

Managing Construction Waste in Developed Countries: Lessons Learned for Indonesia

by Ferry Hermawan

Submission date: 08-May-2023 02:33PM (UTC+0700)

Submission ID: 2087335672

File name: n_Waste_in_Developed_Countries_Lessons_Learned_for_Indonesia.pdf (345.58K)

Word count: 4224

Character count: 23965

Managing Construction Waste in Developed Countries: Lessons Learned for Indonesia

L Fitri, J U D Hatmoko and F Hermawan

Department of Civil Engineering, Faculty of Engineering, Diponegoro University, Semarang - Indonesia

Corresponding author: lailatulfitri.92@gmail.com

Abstract. Many construction practitioners in developed countries are already aware of reducing and managing construction waste. In Indonesia, it has not yet become a primary concern. Typically, the priority still focuses on how to win competitions instead and finish them on time with some profits. Whereas, the volume of waste in the world continues to grow day by day. The aim of this study is to explore best practices of construction waste management in developed countries to be implemented in Indonesia. The objectives are; (1) to examine the implementation of waste management in construction projects in developed countries and (2) to identify context, drivers and barriers of the construction waste management practices. A comprehensive literature review is conducted to address these aim and objectives. The results show that in general, many developed countries can reduce and manage their construction waste with supports from stakeholders, the availability of regulation with strong sanctions, law enforcement from the government, another supporting system, and high awareness from the practitioners. Although each country arguably may have best practices due to the local context, nevertheless these results may give insight and are useful for stakeholders in the Indonesia construction industry.

Keywords: Construction waste, waste management

6

1. Introduction

The construction sector is one of the major contributors to global waste generation, which is up to 30% of the waste ends up in a landfill [1]. Within construction activities, the appearance of solid waste could not be denied [2]. Sending construction waste continuously into landfill allows impacts to the environment. In China, large amounts of construction waste produced in recent years cause many issues of environment, such as the decline of air quality, destruction of soil structure, water pollution and damage the appearance of the city [3]. Greater awareness about waste construction and implementation of better waste management are the key to reducing those impacts.

Solid waste construction has been explored by researchers and experts. They classify the waste and find the greatest proportion of components related to the solid waste produced in the project. For example, there are several types of construction waste found from three investigated projects in Malaysia, which are timber, metal, concrete, mortar, packaging waste and bricks [4]. The largest amount of waste produced is derived from wood material.



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Published under licence by IOP Publishing Ltd

12 There are many factors causing the production of construction waste. Recurrent design changes, errors in design and construction detail, and waste from cutting uneconomical shapes are factors contributed to waste generation [5]. Other factors that lead to construction waste generation are lack of knowledge and experience in construction waste, purchase of materials which are unsuitable with the specification, inappropriate storage causing to failure and rework [6]. Based on the fact, the construction players have to concern about waste construction not only in construction phase but also in design phase and take action in minimizing the waste.

Waste management becomes popular in developed countries. They begin to do reducing, reusing, and recycling (3R) in their waste management model. They treat the waste especially in construction becomes resources again. Although they have already started applying the 3R principle, however, there is still construction waste dumped into the disposal area. Reducing waste production can reduce the transportation costs and waste disposal [7]. In addition, the reuse of material considered waste can also reduce waste dumped in landfills and impact to cost savings for construction projects. At last, using recycled materials will protect the environment and reduce the use of natural resources. Moreover, in developing countries, the amount of construction waste disposed into landfill is still in large number. The impact of waste disposal not only pollutes the environment but also can contribute to land constriction. In the future, there must be an improvement in the implementation of better and sustainable waste management.

21 There are still few studies discussing the amount of construction waste generated in projects in the construction industry in Indonesia. Construction practitioners in Indonesia rarely calculate the amount of construction waste generation in their projects because it will add to the cost and time [8]. In several building construction projects in Indonesia, construction waste management efforts are carried out by selling construction waste, using waste as a container, providing waste / residual material to local residents or artisans and transporting non-toxic (non-B3) liquid waste in the form of cement water to drainage channels around the project [9]. However, this method is deemed ineffective in reducing construction waste and increasing construction waste recycling activities.

21 Minimizing construction waste generated from project activities can save the cost expended by the contractor and also can increase the profitability of the company [10]. The existence of waste in construction project indicates that there is a material which is damaged or not used. So there must be additional costs to replace the damaged or unused material. Moreover, by minimizing the production of waste will reduce the amount of waste sent into landfills, which reduces the use of landfill [11]. In Indonesia, policies related to waste are regulated in law no. 18/2008 on waste management. However, the specific regulation criticizing about construction waste management in Indonesia is not available yet. Management of waste published on law no. 18/2008 only defines about three categories of waste, which are: (1) household waste, which is garbage derived from daily activities in the household, does not include feces and specific waste, (2) garbage is a kind of household waste, which is waste originating from commercial areas, industrial areas, special areas, social facilities, public facilities, and other facilities, (3) specific waste, which is waste containing hazardous and toxic materials, waste containing hazardous and toxic waste materials, waste arising from disasters, building debris, waste that is not yet technically processed, and garbage that does not occur periodically.

In addition, regulations related to waste management in Indonesia is still focus on urban waste. With the rapid growth in infrastructure building carried out by the government, the ministry should create the rules to minimize and manage the construction waste in order to reduce the impact of future problems.

The aim of this research is to explore lessons learned from many developed countries' waste management implementation success story to be adopted in Indonesia. The objectives of this article are: to examine the implementation of waste management in construction projects in developed countries, and to identify context, drivers and barriers of the construction waste management practices,

2. Methods

A comprehensive literature review is conducted to address the aim and objectives of this research. Descriptive analysis was established based on the concept, principle, theory, data and information, and policies related to construction waste management.

3. Results and Analysis

Construction waste management practices vary in different countries. For more developed countries, construction waste has become one of the main problems due to high awareness of environmental issues. On the other hand, many developing countries still focus on building and completing infrastructure, that might cause different practices in their waste management. Table 1 summarises the principles of construction waste management carried out by various countries. Here are some views of how every country manages their construction waste.

3.1 United States

Construction waste issues have become a main focus on a project in many countries due to cost and environmental awareness [10]. Many countries keep trying to formulate effective regulations that can minimize the construction waste in order to protect the environment and to improve sustainability of the construction industry. United States produces approximately 136 million tons of construction waste [11]. Therefore, the government and other parties should give more attention to help reducing the amount of waste generated from the construction industry.

There are several waste management models which are applicable in construction sites and projects. From their research, Dajadian and Koch (2013) suggested two types of waste management models that are suitable to be implemented in US [10]. The first model is using a separate subcontractor for waste management. Besides making sure the project will be done properly, the main contractor also has to consider about waste management and other things in the project. Having a separate subcontractor to manage waste on sites can reduce the company's responsibility on it. Waste management (WM) contractor has responsibility not only in charge of managing waste management, but also as an expert in estimating and calculating the amount of waste produced in the project. WM contractor is specialized in managing problems related to construction waste and also has sufficient staffs that are professionally trained and have comprehensive knowledge on construction waste. In every week, WM contractor also hold a weekly meeting to report and discuss about all issues according to waste management in the project.

Another recommended model is having a department of WM that will employ speciality staff. The responsibility of WM staff is to manage waste and dispose of it properly. Besides managing waste on site, this department also develop training sessions for the workers and improve their knowledge according to construction waste types and disposal process. The WM department also has responsibility in estimating the quantity of waste in the design stage, so that the planning waste management can be created previously, and a significant cost will be saved during the construction process.

A construction company which is having a better waste management can reduce the cost of waste disposal as well as environmental pollution. The company that has better construction waste record will have a better chance to meet the government regulations and contractual obligations.

3.2 United Kingdom

The construction industry in the UK contributes the largest proportion of waste dumped in landfills, this is similar in other large countries [12]. One of the key factors that play an important role in reducing the amount of construction waste sent to landfills is the implementation of appropriate regulations.

In their study, Ajayi and Oyedele revealed that waste management legislation and policies could effectively encourage the minimization of construction waste. There are six points that can be applied in the UK, which are (i) awarding of tax reduction and incentives to good waste performers and waste

management companies; (ii) increased targeting of design phases in policies; (iii) extension of a sustainable design assessment system by allocating more points to a proven measure of waste performance; (iv) increase the firmness of legislative steps by requiring the use of proven efficient waste design, procurement and construction; (v) strict fiscal policy improvement by increasing penalties for poor waste performance; and (vi) strengthen policy requirements with enablers and facilitators [13]. By implementing a strict policy, the amount of construction waste can be transferred from the landfill.

3.3 Spain

The most generally waste management model implemented in construction sector in Spain are on-site cleanliness and order, correct storage of raw materials, and prioritization in choosing the nearest authorized waste managers [14]. Whereas, waste management practices which are often performed are the use of a mobile crusher on site, the creation of individualized drawings for each construction site, and the dissemination of the contents of the waste management plan to all workers, to help them to meet its requirements.

3.4 Australia

Study in one of the remote areas in Australia, Alice Springs, showed that the method generally used in managing construction waste is waste disposal to landfills [1]. Cost and time factors related to the management of construction waste in the project (on-site waste management), industrial culture, lack of knowledge, priority of the project to be able to compete, and lack of financial support are the barriers factors in improving the construction waste management system.

3.5 Hong Kong

Construction waste from development activities become prolong serious problem at several countries, including Hong Kong. In recent years, Hong Kong and related stakeholders attempt to craft policy strategy to reduce construction waste in the landfill.

The study from Lu and Tam (2013) proofed that Hong Kong contributed by Construction Waste Management (CWM) policy through concept of 3R and polluter pays. The policy creating policy framework which is relevant and effectively worked to manage CWM in Hong Kong [15]. According to the “reduce, reuse, and recycle (3R)” principle, waste management tends to be performed in the construction processes in Hong Kong by implementing several effort starting from avoidance, minimization, recycling, treatment, and disposal. Before starting the construction process on site, contractors have to create a waste management plan including waste reduction targets and programmes. Contractors also need to organize on site sorting and proper waste disposal, if eventually there is still waste produced.

In Hong Kong, construction waste is classified into inert and non-inert material, whereby the inert materials, comprising mainly sand, bricks, asphalt and concrete, are deposited at public filling areas for sea reclamation and land formation, while the non-inert materials, such as plastics, bamboo, wood, paper and packaging material, are disposed at landfills as solid waste. It is important to segregate these two parts [16]. CMW policies in Hong Kong have significantly increased sorting of construction waste on site project [7]. But in realizing it also needs involvement from the parties as well as site conditions. Site space indicates to the space used for on-site waste sorting. Since construction waste is often the mixture of all kind materials which is not suitable for reusing or recycling but generally disposed at landfills directly, on-site sorting is effective in gaining a higher rate of reusing and recycling waste [17]. However, there is still remaining construction waste that needs to be disposed of by the contractor to landfill.

In 2006, the Hong Kong government established a Construction Waste Disposal Charging Scheme (CWDCS) based on the “polluter pays principle”. This scheme forces the contractor to pay sum of money for the waste they produce. The tariffs are different due to the needs, such as for

16

materials disposed to landfills, the construction waste accepted by off-site sorting facilities, and the waste materials accepted by public facilities.

The CWDCS applied from 2006 has already shown positive impact for reducing construction waste both on site and disposal at landfills [15]. The amount of solid waste in Hong Kong decrease from 40-70 ton to 20 ton in recent years from 40–70 ton during the first half of the last decade. Nevertheless, it is still necessary to consider other CWM regulations that can further reduce the waste production, either through policy methods or waste technologies, or setting up that a certain level of waste generation indeed is unavoidable in Hong Kong.

3.6 Turkey

In the last two decades, recycling of construction waste by facilities has been a reasonable alternative to unsustainable disposal practices, i.e., landfilling and fly tipping [2]. The study from Ulubeyli et al. (2017) showed that from an economic and environmental perspective, recycling waste management systems are more sustainable than producing original materials. Recycled products can play a positive role in a sustainable supply mix.

On the other hand, the implementation of the recycling process will also cause other problems, such as noise and dust. The issue that is no less important is related to the transportation of materials both recycled and those that will be recycled. This activity is a major aspect that consumes the largest capital in the recycling process, which is 44% of all primary energy needs and it is an aspect that gives the greatest contribution to environmental impacts (air pollution). Therefore, a supply chain for recycled construction waste materials is needed to remain in the regional area because it will save costs and the transportation process.

3.7 China

Managing construction waste is important effort in order to reducing the negative impact of construction on environment. In China, construction waste is mostly disposed of in landfills and only about 5% of the total waste is recycled [18]. There are various obstacles to the application of the 3R principle in the construction waste management system in China. The absence of building design standards that refers to the reduction of construction waste, low costs for construction waste disposal (landfill) and improper urban planning are inhibiting factors in the implementation of reducing principles. Meanwhile, an ineffective management system, immature recycling technology, a market for construction and demolition waste (CDW) products that is underdeveloped and an immature (growing) recycling market operation makes the principle of recycling difficult to implement. Whereas, to implement the reusing principle in construction waste management is hampered by a lack of guidelines for the effective collection and sorting of construction waste, lack of knowledge and standards for reused CDW, and a less developed construction market. The effort that can be done to improve these conditions in China based on the 3R principle is to design an effective circular economy model, improve supervision of the producing causes of construction waste, adopt innovative technologies and market models, and implement targeted economic incentives.

According to the research conducted by Lu and Yuan (2010), there are seven factors identified as the critical success factor in managing construction waste, which are waste management regulations, waste management system, awareness of construction waste management, low-waste building technologies, fewer design changes, research and development about waste management, and training in waste management [16].

3.8 Malaysia

11

Landfill is the main technique in disposing of construction waste in Malaysia. Only a few construction practitioners apply the 3R concept in construction waste management [19]. In fact, waste management that is often found in the Malaysian construction industry is illegal dumping activities [20].

Study done by Rahim *et al.* (2017) found that illegal dumping activities in Malaysia were caused by a number of factors, such as the lack of availability of construction waste management facilities, knowledge and education, and the increasing in the number of construction and renovation projects [21].

Table 1. WasteManagement in Several Countries

Country	Waste Management
United States	Some of the construction waste management practices that are often implemented are [10]: <ul style="list-style-type: none"> • Having a WM contractor • Having a department of WM in the contractor company
United Kingdom	The construction industry in the UK contributes the largest proportion of waste dumped in landfills [12].
Spain	The most commonly implemented practices included [14]: <ul style="list-style-type: none"> • On-site cleanliness and order • Correct storage of raw materials • Prioritization of the nearest authorized waste managers
Alice Springs (Australia)	The method generally used in managing construction waste is waste disposal to landfills [1].
Hong Kong	Waste management policies based on two principle, which are [15]: <ul style="list-style-type: none"> • 3R principle - reduce, reuse, and recycle • Polluter pays principle
Turkey	Some of the construction waste management practices that are often implemented are [2]: <ul style="list-style-type: none"> • Recycling the construction waste • Demolition with recycling plants
Chongqing (China)	Generally using disposal methods. Chongqing has sixteen standard construction waste disposal plants. However, because of remote distance, limited capacity, and lack of effective treatment, approximately only 6 percent of construction waste will be dumped into landfill sites, and the others are used for backfill, mixed with solid waste disposal, and dumped anywhere. The rate of construction waste recycling is about 5%, which is far under the world average [22].
Malaysia	The most waste management models implemented are [20]: <ul style="list-style-type: none"> • Illegal dumping of construction waste • Disposal methods into landfills

4. Conclusion

There are several factors that can help reduce waste production in the construction industry, including construction knowledge related to environmental hazards, experience and expertise in managing construction waste, and financial support of each company to deal with the waste that produced in project. Moreover, policies related to effective waste management can also provide guidelines for construction actors to take steps and knows how to reduce construction waste generated in the project. In addition, the imposition of fines on the disposal of construction waste to the landfill can also help the government in its efforts to reduce waste production in the construction industry.

The results show that in general, many developed countries can reduce and manage their construction waste with supports from stakeholders, the availability of regulation with tight sanctions, law enforcement from the government, another supporting system, and high awareness from the practitioners. Although each country arguably may have best practices due to the local context, nevertheless these results may give insight and are useful for stakeholders in the Indonesia construction industry.

5. References

- [1] Crawford R H, Mathur D and Gerritsen R 2017 Barriers to Improving the Environmental Performance of Construction Waste Management in Remote Communities *Procedia Eng.* **196** 830–7
- [2] Ulubeyli S, Kazaz A and Arslan V 2017 Construction and Demolition Waste Recycling Plants Revisited: Management Issues *Procedia Eng.* **172** 1190–97
- [3] Wang Y, Tang Y and Yao W 2016 Research on the Whole Process Management of Construction Waste *ICCREM - ASCE* **1** (iii) 398–405
- [4] Nagapan S, Rahman I A, Asmi A and Adnan N F 2013 Study of Site's Construction Waste in Batu Pahat, Johor *Procedia Eng.* **53** 99–103
- [5] Polat G, Damci A, Turkoglu H and Gurgun A P 2017 Identification of Root Causes of Construction and Demolition (C & D) Waste: the Case of Turkey *Procedia Eng.* **196** 948–55
- [6] Ikau R, Joseph C and Tawie R 2016 Factors Influencing Waste Generation in the Construction Industry in Malaysia *Procedia - Soc. Behav. Sci.* **234** 11–8
- [7] Yuan H, Chini A R, Lu Y and Shen L 2012 A dynamic model for assessing the effects of management strategies on the reduction of construction and demolition waste *Waste Manag.* **32** (3) 521–31
- [8] Dhaneswara 2016 *Analisis Limbah Konstruksi pada Bangunan Hotel Berbintang di Yogyakarta* (Yogyakarta: Univ. Gadjah Mada - unpublished thesis)
- [9] Hastuti S P, Habsya C, Lilo T and Sucipto A 2015 *Waste Management pada Proyek Pembangunan Gedung Sebagai Bagian dari Upaya Perwujudan Green Construction: Studi Kasus Pembangunan Gedung – Gedung di Universitas Sebelas Maret Surakarta* (Surakarta: Univ. Sebelas Maret Surakarta - unpublished thesis)
- [10] Dajadian S A and Koch D C 2014 Waste Management Models and Their Applications on Construction Sites *Int. J. Constr. Eng. Manag.* **3** (3) 91–8
- [11] Yuan H 2012 A model for Evaluating the Social Performance of Construction Waste Management *Waste Manag.* **32** (6) 1218–28
- [12] Oyedele L O, Ajayi S O and Kadiri K O 2014 Resources, Conservation and Recycling Use of Recycled Products in UK Construction Industry: An empirical Investigation Into Critical Impediments and Strategies for Improvement *Resources, Conserv. Recycl.* **93** 23–31
- [13] Ajayi S O and Oyedele L O 2017 Policy Imperatives for Diverting Construction Waste from Landfill: Experts recommendations for UK policy expansion *J. Clean. Prod.* **147** 57–65
- [14] Gangoellis M, Casals M, Forcada N and Macarulla M 2014 Resources, Conservation and Recycling Analysis of the Implementation of Effective Waste Management Practices in Construction Projects and Sites, *Resources, Conserv. Recycl.* **93** 99–111
- [15] Lu W and Tam V W Y 2013 Construction Waste Management Policies and Their Effectiveness in Hong Kong: A Longitudinal Review *Renew. Sustain. Energy Rev.* **23** 214–23
- [16] Wang J, Yuan H, Kang X and Lu W 2010 Resources, Conservation and Recycling Critical Success Factors for On-Site Sorting of Construction Waste: A China Study *Resources, Conserv. Recycl.* **54** (11) 931–6
- [17] Shen L Y, Tam V W Y, Tam C M and Drew D 2004 Mapping Approach for Examining Waste Management on Construction Sites *J. of Constr.on Eng. and Man.* **130** 472–81

- [18] Huang B, Wang X, Kua H, Geng Y and Bleischwitz R 2018 Resources, Conservation & Recycling Construction and Demolition Waste Management in China Through the 3R Principle *Resour. Conserv. Recycl.* **129** 36–44
- [19] Sin T J, Chen G K, Long K S and Hwang G H 2012 *Current Practice of Waste Management System in Malaysia: Towards Sustainable Waste Management Current Practices for Malaysia* Available at: http://eprints.uthm.edu.my/5381/1/FPTP_Paper.pdf
- [20] Nagapan S, Rahman I A and Asmi A 2012 *Construction Waste Management: Malaysian Perspective* Available at: <https://core.ac.uk/download/pdf/12007490.pdf>
- [21] Rahim M H I A, Kasim N, Mohamed I, Zainal R, Sarpin N and Saikah M 2017 Construction Waste Generation in Malaysia Construction Industry: Illegal Dumping Activities *IOP Conf. Series: Mater. Sci. Eng.*, **271**
- [22] Liao Q, Luo M and Jia S 2012 Study on The Problems and Countermeasures of Disposal of Construction Waste in Chongqing *Intern. Conf. on Sust. Design and Const. (ICSDC)* 384–90

Managing Construction Waste in Developed Countries: Lessons Learned for Indonesia

ORIGINALITY REPORT

22%

SIMILARITY INDEX

11%

INTERNET SOURCES

6%

PUBLICATIONS

17%

STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Christchurch Polytechnic Institute of Technology Student Paper	2%
2	Submitted to Universiti Teknologi MARA Student Paper	2%
3	cyberleninka.org Internet Source	2%
4	Submitted to Milwaukee School of Engineering Student Paper	2%
5	futur.upc.edu Internet Source	2%
6	Submitted to University of Central England in Birmingham Student Paper	1%
7	Submitted to Universitas Diponegoro Student Paper	1%
8	Submitted to Universiti Tunku Abdul Rahman Student Paper	1%

9	Submitted to National Economics University Student Paper	1 %
10	www.2minuty.pl Internet Source	1 %
11	11worcesterondurban.co.za Internet Source	1 %
12	Submitted to RMIT University Student Paper	1 %
13	Submitted to Curtin International College Student Paper	1 %
14	Submitted to University of Central Lancashire Student Paper	1 %
15	Submitted to University of Witwatersrand Student Paper	1 %
16	hub.hku.hk Internet Source	1 %
17	eudl.eu Internet Source	1 %
18	www.scribd.com Internet Source	<1 %
19	Submitted to PSB Academy (ACP eSolutions) Student Paper	<1 %
20	Rezha Carina Rachmady, Ari Rahman, Wahyu Kunto Wibowo. "Textile wastewater	<1 %

purification using corona discharge method",
AIP Publishing, 2022

Publication

21	"Proceedings of the 20th International Symposium on Advancement of Construction Management and Real Estate", Springer Science and Business Media LLC, 2017	<1 %
----	--	------

Publication

22	eeae1fb1-a94b-4d1b-b2c8-f17b9925c07e.filesusr.com	<1 %
----	---	------

Internet Source

23	espace.library.uq.edu.au	<1 %
----	--------------------------	------

Internet Source

24	docplayer.net	<1 %
----	---------------	------

Internet Source

25	Yuan, Hongping, Weisheng Lu, and Jane Jianli Hao. "The evolution of construction waste sorting on-site", Renewable and Sustainable Energy Reviews, 2013.	<1 %
----	--	------

Publication

Exclude quotes On

Exclude matches Off

Exclude bibliography On

Managing Construction Waste in Developed Countries: Lessons Learned for Indonesia

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8