

Current practices of construction waste reduction through 3R practice among contractors in malaysia: Case study in penang

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Abstract. The effectiveness of the implementation of construction waste reduction through 3R reflects the sustainability in construction waste management. Weak implementation of construction waste reduction through 3R among contractors will lead to unsustainable construction waste management. Increase in construction waste on landfills is critical especially on islands where land is very limited for solid waste disposal. This aim of this paper is to investigate current practice of construction waste reduction through 3R practice among contractors in Penang, Malaysia. The findings reported herein is based on feedbacks from 143 construction contractors of grade CIDB G7, G6 and G5 in Penang and experts from Penang Local Authority, CIDB in Penang and its Headquarters, National Solid Waste Management Department, and Headquarters of Solid Waste and Public Cleansing Management Corporation. Interviews and questionnaire surveys have been found that 3R practice is not mandatory in construction waste management in Penang. Only 39.8% construction contractors practiced 3R in managing their waste. Therefore, 3R practices should be emphasized in construction industry. Reducing wastes through 3R practices in construction industry is a way forward towards sustainable construction waste management especially in expanding the lifetime of landfill.

1. Introduction

Construction industry consumes a huge amount of natural resources and generates large quantities of construction waste [1]. Construction waste is defined as waste generated from construction industry during construction activities, building renovation, civil construction and building, construction site cleaning, road construction and demolition activities, including soil excavation. Some of construction wastes are recyclable and reusable; however most of the wastes are usually dumped on landfill [2]. Basic construction waste such as dirt, brick, concrete, asphalt, glass, wood, plastic and metal [3]. According to [4], construction waste management is a tool to control the cost of construction waste disposal and to facilitate other alternative than disposal method such as reuse and recycling to reduce construction waste disposed at landfills at the last stage. Construction waste should be recognized as a valuable resource because many types of construction waste can be reused or recycled [5].



1.1. Construction waste reduction through 3R in Malaysia

Solid waste reduction through 3R is one of the thrusts of National Solid Waste Management (NSWM) Policy. Construction waste is one of the controlled solid wastes [6]. 3R practices represent the concept of reduce, reuse and recycle [7].

- **Reduce:** Reduction is considered as the most effective and efficient method to manage construction waste. Reduction does not only reduce construction waste generation, it also can reduce the cost for transportation, waste disposal and waste recycling [1,8-10].
- **Reuse:** Reuse is usually a favourite option because some construction waste can be reused in other construction project. Reuse is most beneficial and contractors can save money since disposal involved cost [11]. Reuse is using the same material more than once for the same function such as formwork in construction [12]. Any material which cannot be reused but can be recycled will be sent to recycling center [13].
- **Recycle:** When reduction and reuse become difficult, recycling is desired. Some new materials can be made out through recycling [14]. Recycling construction waste can be categorized into on-site and off-site. On-site recycling is defined as segregation of construction waste for subsequent use as the raw materials in construction project. Meanwhile, off-site recycling is segregation of construction waste which are then transported to other organizations or locations and the waste is used as raw materials [15].

3R practice has become more popular as it has been included in policy and option among other alternative of waste hierarchy concept and it is based on the idea of fully utilizing the resources before disposal [16]. Efforts have been placed in focusing on 3R towards reducing the solid waste [17].

Malaysia like other developing countries are facing problem of high construction waste generation due to rapidly growth of construction industry. Landfill dumping is common practices in handling construction waste in Malaysia [18]. At much 70% to 80% recyclable materials can be found on landfills in Malaysia [19]. This causes landfill to reach their full capacity ahead of time [18]. Sustainable waste management is remains a low priority among majority of contractors in Malaysia. The 3R practices in construction industry are limited since it is not a mandatory requirement for construction companies [20]; and roadside illegal dumping is still an issue for the authorities [21]. Majority of contractors do not practice source separation, reduction, reuse or recycling at construction sites in Malaysia [20].

Moreover, practice of reuse and recycling construction waste has always been neglected because most of the efforts were focused on handling domestic waste [5]. Municipal Council only provides disposal services at landfill but does not interfere in construction waste management since it is the responsibility of contractors to manage construction waste on-site [13]. Currently, there is no systematic information record on the volume and type of construction waste being generated, amount of raisings generated and disposed in Malaysia. Data on waste minimization and recycling provided by local authorities is widely varied, not standardized, non-uniform, and inconsistent [19].

Disposal activities are very limited and the waste surface is estimated to be 38 m high above the mean sea level beside the Jelutong landfill [21]. With the shortage of open area in Penang Island [22], Penang has difficulty in locating new site for solid waste disposal because landfill are requires large area. Almost all construction wastes in Penang are sent to Jelutong landfill [21]. Residents at a high-rise condominium are up in arms over the worsening stench from the open burning at Jelutong landfill in Penang Island. They are infuriated by the delay of local authorities in relocating the landfill. The residents had complained to the authorities many times, but no action had been taken to relocate the landfill. Nearby residents want Jelutong Landfill be relocated due to the raging fire and the resulting smog which posed threat to health. They are worried as the landfill had been expanding and it is located a mere 500m from their condominium. The landfill has been getting bigger and moving closer to the sea. Fire has been spotted at the landfill especially during the hot and dry season [23].

1.2. Negative impacts due to ineffective of implementation of construction waste reduction through 3R practice

Rapid growth in construction activities increases construction waste problems around the world [24]. Construction wastes become serious environmental problems since large volumes of construction waste reduces landfill capacities and leads to environmental issues [8]. Construction waste has not only created environmental problem, but also poses negative impact on human health and hygiene [25]. Besides, expanding construction waste shows that the bulk dissipation of natural resources [26].

- **Environmental:** The environmental impact of the construction industry is substantial in developing countries than developed countries because developing countries are still under construction and going through rapid urbanization and industrialization [27]. Construction waste may cause environmental pollution on landfill. When it rains, construction waste may seep into and pollute the ground water, surface water and soil [28]. Contractors dump construction waste illegal at road side or into river will cause environment pollution [29].
- **Human health:** Traditional disposal method requires large of land which impose apprehensive and psychological fears due to the health and ecological risks [30]. Construction waste which is not properly managed will lead to human health problems [18].
- **Resource:** Higher construction waste being generated will result in higher consumption of natural resources [18]. 3R practice is an efficient and effective way to reduce waste going into landfills and decrease resource throughput, as using recycled material means reducing amount of new resources needed to manufacture a new product [31].

2. Research methodology

In this study, semi-structure interviews were carried out with experts from Penang Local Authority, CIDB in Penang and its Headquarters, National Solid Waste Management Department, and Headquarters of Solid Waste and Public Cleansing Management Corporation. A total 143 set of validated questionnaires were collected randomly from construction contractors of grade G7, G6 and G5 under CIDB accreditation located in Penang. These 143 responses are equivalent to 65.9% of response rate. According to [33], as a rule of thumb, a 30% return is seen as fairly satisfactory while more than 50 per cent is good. Collected questionnaire were analyzed using Statistical Packages for Social Sciences (SPSS) while interview data were analyzed through Content Analysis.

3. Current practice of construction waste reduction through 3R among contractors in Penang

Based on the questionnaire survey, it has been found that 67% of contractors have the knowledge on 3R concept. Meanwhile, 20% of the contractors are not sure and 13% of contractors have no knowledge whatsoever on 3R concept. Figure 1 summarises the finding. Majority of contractors get to know the about 3R through media, workshop and courses. Small portion of contractors obtained information on 3R through law and regulation and requirement of contract. Besides that, a few of the contractors also learn about 3R through university and reading materials.

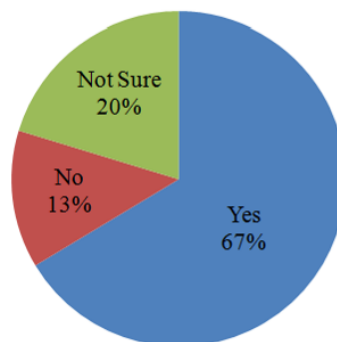


Figure 1. Level of knowledge on 3R concept among contractors in Penang.

Based on experts' interview, only an expert pointed out that effectiveness of the implementation of waste reduction through 3R in Penang has achieved 40% but this does not account for illegal dumping. Two experts highlighted that construction waste reduction through 3R among contractors in Penang is minimum since there is no ruling, technology, incentive, market and figure or record on it that exist. Meanwhile, three experts mentioned that waste management is under local authority and their agencies have no information on the current implementation of waste reduction through 3R in Penang.

Survey also shows that only 39.2% of contractors practiced 3R in managing construction waste, as depicted in figure 2. More than half of contractors (60.8%) do not practice 3R in managing construction waste. Most of the contractors sent their construction waste directly to landfill. This reveal that 3R implementation in construction waste reduction among contractors in Penang is still at its infancy. Table 1 shows percentage of waste being managed through 3R by contractors. From a total of 56 (39.2%) contractors who practice 3R, 37% of them managed only 20% or lower of their total construction waste through 3R. Only 11 contractors managed as much as 50% and more of their total construction waste through 3R.

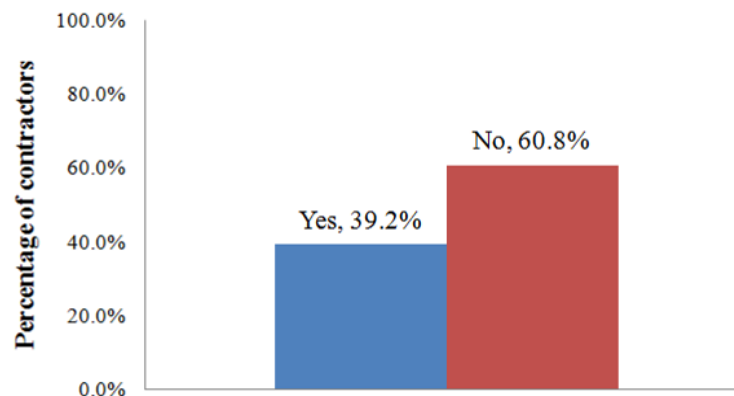


Figure 2. Percentage of contractors that practice 3R in managing construction waste at Penang.

Table 1. Total percentage of waste managed through 3R practice by contractors.

Total percentage of waste managed through 3R	Number of contractors
10%	19
20%	18
30%	8
40%	1
50%	7
60%	1
70%	1
80%	2
90%	0
100%	0
Total	56 (39.2%)

The reasons why these 56 contractors (39.2%) practiced 3R in managing construction waste are shown in table 2. 45 of them practice 3R in construction waste management for environmental protection while 38 contractors are because of the high scrap value of recycled material. Monetary value of waste is the reason for 26 contractors to practice 3R. 12 others contractors practiced 3R because of contract requirement, while 2 contractors indicated that 3R practice may save cost.

Conversely, most of contractors do not practice 3R in managing construction waste, which is unsustainable. It has been identified that weak implementation of 3R practice is due to constraint in time and cost, lack of space, lack of enforcement, lack of awareness and knowledge, lack of coordination, and contractors' attitude and low participation. Therefore, governing bodies should put in efforts in encouraging, promoting and enforcing 3R practices. 3R practice is an appropriate approach for contractors in managing construction waste because it is sustainable and beneficial.

Table 2. Reason of contractors practiced 3R in managing construction waste.

Reason	Number of contractors
Environmental Protection	45/56
High scrap value of recycled material waste	38/56
Profit	26/56
Contractor requirement	12/56
Others	2/56

Survey also found that only 33.6% of contractors indicated that 3R is mandatory in construction waste management as shown in figure 3. Meanwhile, 37.1% contractors revealed that 3R is not mandatory and 29.4% of contractors not sure whether 3R is mandatory in construction waste management. However, based on the feedbacks provided by experts interviewed, one expert stated that 3R practice is mandatory to legal contractor because minimization and recycling construction waste are stated in Planning Permission Plan. Meanwhile, others experts stated that 3R practice are not mandated and not stated in project contract. However, some contractors do practice 3R in managing waste and stated in contract and in pursuing sustainable building rating like Green Building Index (GBI) and Malaysian Carbon Reduction & Environmental Sustainable Tool (MyCREST) where 3R practice is one of the criteria. Their agencies are in progress enforcing the law and regulation to mandatory 3R practices. Overall, this study revealed that 3R practice currently is not mandatory in construction waste management and it depends on contractor's initiative and pursuing the sustainable building rating. But, it will be mandatory when law and regulation has been enforced.

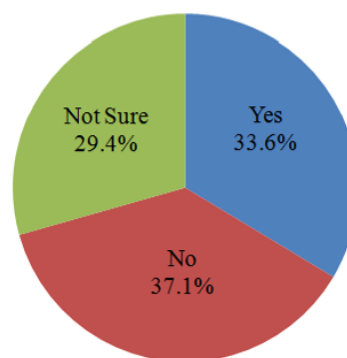


Figure 3. Practice 3R is mandatory in construction waste management.

All the experts being interviewed indicated that environmental pollution, human health risk and dissipation of resources are the definite negative impacts due to ineffective implementation of construction waste reduction through 3R. Environmental pollution is in existence due to improper dumping of construction waste and the carbon footprint of vehicle use to send waste to landfill. Further, improper segregation of construction waste also led to environmental pollution. Construction wastes that contain hazardous chemical will also pollutes the water and soil. Meanwhile, environmental pollution can also occur due to unavailable of very good inert landfill. All experts agreed that environmental pollution affected human health directly especially from polluted drinking

water sources and air. They also stated that a lot of recyclable and reusable waste at landfill reflects the dissipation of resources. These unsustainable impacts will remain exist if new resources such as timber are continually used without practice 3R. Table 3 shows that majority of the contractors (86.7%) pointed out that environmental pollution is ranked first as the negative impacts that arises from ineffective implementation of construction waste reduction. Impact of human health risk was pointed out by 90 contractors while 37.1% of contractors indicated that dissipation of resources is also one of the impacts. Only 2.1% contractor indicated the others impacts such as excessive spending on waste cleaning.

Table 3. Negative impact arises of ineffective implementation of construction waste reduction through 3R practice.

Negative impacts	Number of contractors (%)
Environmental Pollution	124 (86.7)
Human health risk	90 (62.9)
Dissipation of resources	53 (37.1)
Others	3 (2.1)

4. Recommendation

In order to improve the effectiveness of waste reduction through 3R in construction industry, there are important elements which should be emphasized, i.e. law and regulation, scheme and incentive, awareness and knowledge on 3R, participation of contractors, and available technology. Moreover, top-down approach with enforcement of legislation and policies and good governance concept should be implemented towards sustainable construction waste management. Good governance is beneficial and leads a clear and legitimate process towards effective policy implementation. A framework encompassing these important elements with top-down approach and principle of good governance is needed to be developed in order to have effective construction waste reduction through 3R among contractor.

5. Conclusion

Rapid growth of construction industry has produced large amount of construction waste and increases the quantity of waste to be disposed on landfills. Landfills cannot accommodate the accumulating wastes for long term. Penang, which is an island area has scarce land for new landfills since landfill requires sizeable area. 3R implementation in construction waste reduction among contractors in Penang is still at its infancy. More than half of contractors do not practice 3R in managing construction waste. Many studies have shown that various types of construction waste have the potential to be reused or recycled. Therefore, contractor should fully reduce, reuse and recycle construction waste instead of sending the waste to landfill. All parties involved should be accountable and be responsible to achieve sustainable construction waste management.

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