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Construction and demolition waste management in China through the 3R principle



Beijia Huang^{a,b,*}, Xiangyu Wang^a, Harnwei Kua^c, Yong Geng^{d,e}, Raimund Bleischwitz^f, Jingzheng Ren^g

^a College of Environment and Architecture, University of Shanghai for Science and Technology, Shanghai, China

^b Department of Environment and Low Carbon Science, University of Shanghai for Science and Technology, China

^c Department of Building, School of Design and Environment, National University of Singapore, Singapore

^d School of Environmental Science and Engineering, Shanghai Jiao Tong University, Shanghai, China

^e China Institute for Urban Governance, Shanghai Jiao Tong University, Shanghai, China

^f Institute for Sustainable Resources, University of College London, London, United Kingdom

^g Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hong Kong, China

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ABSTRACT

Construction and demolition waste (CDW) accounts for 30% to 40% of the total amount of waste in China. CDW is usually randomly dumped or disposed in landfills and the average recycling rate of CDW in China is only about 5%. Considering there is big challenge in adoption of circular economy in CDW industry in China while related research is still limited, we conduct the CDW management analysis through 3R principle. Existing policies and management situations were investigated and analyzed based on the reduction, reuse and recycle principles. Results reveal that primary barriers of reducing CDW in China include lack of building design standard for reducing CDW, low cost for CDW disposal and inappropriate urban planning. Barriers to reuse CDW include lack of guidance for effective CDW collection and sorting, lack of knowledge and standard for reused CDW, and an under-developed market for reused CDW. As for recycling of CDW, key challenges are identified as ineffective management system, immature recycling technology, under-developed market for recycled CDW products and immature recycling market operation. Proposals to improve the current situation based on 3R principle are also proposed, including designing effective circular economy model, reinforcing the source control of CDW, adopting innovative technologies and market models, and implementing targeted economic incentives.

1. Introduction

It is generally agreed that construction and demolition waste (CDW) management practices should be guided by the “3R” – reduce, reuse and recycle – principle (Peng et al., 1997). However, the effectiveness of embracing such practices in China, where CDW accounts for about 30%–40% of the total municipal waste, is still very limited; the recycling and reuse rate of CDW is less than 5%. Comparatively, the CDW recycling and reuse rate can reach 70%–95% in some developed countries, including the United States, Denmark, South Korea, Singapore, Japan and Germany (Xiao et al., 2015). Although the problem of low recycling and reuse rate has been attracting much attention from researchers in China since the early 1990s, waste management in the construction sector has not improved substantially (Wang and Yuan, 2010; Jin and Li, 2017). At present, around 75% of Chinese cities are facing what is now known as “CDW surrounding” (Jiao and Sun, 2013).

Considering that CDW has leads to considerable environmental burdens and threats, reasonable treatment of the CDW is urgently needed.

Gluzhge (1946) first proposed the concept of CDW recycling, with a focus on recycling discarded concrete. The positive contribution of recycling CDW is distinct when it is compared with traditional treatment methods. Ortiz et al. (2010) and Mohamed (2014) compared three different scenarios (recycling, incineration and land filling) and found that in terms of global warming potential, the most environmentally friendly way of treating CDW is recycling, followed by incineration and the last is land filling. Wu et al. (2016a) analyzed the eco-efficiency of three scenarios of CDW treatment – landfilling, recycling using private or state-owned facilities – and suggested that government should put more emphasis on state-owned recycling centers because of its highest eco-efficiency. Some researchers explored the status and shortcomings in managing CDW treatment in China. Katherine (2017) conducted a survey on the awareness of circular economy concept in China's

* Corresponding author at: College of Environment and Architecture, University of Shanghai for Science and Technology, Shanghai, China.
E-mail address: ywhbjia@163.com (B. Huang).

construction industry, and his results indicated that while there is industry wide awareness of the concept, clients, designers and sub-contractors are the least informed and this is a key challenge for greater adoption. Yuan et al. (2010) claimed that the major obstacles of CDW management in China are lacking well-developed waste recycling market, insufficient regulatory support and the predominant trend whereby building designs do not pay sufficient attention to waste reduction. After evaluating the economic feasibility for the recycling of CDW in Chongqing, Zhao et al. (2010) discovered that operating CDW recycling centers may face investment risks because of the high cost involved. Another group of researchers attempted to give suggestions for enhancing CDW reuse and recycling. Duan and Li (2016) suggested that more attention should be put on improving the management of concrete, masonry (bricks and concrete/stone blocks), mortar and ceramic wastes, because these four types of CDW account for about 90% of the CDW in China and have the largest potential for recycling. Wang and Cao (2016) indicated that the CDW recycling in Handan is limited at certain materials such as concrete brick. In order to improve the comprehensive reuse and recycling of CDW, network information technologies should be applied to monitor the CDW production and treatment processes.

In general, although there is awareness of the urgency to promote CDW reduce and recycling, the current situation of CDW treatment is not good in China. Results of researches revealed that there are shortcomings in related CDW policies and management methods. Our literature review finds that although there are some studies discussed about the CDW management status, a detail review of the CDW management policies in China at the national level is still absent. Furthermore, the existing barrier analyses mostly only focus on reuse and recycling of CDW from different perspectives. Considering that it is crucial to reduce CDW at source, and there is big challenge in adoption of circular economy in CDW industry (Katherine, 2017), we contribute to the literature by conducting analysis of the CDW management by using the 3R principle. We believe that a comprehensive review of the CDW management policies and the current status of CDW treatment status, combined with interviews with the relevant stakeholders in the CDW industry, can help us better understand the current barriers in treating CDW in a circular economic way. This study will attempt to answer the following three questions: (1) What are the existing CDW management policies and what is the current situation of CDW management in China? (2) What are the challenges of managing CDW in China using the 3R principle? (3) What corresponding solutions can be suggested for enhancing effectiveness of managing CDW in China?

2. Research framework and method

2.1. Research framework

In order to better understand the current situation of CDW treatment and management in China, existing CDW related policies and

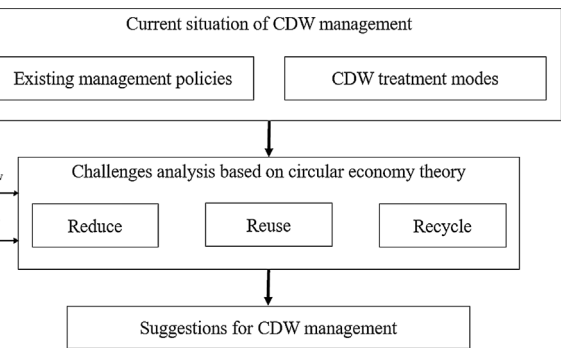
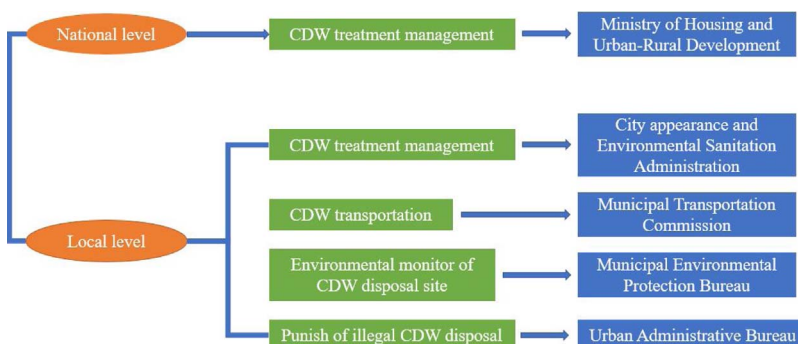


Fig. 1. Research framework adopted for this study.

treatment modes were reviewed. Subsequently, the challenges of CDW management in China were analyzed by interviews with most relevant stakeholders guided by the “3R” principle. Challenges were reviewed and discussed in aspects of reducing, reuse and recycling. The views of 40 stakeholders in the field of CDW management were sought. Interviews were carried out through face-to-face or remote discussions (via phone). Some proposal regarding policy strategies for improving CDW management practices in China were brought forth based on the findings. In summary, the overall research framework is presented in Fig. 1.

2.2. Research method

In this paper, literature review and personal interviews were conducted to analyze the present barriers of CDW management in China. Articles related with the CDW treatment situation and barriers in China were reviewed to get the basic information. Interviews were conducted in order to get more information and thus have better understanding of the barriers. Three groups of stakeholders most relevant to the CDW industry were interviewed; they were (1) scholars/researchers (11 persons); (2) operators from building design (5persons), construction (5 persons) and demolition companies (9 persons); and (3) CDW treatment/recycling companies (10 persons). These interviewees were selected based on the availability and their familiarity with the CDW industry. Subsequently, we conducted a semi-structured interview either face-to-face or over telephone. In order to have more comprehensive information, interviewed topics are not limited to those in questionnaires. All answers were collected and those that occurred at highest frequency were used to identify the CDW management barriers in China. The questions of the survey and corresponding answers are illustrated in the Appendix A.

3. Current state of CDW policies and treatment modes in China

This section provides a comprehensive review of the existing CDW

Fig. 2. The different departments that are involved in the CDW management (general situation).

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