transporters, resource-utilizing enterprises and consumption sites of CDW in the area should fill in their detailed information. After being approved by the competent departments, such information should be stored as enterprise resources. Second, the data sharing function. Data sharing is not limited to all parties in waste generation, transportation, consumption, and resource utilization enterprises, but also involves various regulatory departments such as housing construction, transportation, environmental protection, environmental sanitation, and potential resource utilization departments such as gardens. The data sharing function bridges the “information gap” between various stakeholders, breaks down communication barriers, and facilitates effective supervision and precise disposal of CDW. Third, the intelligent decision-making function. After the CDW producers enter construction design information into the system, the system automatically performs resource classification and quantity prediction. Through intelligent decision-making, the system can generate the optimal allocation plan for transportation and disposal. Fourth, precise supervision function. In addition to real-time monitoring of the whole process of CDW from the outset to transportation to disposal, the system can also precisely control the amount of CDW in each stage of production, transportation and disposal. These functions are conducive to achieving the ultimate resource utilization goal.
5. Conclusion
The current study provides a government-led management-and-control mode for CDW. The overall idea of this mode is to prioritize reduction, reuse and resource utilization. This mode requires the government's pre-planning and mandatory resource utilization, and the help of the information-based system for management and control of precise disposal. These measures allow the achievements of quantitative classification prediction from the source, process management and control, and optimal resource allocation. This mode has transformed the disposal of CDW from the goal of governance to the goal of reduction and resource utilization, from principled encouragement to mandatory implementation, from post-event supervision to overall planning beforehand, and from free development to market-oriented behavior restricted by the government. It is conducive to reducing CDW from the source and promoting the virtuous circular development of the resource-based industry.

Acknowledgments
This study was supported by the National Key R&D Program of China (2018YFC0706002).

References
[1] Dahlbo H, Bacher J, Lahtinen K, Jouttijarvi T, Suoheimo P, Mattila T, Sironen S, Myllymaa T and Saramaki K 2015 J. Clean. Prod. 107 333-341.
[2] Akinade O O, Oyedele L O, Ajayi S O, Bilal M, Alaka H A, Owolabi H A and Arawomo O O 2018 J. Clean. Prod. 180 375-385.
[3] Huang B, Wang X, Kua H, Geng Y, Bleischwitz R and Ren J 2018 Resour. Conserv. Recyc. 129 36-44.
[4] Wu Z, Yu A T W and Shen L 2016 Waste Manag. 60 290-300.
[5] Lu W and Yuan H 2010 Resour. Conserv. Recyc. 55 201-208.
[6] Jin R, Li B, Zhou T, Wanatowski D and Piroozfar P 2017 Resour. Conserv. Recyc. 126 86-98.
[7] Xu J, Shi Y, Xie Y and Zhao S 2019 J. Clean. Prod. 229 308-324.