Nature Environment and Pollution Technology An International Quarterly Scientific Journal	p-ISSN: 0972-6268 e-ISSN: 2395-3454	Vol. 17	No. 3	pp. 823-829	2018

Original Research Paper

Open Access

Estimation of Output of Civil Engineering Construction Wastes and Resource Utilization – Taking Henan Province in China as an Example

Hai Qiang Miao

Institute of Architecture and Engineering, Huanghuai University, Zhumadian 463000, Henan, China

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 18-06-2018
Accepted: 20-07-2018

Key Words:
Construction wastes
GM (1,1) model
Resource utilization

ABSTRACT

The large-scale construction of civil engineering buildings has brought significant development in the building industry, but increased the amount of construction waste. The enormous amount of civil engineering construction waste poses tremendous threats to the ecological environment and social development. Vigorously promoting the resource utilization of construction waste is the most fundamental and effective path to solve the construction waste problem. This study aims to further analyse civil engineering construction waste and propose corresponding effective resource utilization countermeasures. Henan Province of China was taken as an example, the deficiencies in the pollution management of civil engineering construction waste were first analysed. The total outputs of construction waste in Henan Province from 2017 to 2020 were predicted using the gray prediction model [GM (1,1)]. Results indicate that ineffective management of waste sources, difficulty in implementing the management system, and outmoded execution of management are concrete manifestations of inefficiencies in the aspect of civil engineering construction waste management. The GM (1,1) model can accurately predict the building construction area. The annual output of construction waste from 2017 to 2020 presents an overall steady growth trend with a large increase in amplitude, and the average annual growth rate is 14.45%. The resource utilization countermeasures of civil engineering construction waste include strengthening the establishment of laws, regulations, and standards, defining the responsibilities of multiple parties, such as government and enterprises, innovating policy mechanism for waste disposal, promoting the application of regenerated products, and perfecting fiscal and monetary policies. This work provides important reference values for strengthening the management of the disposal of wastes generated by civil engineering construction, promoting resource utilization, reducing construction wastes, reducing environmental pollution, saving the land, improving urban building environment and people's living environment, and increasing the regeneration and utilization efficiency of construction wastes.

INTRODUCTION

China's national economy has rapidly developed in recent years; in particular, the building industry has considerably progressed because of large-scale modernization in construction. The amount of construction wastes generated from civil engineering construction increases due to large-scale infrastructure construction and ever-increasing promotion of urbanization. The total output of urban solid wastes in China is the highest worldwide, and the annual output of civil engineering construction waste increases annually. The enormous output of construction waste poses tremendous threats to the environment and the economy.

As a province in China with a large population, Henan has witnessed accelerated urbanization progress and an annual growth in the total output of the building industry (Fig. 1) in recent years. However, large quantities of civil engineering construction wastes are generated with the accelerated transformation of old cities, villages in the cities, and shanty towns. Furthermore, most cities in Henan Province have no fixed and professional disposal sites for construction wastes, and the transportation enterprises feature small scale, large quantity, outmoded equipment, and disorderly competition; illegal activities, such as the arbitrary disposal of construction wastes, over-speeding and overloading, throwing of wastes along the way, and dumping in undesignated places. These activities affect urban development and pollute water bodies and air, thereby becoming a major concern of the society. The rates of urban demolition and relocation increase with increasing construction wastes when Henan Province comprehensively clears up and dismantles illegal buildings in urban built-up areas. However, by implementing comprehensive waste disposal and formulating incentive policies of waste classified recycling, waste disposal and resource utilization are docked. Moreover, industrial chains of circular economy and new economic growth points are cultivated, and the coordination and unity of industrial development, environmental protection and environmental improvement can be realized. Therefore, resource utilization of civil engineering construction wastes is the fundamental means of solving the pollution caused by construction wastes and an important method to promote urban quality of life and ecological development.

EARLIER STUDIES

Foreign studies on the environmental pollution caused by construction wastes in civil engineering and how to strengthen the disposal of construction wastes have had an early start, and a relatively mature management pattern has been formed through the management of construction wastes for many years with high attention and great capital input, and thus many successful cases in aspect of reasonable governance of construction wastes exist. Zhang et al. (2005) investigated the residential projects in America and reported that the quantity-reducing management of construction wastes could also improve building quality and construction safety. Mulder et al. (2007) proposed the concept of closed cycle construction, which indicated that many construction wastes could be recovered and regenerated into useful construction materials by reasonable means and paths. Kourmpanis et al. (2008) studied the concrete disposal method and the management pattern of construction wastes and suggested that the emphasis of construction wastes management in the sites should be on recyclable construction wastes. Osmani et al. (2008) believed that the design scheme of an architect is important in reducing construction wastes and reported that approximately 1/3 of construction wastes are caused by unreasonable design. Lau et al. (2008) obtained the causes of construction wastes by studying their compositions according to the waste compositions and features of civil buildings in the construction process in Malaysia. The study implemented by Bohne et al. (2008) indicated that reasonable policies should be taken to manage construction wastes and stricter standards and higher requirements for regional resource utilization should be implemented. The study results of Tam (2008) showed that the most effective means of managing construction wastes is to take full advantage of prefabricated parts during the building construction process. Solís-Guzmán et al. (2009) summarized the quantification and management pattern of construction wastes in Spain and proposed measures of using construction wastes. Kofoworola et al. (2009) estimated the output of construction wastes in Thailand and analysed and summarized the present management method of construction wastes. Begum et al. (2009) conducted an in-depth analysis of attitudes and behavioural factors in the Malaysian management of construction wastes. Ortiz et al. (2010) compared the influences of landfilling, recycling, and incineration of construction wastes on the environment by studying a case in a Catalonian area according to the life cycle assessment of European Environmental Commission. Yuan (2013) used the SWOT (strengths, weaknesses, opportunities and threats) analysis method to analyse the management method of wastes and garbage in China constructional engineering. Hossain et al. (2017) conducted a comparative evaluation of classified management methods of different types of construction wastes in Hong Kong and analysed the different effects of the classified management of construction wastes. Bakshan et al. (2017) used the Bayesian network analysis method to analyse factors that dictate behaviours that strengthen the management of construction wastes. Wu et al. (2017) used a questionnaire to investigate the factors that dictate the behaviours of managing wastes in building demolition in Mainland China. Huang et al. (2018) proposed using 3R principles to manage building and demolition wastes in China effectively to reduce environmental pollution. According to the existing literature, formulating incentive policies of classified garbage collection, promoting docking between garbage disposal and resource utilization are some of the effective means of managing civil engineering construction wastes. However, resource utilization is the basic way of solving the problem of a city filled with garbage. It not only disposes construction wastes and improves the ecological environment, but also effectively reuses waste resources in industrial construction. Therefore, taking Henan Province in China as an example, resource utilization countermeasures of civil engineering construction wastes are proposed in this paper and are expected to provide reference for reducing the output of construction wastes, reducing environmental pollution, saving land, improving urban building environment and people's living environment, and elevating the regeneration and recycling efficiency of construction wastes.

DEFICIENCIES IN POLLUTION MANAGEMENT OF CIVIL ENGINEERING CONSTRUCTION WASTES IN HENAN PROVINCE

Insufficient management of sources of civil engineering construction wastes: The source management and control of civil engineering construction wastes have loopholes, and many cities have not established the full-chain supervision system from generation of constructions wastes to the clearing and transportation, disposal, and resource utilization of construction wastes. Reducing-quantity and classifying and concentrated transportation of civil engineering construction wastes has not been started yet, charging system has not been established, and responsibilities for digestion, disposal and management of construction wastes are unclear with ineffective management and pollution and potential safety hazards, which can easily result in ineffective supervision of

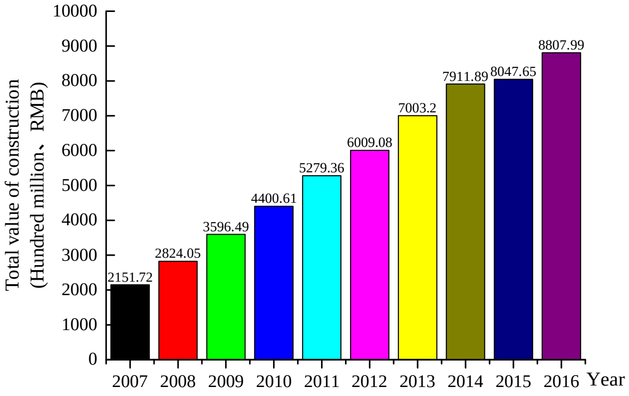

Fig. 1: Total waste outputs of Henan building industry in 2007-2016. [Data source: China Statistical Yearbook (2008-2017)]

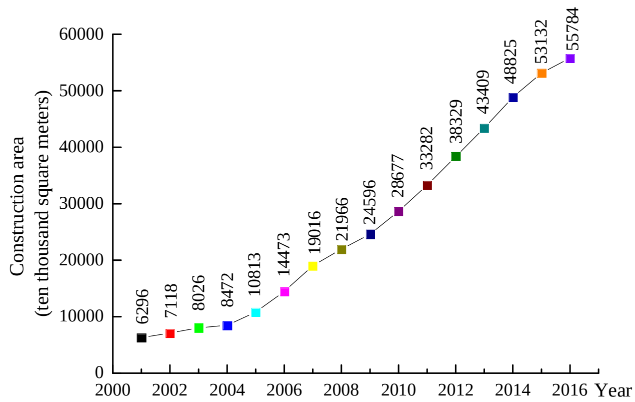

Fig. 2: Building construction areas in Henan Province in 2001-2016. (Data source: Database of National Bureau of Statistics of China, http://data.stats.gov.cn/index.htm)

generating parties of civil engineering construction wastes. Generating parties privately entrust black trucks to transport and arbitrarily dump the construction wastes, which can't be restrained, thus forming many owner-less waste. It's difficult to start implementing disposal of construction wastes from the sources, not to mention to form the whole-process closed management from generation, transportation to disposal.

Large difficulties in implementing the management system of civil engineering construction wastes: The approval system for disposing civil engineering construction wastes is extremely difficult. Construction wastes generating parties will not submit for approval by their own initiative, and thus problems, such as whether clearing vehicles used by construction wastes generating parties are approved qualified vehicles and whether construction wastes are transported to the disposal site, cannot be mastered from the source. Source management is not implemented, and the department linkage mechanism has not exerted deserving effect. Illegal behaviours are not effectively controlled from the sources, approved transportation enterprises are not used for wastes clearing and transportation, arbitrary dumping phenomenon occurs, and a large quantity of construction wastes cannot be disposed immediately. The competent department for construction wastes can only manage investigation and punishment. When certifying the failure of a construction site to handle approval formalities, the department orders it to handle formalities and starts documentary procedures of law enforcement, but the process is slow, and the goal of governance work cannot be reached.

Management and law enforcement ways of civil engineering construction wastes are outmoded: The law enforcement in the aspect of the transportation of civil engineering construction waste needs the cooperation of various departments, such as the city management, housing construction, public security, transportation, and environmental protection departments. For instance, the housing construction department should implement the registry system of prevention and governance schemes for flowing dust pollution; the city management department should implement the approval system for the disposal of construction wastes; the public security department should strictly examine and stop illegal behaviours, such as the over-speeding and running the red light of residue soil vehicles and the clearing and transportation behaviours in which vicious powers are involved; the transportation department should examine and stop illegal behaviours, such as exceeding the limit of and unlicensed operation; and the environmental protection department should examine and stop major pollution projects. In the era of "internet +" big data, Henan construction waste management work should establish a complete and long-term linkage mechanism and include the government, related management organizations and their personnel, generating party, clearing and transportation and disposing parties of construction wastes, and the consumers of products regenerated from construction wastes into the systematic management.

ESTIMATION OF OUTPUT OF CIVIL ENGINEERING CONSTRUCTION WASTES IN HENAN PROVINCE

Establishment of grey prediction model GM (1,1): As an applicable model with the core being the GM (1,1) model, the grey prediction model can predict with a small quantity of known information. It has been applied to all kinds of actual prediction models. This model is similar to differential and difference equations with mathematical characteristics, such as index, difference and differential simultaneously. Model parameters and structure can select a small quantity of data information according to a known parameter change, which breaks through the limitations of large sample-size data modelling. Considering the particularity of construction wastes and the limitation of data sources, the grey prediction model is adopted.

The GM (1,1) model is a sequence prediction model that is generated based on accumulation, and its concrete steps are as follows. n observation values $x^{(0)}(i)(i=1,2\cdots,n)$ are set (namely original data needing prediction and they are non-negative numbers) in the time sequence $x^{(0)}(t)=\left\{x^{(0)}(1),x^{(0)}(2),\cdots x^{(0)}(n)\right\}$. A new sequence is obtained through the first accumulation processing of the original data, that is, $x^{(1)}(t)=\left\{x^{(1)}(1),x^{(1)}(2),\cdots x^{(1)}(n)\right\}$ where,

$$x^{(1)}(k)=\sum_{i=1}^{k}x^{(0)}(i),k=1,2,\cdots n \quad ...(1)$$

Compared with the original sequence, the new sequence has an effectively weakened randomness and a fluctuation of data, with the stability improved to a certain degree. A differential equation is set to express the change trend of the new sequence:

$$dx^{(1)}(t)/dt+ax^{(1)}(t)=u \quad ...(2)$$

where a and u are identifying parameters. The following can be obtained through least squares fitting:

$$\begin{bmatrix}a\\u\end{bmatrix}=(B^TB)^{-1}B^TY_N \quad ...(3)$$

where, $Y_N=\left[x^{(0)}(2),x^{(0)}(3),\cdots,x^{(0)}(n)\right]^T$. Data matrix B is constructed as follows:

$$B=\begin{bmatrix}-1/2\left[x^{(1)}(1)+x^{(1)}(2)\right] & 1\\ -1/2\left[x^{(1)}(2)+x^{(1)}(3)\right] & 1\\ \vdots & \vdots\\ -1/2\left[x^{(1)}(N-1)+x^{(1)}(N)\right] & 1\end{bmatrix} \quad ...(4)$$

The prediction mode is solved as

$$x^{(1)}(t+1)=\left[x^{(0)}(1)-u/a\right]e^{-at}+u/a \quad ...(5)$$

Construction area prediction of civil engineering buildings in Henan province: To guarantee data accuracy and authority, the building construction areas in Henan Province are shown in Fig. 2.

According to original data in Fig. 1, the accumulated sequence is obtained through Formula (1). According to Formulas (2) and (3), a = -0.134979 and u = 8258.799762 are calculated through the related combinational operation of the matrix and are substituted into Formula (5) to obtain the prediction model:

$$x^{(1)}(t+1)=674813.83465\times e^{0.134979t}-61185.83465 \quad ...(6)$$

According to the calculation results of formula (6), simulated value, residual error, and relative error are calculated and shown in Table 1.

The building construction areas in 2017-2020 are predicted according to the obtained prediction model.

The comparison indicates that the predicted values of building construction areas from 2001 to 2016 are estimated to coincide with the actual values, indicating that the GM (1,1) model provides an accurate prediction of building construction areas. The total building construction areas will continue to grow and break through 1.1 billion square meters until 2020, as shown in Table 2.

Estimation of output of civil engineering construction wastes: No authoritative statistical data related to the output of construction wastes in China exists, and numerous studies indicate that three factors influence the output of civil engineering construction wastes, namely, building construction area, building decoration area, and transformation and renovation area. Several studies studied the relationship between building construction area and the output of construction wastes. Literature (Li et al. 2011) indicates that under general circumstances, 550 t of construction wastes can be generated for every 10,000 m^2 of building construction area. Also the contribution rate of building construction area to the output of construction wastes has reached 47.99% (Lu et al. 2008) . According to the prediction results in Table 2 and the research results in literature (Li et al. 2011) and (Lu et al. 2008), the estimated

Table 1: Analog value, residual error and relative error.

Year	Analog value	Residual error	Relative error
2002	9751.98	2633.98	37.00
2003	11161.27	3135.27	39.06
2004	12774.21	4302.21	50.78
2005	14620.25	3807.25	35.21
2006	16733.06	2260.06	15.62
2007	19151.20	135.20	0.71
2008	21918.79	-47.21	-0.21
2009	25086.33	490.33	1.99
2010	28711.63	34.63	0.12
2011	32860.82	-421.18	-1.27
2012	37609.63	-719.37	-1.88
2013	43044.69	-364.31	-0.84
2014	49265.20	440.20	0.90
2015	56384.65	3252.65	6.12
2016	64532.94	8748.94	15.68

Table 2: Predicted building construction areas during 2017-2020. Unit: ten thousand square meters.

Year	Predicted value
2017	73858.77
2018	84532.30
2019	96748.29
2020	110729.65

Table 3: Predicted values of building construction wastes and construction wastes (unit: t).

Year	Predicted value of annual output of building construction wastes	Predicted value of annual output of construction wastes
2017	40622323.50	84647475.52
2018	46492765.00	96880110.44
2019	53211559.50	110880515.73
2020	60901307.50	126904162.33

values of two indexes- annual output of building construction wastes and annual output of construction wastes from 2017 to 2020 can be obtained as shown in Table 3.

According to Table 2, the annual outputs of civil engineering construction wastes in Henan Province during 2017 to 2020 present an overall steady growth trend with a large increase amplitude, and the average annual growth rate is approximately 14.45%. If reasonable measures are not taken immediately, construction wastes will occupy more land resources and seriously pollute the natural environment and affect people's lives.

RESOURCE UTILIZATION COUNTERMEASURES OF CIVIL ENGINEERING CONSTRUCTION WASTES IN HENAN PROVINCE IN CHINA

Enhance the consciousness of resource utilization of civil engineering construction wastes and strengthen governmental planning guidance: The urban development space and region are limited, and the continuously elevated demands for social development are limitless. Under limited environment and resources, urban development must take a recyclable and sustainable development path. In the past, the government and the public only attached importance to urban construction and ignored the generation and disposal of construction wastes. Furthermore, the government did not impose concrete implementation guidelines of resource utilization of construction wastes in the formulation of the urban development plan. We should obtain a full understanding of the great significance of resource utilization of civil engineering construction wastes and take it as an important measure in implementing the development of the circular economy, energy conservation, and emission reduction and the sustainable development strategy for positioning, as an important link in promoting the scientific transition of urban-rural construction pattern for planning and as an important hand grab for adjusting and optimizing the industrial structure and creating output value and employment. Related departments should cooperate with other departments, such as urban construction, planning, and land departments, to refine the objectives and requirements of national construction waste management, formulate special planning of resource utilization of construction waste, consider the quantity reduction of construction waste, reasonably plan and arrange transfer, distribution and digestion sites for construction waste as well as the quantity of resource utilization factories and their production scales, and facilitate harmless and resource disposal of construction wastes.

Strengthen standard laws and regulations construction and identify responsibilities of various parties like government and enterprises: We should establish and perfect the legal system in the resource utilization field of civil engineering construction waste, formulate special laws relating to the resource utilization of civil engineering construction waste, and identify the legal responsibilities and duties of various links and subjects, such as generation, classification, transportation, resource utilization, and engineering application of civil engineering construction waste. The standard system of resource utilization of civil engineering construction waste should be established, and standard specifications should be established in the fields of resource utilization of construction waste, such as demolition, classification, transportation and disposal, and production of construction waste, and the application of regenerated building materials. Related standard specifications to the disposal of construction waste should be formulated, revised, and perfected, and technical guidelines, design standards, collective drawings, and construction and acceptance specifications of resource utilization products of construction waste should be timely compiled. Mandatory laws and regulations should be reinforced appropriately. A strict registry system should be implemented to identify the responsibilities of various parties, such as the government, enterprises, and individuals, starting from the generation of construction waste. Strict laws should be used to form legal binding on related parties, and the strict execution of "whoever generates should take the responsibility" should be guaranteed. Local governments should implement guidelines, such as classified demolition and resource utilization of building materials, in the areas where they have jurisdiction according to their basic principles; related enterprises should strictly check and approve the fields, such as building design, selection of building materials, building construction technology, and quality of regenerated resource products, and exert best effort into reducing and avoiding the generation of construction wastes and actively using building materials regenerated by construction wastes; people must inhibit the discharge of wastes, actively promote regenerated products, and cooperate in quantity-reducing and other appropriate disposal measures of construction waste formulated by the national and local governments.

Innovate policy mechanism of waste disposal and promote application of regenerated products: Local administrative departments should perfect the charging system of civil engineering construction waste, establish a franchising operation system of collection, monitor the transportation and resource utilization, formulate industrial standards and exit mechanism, add supervision and management of resource utilization work of construction waste to urban management objectives and energy-conserving and emission-reducing approval system, and reinforce the supervision and management. They should reinforce fiscal taxation and financial support and formulate policies of fiscal subsidies relating to the resource utilization of construction waste; incorporate equipment and accessories of resource utilization of construction waste, which should be imported urgently into the national strategic major technical equipment and product catalogue for exemption from export and import tariffs. High-quality regenerated products that conform to standards should be included in the promotion and application catalogue of green building materials and governmental green procurement catalogue. The projects funded by national financial funds should utilize regenerated products from construction wastes according to a certain proportion. A related work on the evaluation and identification of green building materials proposed that priority should be given to regenerated products or building materials using regenerated aggregates at a certain proportion. The return system of disposal fee of a certain limit should be implemented for constructing parties that set up the projects for resource utilization of construction wastes or use regenerated products. Meanwhile, propaganda and training should be strengthened for the public and employees to obtain a correct understanding of and the use of regenerated products from construction wastes and an improved recognition degree of products.

Perfect fiscal and monetary policies and optimize the taxation system: Enterprises involved in the comprehensive application, development, and industrial development of civil engineering construction wastes can apply for certification as high and new-tech enterprises according to laws. Meanwhile, the projects they construct can be applied for certification as high and new-tech projects for the identified enterprises and projects to enjoy preferential tax policies. Application conditions should be loosened, product range should be expanded, and product types should be identified at the national level for enterprises practicing the proper resource disposal of civil engineering construction wastes to enjoy rebate and exemption policies of value-added tax. From the perspective of enterprises that practice proper resource disposal of construction wastes, if the regenerated products they produce conform to the above green product certification or adopt the new operation pattern of green regenerated products, financial institutions should give them loans with low interests. After these enterprises sign related licensing agreements with the government, the government may compensate them with a preferential policy of loan with discounted interests within a limited time range.

CONCLUSIONS

Civil engineering, as the main resource consumer, has generated large quantities of construction waste, and the corresponding conflict between buildings and environmental pollution has become increasingly serious. To analyse the output of civil engineering construction waste further and propose effective resource utilization counter-measures governing civil engineering construction wastes, Henan Province in China was taken as an example. The deficiencies in the management of civil engineering construction waste were analysed, the grey prediction model (GM (1,1)) was built to predict the total outputs of construction waste during 2017-2020, and resource utilization countermeasures governing civil engineering construction waste were proposed. The results of this study indicate that the management of civil engineering construction waste has three problems: ineffective management of waste sources, difficulty in implementing the management system, and outmoded management practices; the GM (1,1) model is suitable for predicting the building construction area; the annual output growth rate of construction waste from 2017 to 2020 is approximately 14.45%; the resource utilization of civil engineering construction waste can be realized by reinforcing standard laws and construction regulations, innovating the policy mechanism of waste disposal, promoting the application of regenerated products, and perfecting the fiscal and financial policies. We suggest an in-depth study of the development pattern of resource utilization of civil engineering construction waste, the key technological problems of the resource utilization of residual soil-type construction waste, and the complete set of resource utilization technologies for raw civil engineering construction waste with complicated compositions.

REFERENCES

Bohne, R. A., Brattebø, H. and Bergsdal, H. 2008. Dynamic eco efficiency projections for construction and demolition waste recycling strategies at the city level. Journal of Industrial Ecology, 12(1): 52-68.

Bakshan, A., Srour, I., Chehab, G., et al. 2017. Behavioral determinants towards enhancing construction waste management: A Bayesian network analysis. Resources, Conservation and Recycling, 117: 274-284.

Begum, R. A., Siwar, C., Pereira, J. J., et al. 2009. Attitude and behavioral factors in waste management in the construction industry of Malaysia. Resources, Conservation and Recycling, 53(6): 321-328.

Eastham, D.L., Zhang, J. and Bernold, L.E. 2005. Waste-based management in residential construction. Journal of Construction Engineering and Management, 131(4): 423-430.

Huang, B., Wang, X., Kua, H. et al. 2018. Construction and demolition waste management in China through the 3R principle. Resources, Conservation and Recycling, 129: 36-44.

Hossain, M.U., Wu, Z. and Poon, C.S. 2017. Comparative environmental evaluation of construction waste management through different waste sorting systems in Hong Kong. Waste Management, 69: 325-335.

Kofoworola, O.F. and Gheewala, S.H. 2009. Estimation of construction waste generation and management in Thailand. Waste Management, 29(2): 731-738.

Kourmpanis, B., Papadopoulos, A., Moustakas, K., et al. 2008. Preliminary study for the management of construction and demolition waste. Waste Management & Research, 26(3): 267-275.

Lu, N., Lu, L., Li, P. et al. 2008. Calculation for urban construction waste output in China and forecasting method. Journal of Chang'an University (Social Science Edition), 10(3): 79-82.

Li, K., Li, S. S. and Zhang, Y. 2011. Discussion on countermeasures of construction waste resources in China. Environmental Protection and Circular Economy, 31(5): 31-33.

Lau, H.H., Whyte, A. and Law, P.L. 2008. Composition and characteristics of construction waste generated by residential housing project. International Journal of Environmental Research, 2(3): 261-268.

Mulder, E., de, Jong. TP. and Feenstra, L. 2007. Closed cycle construction: an integrated process for the separation and reuse of C&D waste. Waste Management, 27(10): 1408-1415.

Osmani, M., Glass, J. and Price, A.D. 2008. Architects' perspectives on construction waste reduction by design. Waste Management, 28(7): 1147-1158.

Ortiz, O., Pasqualino, J. C. and Castells, F. 2010. Environmental performance of construction waste: comparing three scenarios from a case study in Catalonia, Spain. Waste Management, 30(4): 646-654.

Solís-Guzmán, J., Marrero, M., Montes-Delgado, M. V. et al. 2009. A Spanish model for quantification and management of construction waste. Waste Management, 29(9): 2542-2548.

Tam, V. W.Y. 2008. On the effectiveness in implementing a waste-management-plan method in construction. Waste Management, 28(6): 1072-1080.

Wu, Z., Yu, A. T. W. and Shen, L. 2016. Investigating the determinants of contractor's construction and demolition waste management behavior in Mainland China. Waste Management, 60: 290-300.

Yuan, H. 2013. A SWOT analysis of successful construction waste management. Journal of Cleaner Production, 39(5): 1-8.