

Constraints to 3R construction waste reduction among contractors in Penang

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Abstract. Rapid development of construction industry increases construction waste on landfill leading to shorter life span of the landfill. Waste reduction through Reduce, Reuse and Recycle (3R) practice has been encouraged in construction industry towards sustainable waste management since couple of decades ago. However, waste reduction through 3R is still at its infancy in construction industry in Penang, Malaysia. The aim of this paper is to determinate the constraints to construction waste reduction through 3R among contractors in Penang. The findings reported herein is based on feedbacks from 143 construction contractors of grade CIDB G7, G6 and G5 based in Penang, 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 (SWCorp). Based on interviews and questionnaire surveys, constraints identified are Time and cost, Contractor's attitude and low participation, Lack of enforcement law and regulation, Lack of awareness and knowledge, Lack of coordination, and Lack of space. Awareness and knowledge, and enforcement law and regulation are the major barriers which influence others constraints as well. Therefore, these constraints should be emphasized by the authorities in order to improve the implementation of 3R construction waste reduction.

1. Introduction

Solid waste reduction through 3R is one of the thrusts of National Solid Waste Management (NSWM) Policy [1]. The 3R approach refers to reduction, reuse, and recycling, which is a three classification of waste management strategies [2] and waste resources will be fully utilized before it is send to disposal [3]. Reduction of waste through 3R is one of the steps towards sustainable construction waste management [4]. Malaysia like other developing countries are facing greater generated construction waste due to rapid growth in construction industry. In Malaysia, dumping on landfill is common practice in discarding construction waste. Due to rapid development in construction industry, landfill will reach their full capacity earlier [5]. Almost all construction waste in Penang was sent to Jelutong Landfill. The disposal area is getting limited, with the waste surface beside the landfill estimated to be 38 m high above the sea level [6]. In addition, residents staying adjacent to Jelutong landfill want the landfill to be relocated due to raging fires, with the resulting smog posing threats to health. Residents are also worried about the expanding landfill since the landfill is located at a mere 500 m from their



condominium. The landfill has been getting larger and moving close to the sea [7]. According to Ng *et al.* [8], 3R implementation in construction waste reduction among contractors in Penang is still at its infancy. Weak implementation of 3R on construction waste among contractors will lead to non-sustainable construction waste management. Increase of construction waste on landfills is critical especially for islands where land is very limited for solid waste disposal.

2. Constraints of 3R practice in construction waste management

The constraints to 3R practice in construction waste management have been identified in previous studies [6] & [8]. **Time and cost:** Most contractors only focus on short-term economic benefits and unwilling to increase inputs on construction waste management [9]. The reasons behind the lack of sustainable waste management practices were found to be due to profit, time, and cost [10]. On-site waste segregations will require substantial labour input which would increase the cost of construction project [11]. **Contractor's attitude and low participation:** Lack of public participation is another issue in construction waste management [12]. There is lack of effort to practice positive attitudes and perceptions to improve the waste minimization among construction workforce [10]. Nevertheless, terms and conditions in contract can set bounds for contractors in managing construction waste [13]. The aim of waste segregation is to recycle materials of high scrap value while non-profitable wastes are discarded via landfill, burned or illegally buried on site [14], [15] & [9]. **Lack of enforcement law and regulation:** There is very low possibility of improvement in waste management practices if policy enforcement is weak and ineffective, especially in developing countries [16]. The existence of policies, laws and regulations governing 3R in construction waste is minimal in Asia. There is no specific regulations formulated for construction wastes in most of the countries [17]. Due to lack of governmental enforcement, there is no definite regulation and the associated existing legislation does not facilitate the construction waste management adequately to effective direction [12]. The related regulations and legislations enforced by government are too liberal. Waste producers would not address construction waste management if enforcement is non-mandatory [15]. **Lack of awareness and knowledge:** Lack of knowledge on construction waste management is seen as a major constraint compared to other issues [18]. Awareness should be addressed at the grass-roots level [19]. Low awareness and concern among public are among the causes for limited recycling implementation. Public will only participate and practice 3R when there are policy and political drives [20]. **Lack of coordination:** Effective implementation of construction waste management strategies particularly 3R requires coordination and cooperation between local, national and regional authorities [17]. Lack of cooperation among waste generators [21] and relevant agencies often results in different agencies becoming not aware about what other national agencies are doing leading to inefficiency. There is often blurring roles of various national agencies in relation to waste management and no committee designated to coordinate waste management projects and activities [19]. **Lack of space:** On-site waste segregation is an effective method in reducing construction waste to be disposed on landfills. However, segregation activities involve much site space and require high level of management [11]. Limited waste storage area on site also recognised as barrier in implementing waste segregation [22].

3. Research methodology

Mixed method is used is to reduce disadvantage and overcome bias of individual approach. Semi-structure interviews were carried out with experts from Penang Local Authority, Penang CIDB and its headquarters, NSWM Department, and SWCorp. These experts are selected in order to obtain specific information based on their expertise. There are 515 contractors grade G7, G6, G5 under CIDB accreditation located in Penang. According to Krejcie and Morgan [23], 217 samples are needed to produce satisfactory study if population is 500. Reliability test is considered satisfactory and the questions are reliable if alpha value is 0.965. Questions posed in the questionnaire have been validated by academics and industry expertise as well. A total of 143 sets of validated questionnaires from 217 samples respondents were collected among 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.

As a rule of thumb, a 30% return is seen as fairly satisfactory while > 50% response rate is good [24]. Collected questionnaires were analysed using Statistical Packages for Social Sciences (SPSS). Interview data were analysed through Content Analysis. Findings from interview questions are analysed based on answers provided by expertise which are reported and discussed in the following section.

4. Result and discussion

4.1. Time and cost

Most of the experts interviewed revealed that time and cost is major constraints in implementing 3R among contractors. Development projects which involve demolition of existing building may require management and disposal of wastes. If segregation at source, recycle, and reuse are enforced, additional time and cost will be needed. One of the experts highlighted that 3R practice actually is financially beneficial. Sustainable buildings are also valuable due to their high market value. Surveys showed that 58.7% of contractors encountered time and cost constraints during 3R implementation. Only one expert said that cost of construction waste management is included in project cost, contrary to other experts. However, the experts highlighted that the cost of construction waste management is actually introduced by contractors or projects as it is not mandatory. Contractors will have to include the cost if they want to be evaluated for the award of 5-star rating, GBI or MyCREST since one of the criteria is 3R. Based on surveys, 42% of contractors indicated that the cost of construction waste management is not included in project cost, 32.2% of them revealed that the cost is indeed included in project cost, and 25.9% of them were not sure. According to most contractors, cost of construction waste management makes up to a maximum of 3% of overall project cost.

Most experts pointed out that the cost of processing recycled waste is higher than disposal. Recycling process requires machineries, equipment and space. Nevertheless, 3R helps to reduce waste and one may not even have to pay disposal cost if zero waste is attained. Recycled material is generally inexpensive compared to new ones, with some exceptions. Recycled materials are normally used as secondary materials such as in road construction. As much as 37.7% contractors agreed that the cost of processing recycled waste is higher than disposal, while 17.5% of them beg to differ. The remaining 44.8% of them were unsure about the costs comparisons. Surveys also showed that only 17.5% of the contractors mentioned that the price of recycled materials is higher than new ones. A majority, i.e. 42% of them agreed that the price of recycled materials is cheaper, with 40.6% of them were not sure. Findings on time and cost constraints based on survey are summarized in figure 1. Time and cost are major constraints in implementing 3R among contractors as agreed by experts and contractors. Most contractors tend to adopt easier approach without recycling due to the higher cost of processing recycled waste than disposal. Construction waste management cost should be included in project cost. Good incentive should be provided to motivate contractors to practice 3R in managing construction waste as the waste recycling cost is borne by contractors. Contractors should use recycled materials as secondary materials since they are cheaper than new ones. However, the recycled materials should fulfil standard quality requirement.

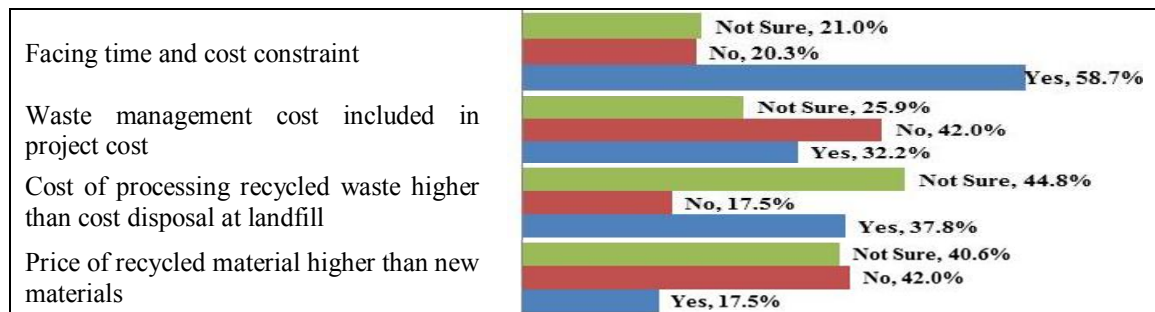


Figure 1. Survey questionnaire findings pertaining time and cost constraints in managing construction waste through 3R.

4.2. Contractors' attitude and low participation

Interviews showed that contractors' attitude and low participation is a constraint to 3R construction waste management. However, it is also influenced by other factors. Most contractors tend to adopt easier approach, i.e. without recycling if it not enforced by law. The option to recycle is also determined by economic factor and lucrative market demand on the construction waste. It is difficult to change the attitude and mentality unless through law enforcement. Contractors' attitude and participation also depends on knowledge and self-awareness. Survey showed that 64.3% of the contractors agreed that contractors' attitude and low participation is one of the constraints to construction waste reduction through 3R. 42% of them indicated that they will practice 3R even though it is not mandatory. However, 30.9% of the contractors will not practice 3R if it is not mandatory with 27.3% of them were left undecided. Interviewed experts concluded that only minority of contractors will practice 3R if it is not mandatory. Contractors will only practice 3R if it is beneficial, i.e. cost saving and valuable waste market value. Meanwhile, according to the survey, 40.6% of the contractors indicated that they will manage construction waste through 3R although the material is not profitable. On the contrary, 37.1% of them would not implement 3R approach on managing construction wastes, while the remaining 22.4% were not sure. Figure 2 summarizes the findings of the survey based on contractors' attitude and participation. Contractors' attitude and low participation is constraint to 3R construction waste management. More than half of the contractors do not and are undecided in practicing 3R since the practice is not mandatory as revealed by experts. Contractors' attitude and low participation is also influenced by factors such as enforcement, monetary, knowledge and self-awareness. Contractors should be committed to reduce construction waste by efficiently adopting 3R practice which reduce and reuse construction waste as much as possible in construction site.

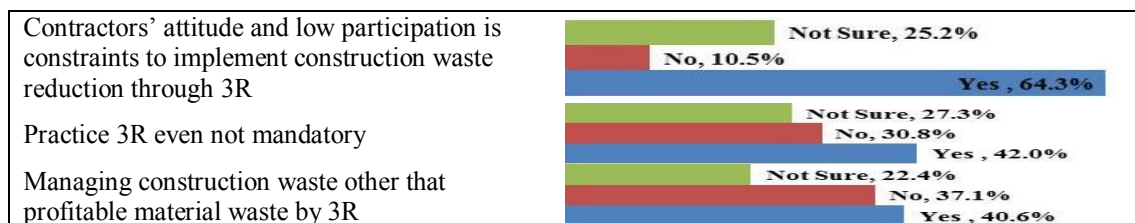


Figure 2. Survey questionnaire result on contractors' attitude and low participation as constraints to managing construction waste through 3R.

4.3. Lack of enforcement law and regulation

Most of the experts agreed that lack of law and regulation is one of the constraints in implementing 3R construction waste management among contractors. Enforcement is a good way to improve contractors' mentality and behaviour. Enforcement need to be carried out in stages and engagement on

framework, briefing, media, newspaper, ministry statement should be part of it. As much as 55% of the contractors agreed with the experts on the importance of law and regulation enforcement. Meanwhile, 12% the contractors disagreed that the law and regulation is the constraint to 3R implementation in construction management. The remaining 35% of the contractors were undecided. All the experts interviewed highlighted that the Act 672 is not to be enforced in Penang. This is due to an agreement between state government and federal government, where the state government wants to employ own local workers to manage waste. However, some 22.4% of contractors thought that Act 672 is enforced in Penang. Majority of the contractors, i.e. 49.7% were not sure about the enforcement. As much as 28% of the contractors knew that the act is not enforced in Penang. Apart from Act 672, most of the contractors were not aware about any other law or regulation enforcement on 3R, with 46.9% indicated not sure and 35% said no. Findings of the survey regarding law and regulation enforcement on construction waste management through 3R are shown in figure 3.

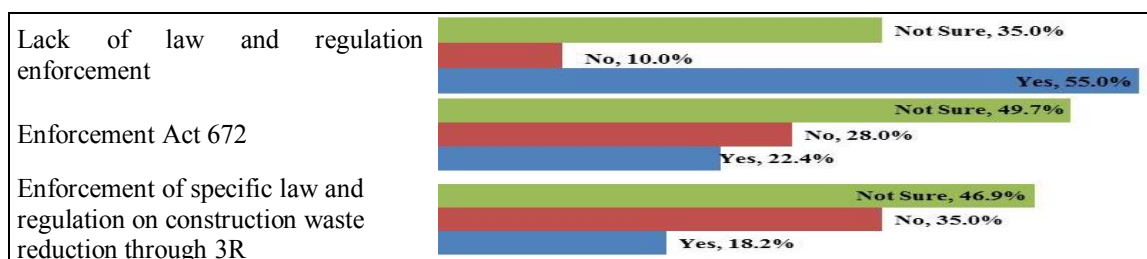


Figure 3. Survey findings on the law and regulation enforcement as constraint to 3R implementation in construction waste management.

Most of the experts interviewed stated that at the moment, there is no specific law or regulation being enforced in construction waste management through 3R, although efforts have been put forth. One expert pointed out that there is a clause in Planning Permission Plan which states that contractors need to recycle all waste and minimize waste generated. All experts agreed that currently there is no penalty even if contractors do not practice 3R. According to Moh and Manaf [25], due to lack of other supporting regulations, Act 672 cannot be enforced and implemented fully even though the enactment has provided framework for solid waste management and legislative empowerment to Malaysian government. In summary, there is no enforced law and regulation on construction waste reduction through 3R. Lack of enforcement is the major constraints which influence other factors. Lack of enforcement lead to ambiguous boundaries and responsibilities of contractor and governing bodies in tackling and determining the involvement of policy implementation. Law enforcement is the best way to improve the attitude and mentality of contractor and increase the participation in construction waste management through 3R at the same time. The enforcement is needed to be carried out in stages and various engagements.

4.4. Lack of awareness and knowledge

All experts agreed and firmly believe that lack of awareness and knowledge among contractors are constraints to implementation of 3R in construction waste management. Contractors do not have the knowledge on how to practice 3R in managing construction waste especially small-scale construction companies. Lack of awareness and knowledge will lead to low participation. One of the experts pointed out that monetary factor will help increase the awareness and knowledge among contractors. Another expert highlighted that government has developed module to train contractors. Survey showed that 66% of contractors are lack in awareness and have little knowledge on implementing 3R in managing construction waste. Only 0.7% of the contractors are really knowledgeable in managing construction waste through 3R, with 31.5% of the contractors are moderately knowledgeable.

Most of the experts' agencies have delivered awareness and knowledge to contractors through briefing sessions, campaigns, workshops, talks, seminars and training programs including MyCREST

and Guidelines on Construction Solid Waste Management at Construction Site. However, contractors' attendance and participation are low. 31.5% of the contractors do know that CIDB and local authorities organize awareness campaign, training program or course to promote 3R in construction waste management from time to time. Meanwhile, 41.3% of the surveyed contractors indicated that CIDB and local authority seldom organized such awareness activities. As much as 17.5% of the contractors revealed that they never knew about such activities. It is alarming that 39.2% of the contractors have never participated in any of the awareness and knowledge programs on construction waste management through 3R while some 23.1% of contractors have minimal participation. Some 32.9% of the contractors do participate in the programs from time to time. Only 12.6% of the contractors provided workshop or training program on construction waste management for their staff, while majority of the contractors (67.8%) never provided any related program to their staff. Table 1 summarizes the findings obtained on the aspect of awareness and knowledge on 3R implementation in construction waste management.

Table 1. Awareness and knowledge aspects as constraint to 3R implementation in construction waste management, based on findings through survey on contractors.

Lack of Awareness and knowledge						
Yes 66%		No 67.8%			Not sure 19.6%	
Level		Not at all	Slightly	Somewhat	Moderately	Extremely
Level of knowledge construction waste reduction through 3R		10.5%	38.5%	18.9%	31.5%	0.7%
Level of frequency		Never	Rarely	Sometimes	Often	Always
Awareness activities promotes CW reduction through 3R organized		17.5%	41.3%	31.5%	5.6%	4.2%
Participation in program on CW reduction through 3R		39.2%	23.1%	32.9%	2.8%	2.1%
Provide workshop/ training program on construction waste management for staff						
Yes 12.6%		No 67.8%			Not sure 19.6%	

Overall, awareness and knowledge on 3R implementation in construction waste management is still limited among contractors. There is dis-coordination among contractors and governing bodies in communicating on the awareness and knowledge of construction waste reduction through 3R. Environmental education should begin on construction sites and training course for construction employees should be given before work. Contractors will practice 3R if they understand the importance of 3R practice and the benefits in environmental protection. Nevertheless, some contractors are more concern on economic factor and the lucrative market demand. Therefore, incentive should be provided when the law and regulation is enforced.

4.5. Lack of coordination

Most of the experts mentioned that there is coordination between Penang Development Corporation, developers, local authority and contractors towards integrated construction waste management. However, one expert pointed out that it is still a long way to integrated construction waste management and it takes time for all the parties to get involved actively. Nevertheless, there exist some strategies proposed by the coordinating bodies. Law and regulation enforcement at national level is under the jurisdiction of Federal Government; however construction waste management depends on the strategies implemented by Local Authority. Local Authority is currently in progress to enact a law which requires future development project to recycle construction materials at a minimum percentage. Although the Guidelines on Construction Solid Waste Management at Construction Site has been published by SWCorp, the implementation is not mandatory. Only 37.8% of the contractors agreed that lack of coordination is constraint to implementing construction waste management through 3R. 39.2% of the contractors were undecided while the remaining 23.1% do not agree that it is a

constraint. As much as 65.7% of the contractors are not sure whether there is solution or strategy proposed by governmental coordinating bodies. The summary of the survey findings on lack of coordination in implementing 3R in construction waste management is shown in figure 4. This shows that most contractors are not made aware of the strategies in managing construction waste through 3R proposed by coordinating bodies of government. There are communication gaps between contractors and governing bodies and limited coordination have leads to disconnection between policy and actual practice although the coordination among governing bodies is good. The important information and decision are not delivered to the contractors.

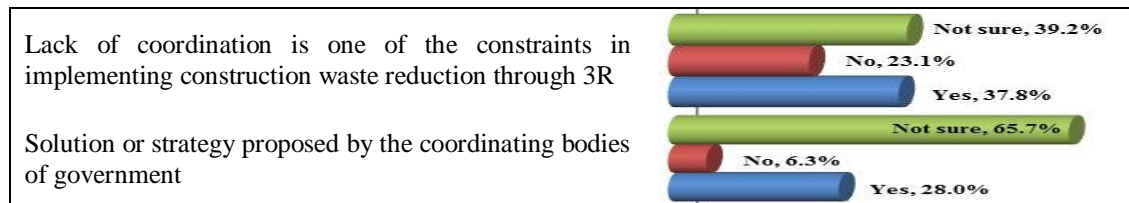


Figure 4. Feedbacks from survey conducted on lack of coordination between authorities, developers and contractors as constraint to implementation of 3R on construction waste management.

4.6. Lack of space

Some experts interviewed agreed that lack of space is one of the constraints in implementing construction waste reduction through 3R among contractors. This is because an area, which may not be very large area is needed for transporting, processing and storage of recycled materials including segregation process, recycling facility and storage bin. The size of space depends on contractors, management, location, type and size of project. Some expertise highlighted that space is not a critical issue since temporary recycling site is commonly available for contractors to practice recycling until project completion. On the contrary, survey shows that 67.8% of contractors have issue of limited space in managing construction waste through 3R. More than half of contractors, i.e. 52.4% believe that 3R practice will take up much space on site. Findings based on survey shows that lack of space is also a constraint to contractors in managing construction waste through 3R, as shown in figure 5. Lack of space is not a major barrier compared to other constraints because it depends on management, location, type and size of project. However, size of space for segregation and recycling should be considered ahead of project commencement since it influences the construction site layouts.

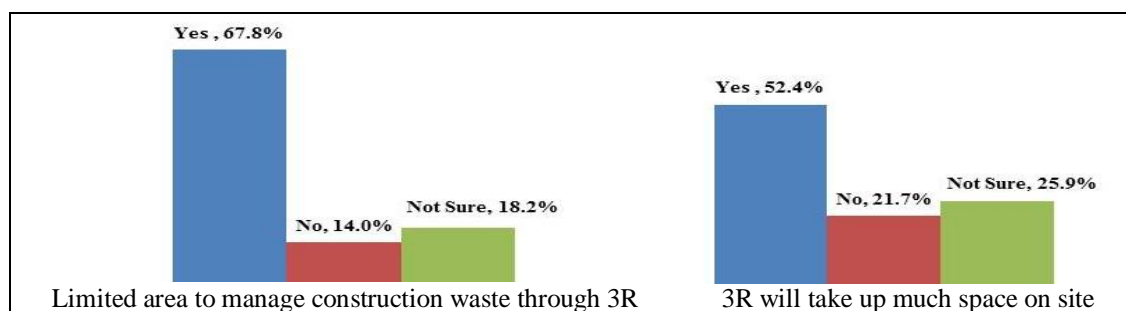


Figure 5. Survey shows that lack of space is a constraint to 3R implementation in managing construction waste among contractors.

5. Conclusion

Weakness in managing construction waste reduction through 3R among contractors is due to existence of some constraints. Awareness and knowledge, and enforcement law and regulation are critical constraints which influence the time and cost, contractors' attitude and participation, coordination, and

space for recycling. Awareness and knowledge go along with law and regulation enforcement. Once awareness, knowledge and enforcement are in place, contractors and governing bodies will have clear roles and responsibilities in relation to construction waste management. Thus, governing bodies need to emphasize enforcement and awareness and knowledge in construction waste management. Apart from that, contractors should also have own initiatives in gaining knowledge of 3R implementation in managing construction waste.

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