Sustainable Waste Management Practices for the Construction Industry

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The construction industry in Malaysia has been quite robust for the last few years with double-digit growth, and this is expected to continue in the future. The construction industry is recognised as one of the key industries in the country with a 10% contribution to the nation's gross domestic product (GDP). Moving towards a developed nation, the number of construction projects is expected to increase massively. The demand in implementing major infrastructure projects, together with the construction of commercial buildings and housing development programmes will produce a large amount of construction waste. In accordance with the increasing global acceptance of sustainable development, efficient waste management needs to be emphasised. Under the 11th Malaysia Plan (11th MP), holistic waste management is highlighted as one of the strategies in adopting sustainable consumption and production concepts. Construction waste in the 11th MP lists the types of waste that should be managed in a holistic manner. Unfortunately, the plans formulated under the 11th Malaysian Plan did not work out but CIDB has taken a bold step in preparing a training module for all construction workers to ensure that sustainable waste management is enshrined in the construction industry. Realising the importance of training and changing workers' mind set, CIDB through CREAM engaged EPIC to develop a comprehensive training module that will be used to enhance the understanding and put into practice sustainable construction waste management in Malaysia.

Rapid developments have led to a rapid increase in the generation of construction waste for developing countries such as Malaysia. Unmanaged construction waste results in a negative impact on: -

a) The environment - climate change, water and soil pollution, air pollution, ecological imbalance;
b) The social and health wellbeing - health hazards, use of public space, proliferation of pests and impact on working safety; and
c) The economy - reduction in environmental resources and energy usage, international reputation and effect on tourism.

Despite realising these impacts, the systems adopted in managing construction waste in the country are still at a very poor level. The generation of waste in the construction industry needs to be examined by looking into the whole life cycle of a building – planning, design and procurement; construction; occupancy; operation and maintenance; and renovation

Demolition waste

and demolition. In this context, managing construction waste is achieved by eliminating waste where possible; minimising waste where feasible; and reusing materials which might otherwise become waste. It is envisaged that effective waste management in the construction industry could be achieved by adopting a waste management hierarchy.

Construction waste management is an essential aspect of the sustainable building and green building practices. Going forward, the Government and related enforcement agencies like CIDB and CREAM will push the construction industry towards holistic construction waste management based on the life cycle approach. Integration between the closed-loop approach and the principle of a waste hierarchy is suggested by the authors as a holistic approach in managing waste. Towards this, CIDB as the leading body in the industry has developed a comprehensive training module that will act as a guide towards ensuring that all levels of construction workforce are trained in the principles of sustainable construction waste management. This article highlights some of the principles that have been adopted in the training modules.

Construction and Demolition Waste Definition

A general definition of the term "Construction and Demolition waste" is any substance, matter or thing that is generated as a result of construction work and abandoned whether it has been processed or stockpiled before being abandoned. It is a mixture of surplus materials arising from site clearance, excavation, construction, refurbishment, renovation, demolition and road works (*EPD, 2015*).

However, more importantly, is the definition taken up by the law governing the construction waste industry which is the Solid Waste and Public Cleansing Management Act 2007 (Scheme for Construction Solid Waste) Regulations 2018 (under the National Solid Waste Corporation or SW

Table 1: Examples of Construction & Demolition waste generation from construction activities

Types of development	Construction activities	Example of construction works	Example of C&D waste generated
Renovation	Site management	• Deconstruction of building components • Excavation works	Soil, rocks, woods, window and door frames
	Demolition	• Wall demolition works	Concrete, bricks, ceramic tiles, timbers, steel, gypsum
	Main structure works	• Concreting works • Bricklaying works • Installation of reinforcement bars	Concrete, bricks, steels, packaging, plastic and papers
	Interior and exterior decoration works	• Painting works • Installation of a plaster ceiling • Tile installations	Plastic, paper, painting, barrels, tiles, timber, steel, packaging, gypsum, rubber, PVC, glass
	Site cleaning	• Site cleaning works	Waste residuals, waste from cleaning works, including trees lands etc.
New Building	Site management	• Site clearance	Soil, rocks, wood
	Foundations work	• Excavation and reclamation work	Soil, mud, rocks
	Substructure work	• Piling works • Ground beam construction	Concrete, cement, bricks, formwork and steel
	Main structure work	• Concreting works • Bricklaying works • Installation of reinforcement bars	Concrete, bricks, timber, steel and packaging
	Interior and exterior decorations works	• Painting works • Installation of a plaster ceiling • Tile installation	Plastics, paper, painting barrels, tiles, timber, steel, packaging, gypsum, rubber, PVC and glass
	Site cleaning	• Site cleaning works	Waste residuals, waste from cleaning, including trees, soil.
Demolition	Site management	• Deconstruction of building components • Excavation works	Soil, rocks, woods, window and door frames
	Demolition	• Wall demolition works	Mixed bricks, tiles, timbers, steel, gypsum, plastic, paper, rubber, PVC, electronic waste, hazardous waste, glass
	Site cleaning	• Site cleaning works	Waste residuals, waste from cleaning works, including trees, lands etc.
Infrastructure	Site management	• Site clearance	Soil, rocks and woods
	Foundation works	• Excavation and reclamation works	Soil, mud and rocks
	Structural works	• Concreting works • Installation of reinforcement bars	Concrete, timbers, steel, packaging
	Site cleaning	• Site cleaning works	Waste residuals

Table 2: Composition of construction waste generated in Peninsular Malaysia.

Construction waste	Total wastage (tons)	Total wastage (%)
Metal	10,478.85	3.85
Timber/wood	17,529.75	6.45
Concrete	12,487.12	4.59
Bricks/blocks	3,685.62	1.36
Packaging material	3,650.28	1.34
Ceramic/tiles	40.83	0.02
Soil/aggregate	2,2482.45	8.27
Plastic material	1,506.95	0.55
Cardboard	24.51	0.01
Gypsum board	174.44	0.06
Mixed waste	199,887.35	73.50

Corp) which defines Construction and Demolition waste in two categories, which are:

a) *Residual solid waste* - means any construction solid waste which is not reused, recycled or composted and can be replaced in a receptacle.
b) *Recyclable construction solid waste* - means any construction solid waste which is separated for recycling.

Based on this definition, SW Corp provides several examples of Contruction and Demolition waste (C&D) that could be generated from various types of construction development and construction activities as shown in Table 1.

Construction and Demolition Waste Generated in Malaysia

According to Laporan Akhir Kajian Sisa Binaan 2018, a research conducted by CIDB, the composition, quantity and corresponding percentage of each type of waste generated is as listed in Table 2, while the overall generation and recycling rates are as follows:-

a) Total C&D waste generated in Peninsular Malaysia = 271,948 tons
b) Total C&D waste recycled in Peninsular Malaysia = 37,263.51 tons
c) C&D waste recycling rates in Peninsular Malaysia = 13.7%

On the other hand, Figure 1 shows the amount of material recycled for each type of waste in Peninsular Malaysia. Although there are materials being recycled, the amount is at a very low level. Therefore, the recycling amount needs to be elevated through the right training and workers' mind set.

Legislation for Construction Waste Management in Malaysia

The Department of National Solid Waste Management - Solid Waste and Public Cleansing Management Act 2007 (Act 672)

This provides for and regulates the management of controlled solid waste and public cleansing for the purpose of maintaining proper sanitation. It gives the Federal Government executive authority with respect to all matters relating to the management of solid waste and public cleansing. Under the Act, controlled solid waste is categorised as commercial solid waste, construction solid waste, household solid waste, industrial solid waste, institutional solid waste, imported solid and public waste. This legislation applies throughout Peninsular Malaysia and the Federal Territories of Putrajaya and Labuan.

Solid Waste and Public Cleansing Management Act 2007 (Act 672) - Scheme for Construction Solid Waste (Regulations 2018)

This regulation provides the scope of preliminary, duties of construction solid waste generators or persons in possession of construction waste, duties of licensees

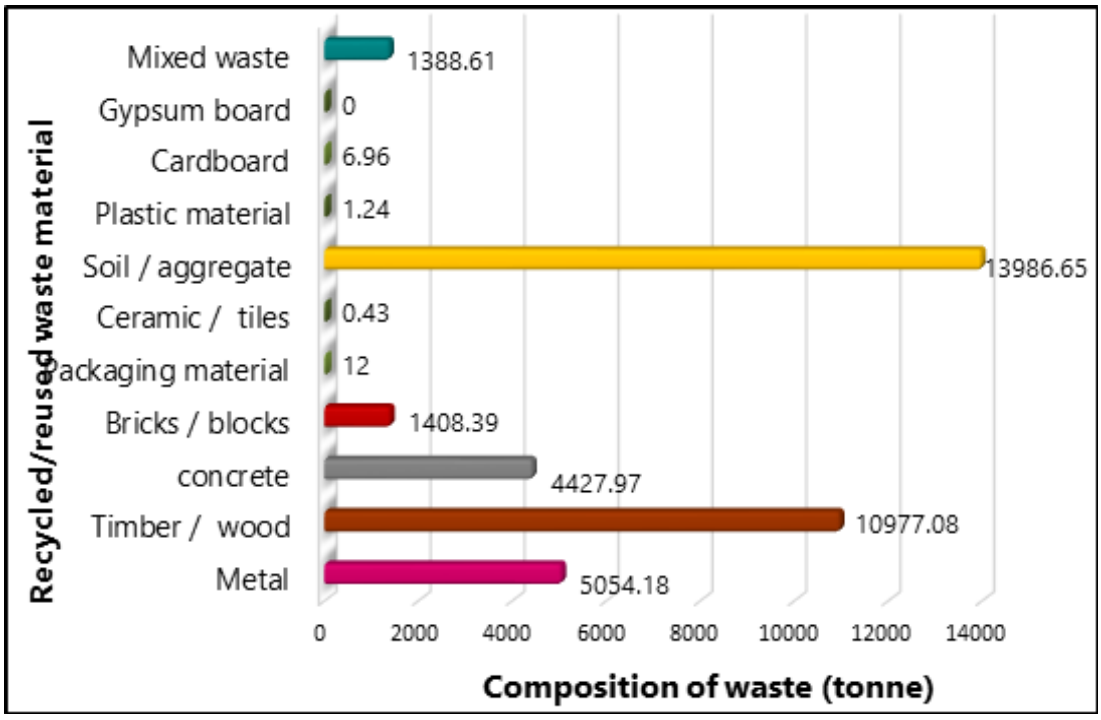

Figure 1: Composition of Construction & Demolition waste recycled/reused in Peninsular Malaysia.

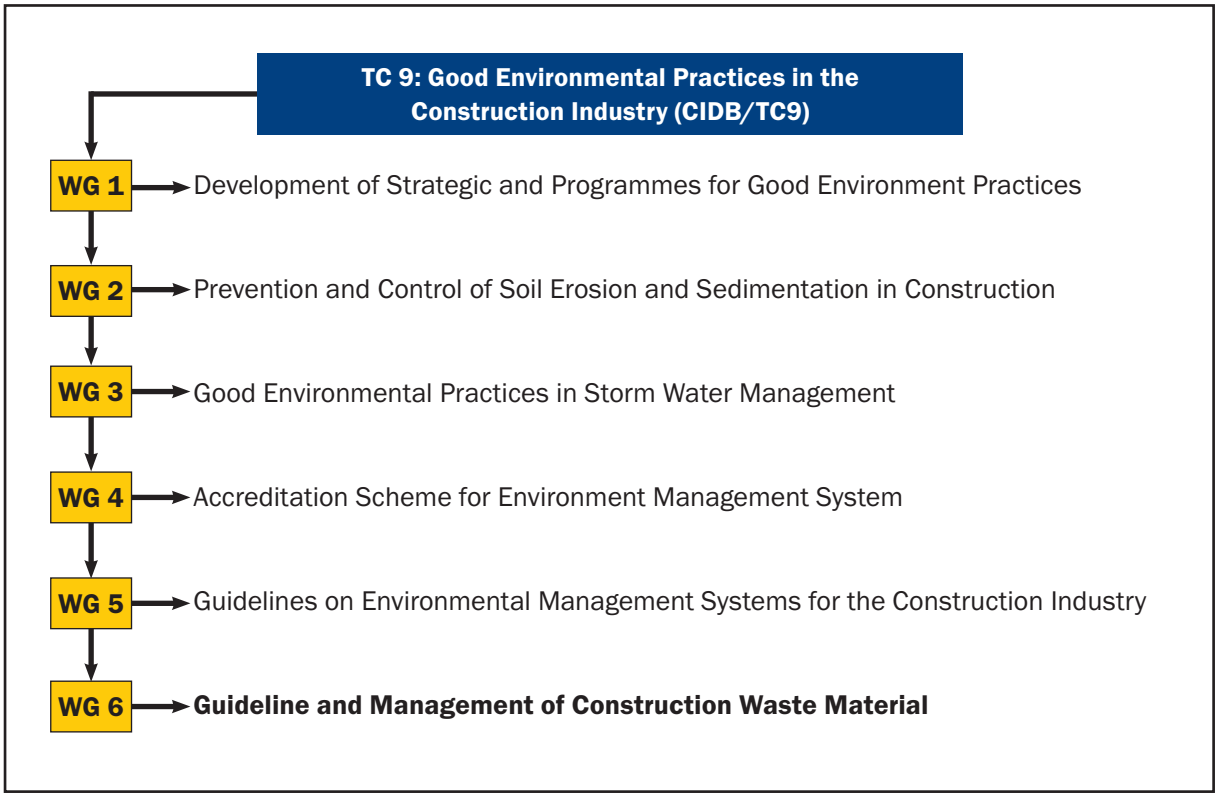

Figure 2: Strategic Recommendation Working Group under Technical Committee 9 (CIDB/TC9) (Zuhairi Abd. Hamid, Ghani, Zain, Kamar, & Rahim, 2009)

Figure 3: A hierarchy of waste management

for collection services, duties of licensees for the transfer station, duties of licensees for transportation services by long-haulage and duties of licensees for treatment and disposal facilities. As stated by the Act and regulations, all the employees in construction industry must be properly trained in all aspects of managing waste. The Environmental Preservation and Innovation Centre (EPIC) with CIDB and CREAM has established extensive training programmes covering construction and demolition waste management and sustainability.

In addition to this, a Technical Committee 9 (TC9), which focuses on Good Environmental Practices in the Construction Industry has been established by CIDB to further enhance good environmental practices. The committee includes environmental experts from Government agencies, professional bodies, academia and construction related associations. TC9 is responsible for identifying, preparing and developing the Construction Industry Standards (CIS) and Good Environmental Practices in Construction Industry. TC9 executes its mandate through the establishment of Working Groups (WG) as stipulated in Figure 2. In this programme, WG 6 focuses on managing construction waste and has published Guidelines on Construction Waste Management (CIDB Malaysia, 2008b) and Construction Industry Good Practices Series – Construction Waste Management (CIDB Malaysia, 2008a). The aims of the guidelines and good practices are as below:

a) To establish proper construction waste management practice in the country
b) To identify roles and responsibilities of construction industry players
c) To provide guidance on waste management plans; and
d) To list legislation requirement associated to waste management.

Waste Hierarchy

The essential element in ensuring sustainable waste management is a good waste management hierarchy, recognised as the best option with less impact on the environment and providing benefits for the economy. Figure 3 shows the

Table 3: Comparison of reduce, reused, recycle and recover

Reduce	• Where possible stop waste coming on-site in the first place. • This can be achieved by ordering only quantities which are required and communicating to manufacturers to order size-specific items which do not require cutting to size.
Reused	• The next option should always be to consider whether the materials can be reused, either on-site or by someone else. • Items such as timber, tiles and bricks are often easily re-used. Packaging items such as pallets and crates may also be collected by the supplier for re-use elsewhere.
Recycle	• This option is for all materials which cannot be reduced or reused. • It involves processing the waste material, for example, crushing concrete to transform into aggregate or melting metal or glass to form new products. • Some recycling can be carried out on-site, but often the waste must be sent to an off-site recycling company for processing. • Segregation of wastes to prevent contamination is important for recycling to ensure that skips are not rejected by the waste contractor.

Recover	• Most construction materials can be recovered with the right recycling equipment, such as trash compactors, shredders, crushers and balers.
	• Commonly recovered materials from construction projects include:
	  • Wood, brick and concrete
	  • Gypsum wallboard
	  • Steel (which is 100% recyclable), and other metals
	  • Asphalt paving and shingles
	  • Non-asphalt roofing and shingles
	  • Architectural salvage materials
	  • Material recovered from land clearing

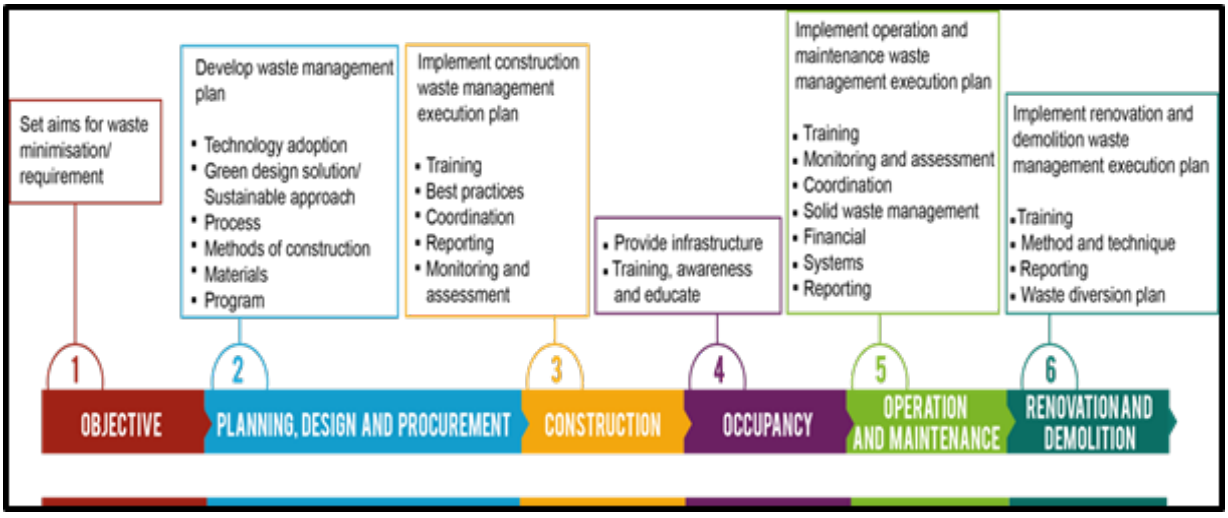

Figure 4: Systematic approach towards construction waste management through a building life cycle

waste management hierarchy based on priority actions. The top priority of any waste management hierarchy is the prevention and implementation of the 3R system; 'reduce', 'reuse', and 'recycle', followed by 'other recovery systems' with the lowest priority being 'disposal' that includes landfilling and incineration. An explanation of each functional component in Figure 3 is described in Table 3.

Construction Waste Management Life Cycle

A closed-loop approach to sustainable construction waste management can provide value at every phase of a building life cycle. Figure 4 shows a systematic process for construction waste management based on this approach. Waste management is discussed according to a 'cradle to cradle' approach.

Phase 1: Objective

Developing the waste management plan, setting up the waste management policy and establishing good work practices in construction waste management need to be introduced at the outset of a project. Proactive waste management plans begin with setting specific objectives by the project owner or client and being understood by the project team. The main objectives in achieving an effective waste management plan must be clear and should be included in the project brief prepared by the owner.

Phase 2: Planning, design and procurement

Requirements set by the owner or client will create a key opportunity to consider and implement the waste minimisation plan. The project team must be able to deliver what is stated in the project brief. An over-arching strategy to achieve waste minimisation begins during programming and planning. The involvement of the project team at early phase is crucial to ensure the waste management plan can be sustained throughout the building life cycle. The selected consultants are the persons who have sound environmental policies or in-house best practice documents.

Phase 3: Construction

The construction phase of a project generates the most impact in minimising waste produced at construction sites. The waste management plan developed during early phase must be adopted on site. Policies with regard to waste management on site include monitoring and record keeping of wastes leaving the site which must be formulated and reviewed periodically in light of developments arising during construction. Designated locations where wastes are dumped in separate compartments make them readily available for recycling as less effort is needed to separate wastes than if they are indiscriminately dumped. Policies on packaging materials can drastically reduce the amount of waste generated on site, if packing materials are taken back by the material supplier, either for final disposal of for reuse or recycling. Contractors should be encouraged to develop and propose new methods of construction in order to reduce the production of waste. Meetings and reports regarding waste management and minimisation on site should be held every week or every month, depending on the involvement of the contractor, the contractor and the consultant or all parties involved in the project. Training for workers and supervisors on sites should be systematically scheduled to ensure that they are aware of and implement the waste management plan. Incentives or awards should be given to employees or sub-contractors who best achieve specified waste minimisation objectives. On the contrary, if employees or sub-contractors fail to comply with the waste minimisation policies, then a penalty should be imposed.

Phase 4: Occupancy

Management of solid waste generated during occupancy needs to emphasise more on environmental solutions to achieve and maintain long term sustainability goals. The project team should design the building with efficient waste management systems based on the building type, geography, occupancy and other special circumstances of each individual building and its occupants. Currently, several green rating tools such as the Green Building Index (GBI), Green RE, the Malaysia Carbon Reduction and Environmental Sustainability Tool (MyCREST) can be used as reference in managing waste during occupancy.

Phase 5: Operation and maintenance

Long term optimisation in the operation and maintenance of a completed building is an

important element in the waste management plan. However, the waste management plan developed at the design stage needs to be congruent with the construction waste management plan's execution, adopted and implemented by occupants and the operation and facilities maintenance team.

Phase 6: Renovation and demolition

Consideration of future waste generated during renovation and demolition works needs to be planned at an early stage. Future waste generated at this stage need to be managed properly with the aim of maximising potential usage and profit. It is important to identify the opportunities and actions that will divert waste materials from disposal. Therefore, a waste diversion plan needs to be discussed among professionals at the planning stage covering all possibilities of waste generated in the future.

Conclusion

The opportunities in managing construction waste throughout the building life cycle are intricately associated with many elements. Law enforcement in the first place is important to ensure construction waste management can be imposed as a requisite at an early phase. Integration between the multi-disciplinary stakeholders during the planning and design stage is crucial in managing a construction project. Building Information Modelling (BIM) is a tool that enables all the stakeholders to work in an integrated environment. BIM is capable of being used as a complete process for transferring sets of data to achieve interoperability throughout the building lifecycle. However, the development of guidelines, standards and best practices are necessary and should be considered to maximise the benefits of waste management. Public awareness and training are essential along with continuous monitoring and assessment of waste. This will indirectly decrease the amount of waste generated and provide a waste data bank for purposes such as benchmarking. ■

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