To what extent is Green Building Design involved in UAE Projects for avoiding construction waste?

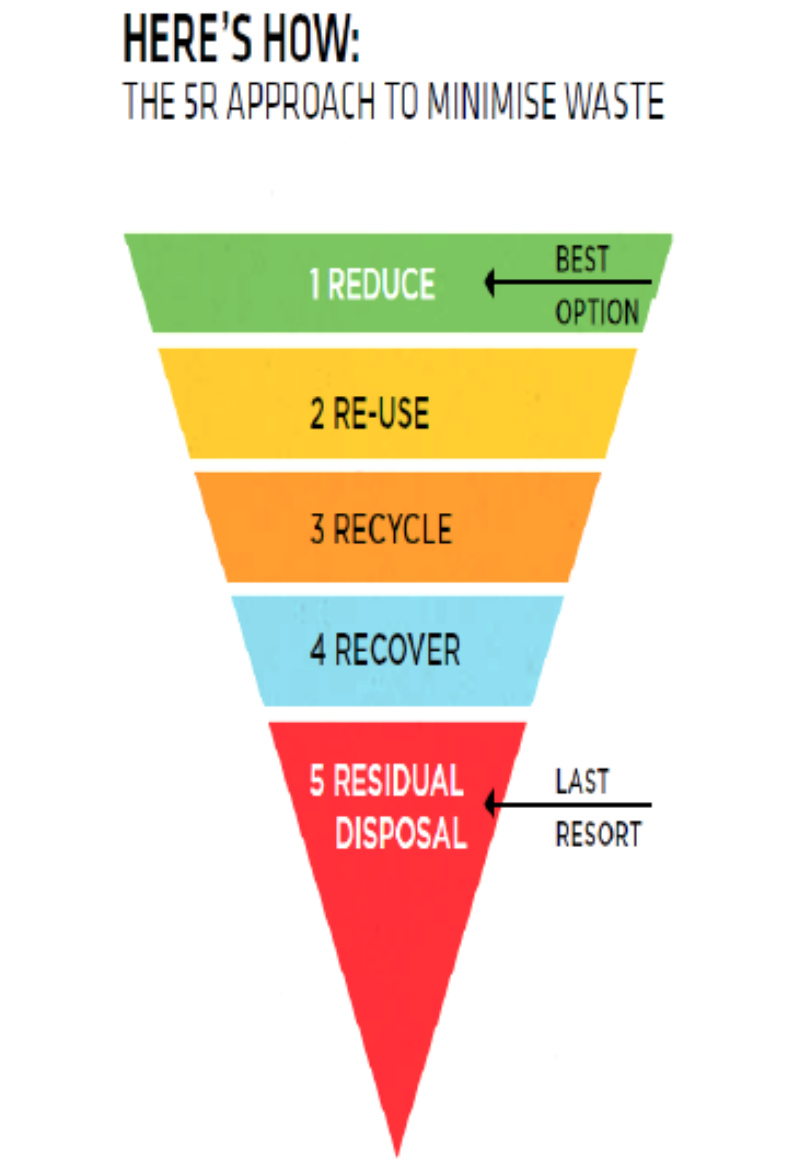
The United Arab Emirates' construction industry is around 40 years old and is one of the significant sectors in the world, with 54 - 75% of all UAE waste generated from construction activities being around six million tonnes per year. By ensuring the implementation of green building and sustainability concepts, principles and techniques, such as the "Designing out Waste" tool, this will assist the reduction in construction waste in UAE, as many other countries have done, such as the UK, USA and Australia.

UAE has introduced Green Building regulation since 2011; and focusing on waste reduction in order to avoid environmental pollution.

Introduction:

Types of construction waste divide into two principal groups; these are material waste and time waste, which are generated through direct and indirect processes. The future of construction is to minimize construction and time costs, to ten percent, annually, by reducing the project defects and eliminating waste to twenty percent per year.

With this in view, green building design and sustainability is to be adopted into designing construction projects, which are useful for overcoming the negative impact of construction waste, either on the environmental side or on the monetary side, by increasing energy efficiency, water conservation, material and resource management and construction waste management. The green design tools used in eliminating construction waste are such implements as; value engineering and management, the "Designing out Waste tool" (Figure 1.0), construction and demolition waste management plans and supply- chain management.



Use the SR waste hierarchy to priorities your waste minimisation options In order of priority, waste reduction (or prevention) is always the best option, followed by re-use then recycling & recovery and as a last resort residual disposal to a clean fill or landfill site.

Figure 1.0: Approach to minimise waste

Fundamentals of Green Building Design Principles:

Since the design stage is the essential initial step toward sustainability and the protection of the natural environment from any hazard threats from the construction industry (Figure 2.0), we should consider the following in order to avoid Construction Waste.

- At the options appraisal stage, consider with the client the opportunities to refurbish an existing asset (instead of redeveloping), to use existing space more efficiently, and to design new works to be flexible to future changes in needs.

- At an early design stage, forecast waste and identify the top opportunities for waste reduction and reuse on which to focus attention. In particular, consider use of in-situ materials (e.g. Through remediation and stabilisation), reprocessing of materials for reuse on site (e.g. demolition and excavation arisings; cut and fill balance), alternative design solutions, and off site construction.

- At a later design stage, focus attention on reducing wastage rates to good practice levels for the 5-10 most wasted products/ components in the waste forecast – for example by matching product and design dimensions, and standardize the choice of components across a project. Select materials and components with high durability.

- Seek early contractor involvement in identifying and vetting low waste solutions (where appropriate).

- Quantify the forecast waste and costs of waste, estimate the achievable cost savings from specific actions, and capture these in a Site Waste Management Plan “SWMP”, starting from the early design stage (e.g. RIBA Stage C or building projects).

- Include the waste/cost estimates and actions in the contractor tendering process, so that tender prices take account of design decisions and potential savings,

Adoption of BIM for Waste Management:

The adoption of BIM for improved collaboration for waste management needs to be considered and implemented at design stage. This use of BIM will assist in adequate collaboration and effective communication. In this regard, BIM plays a major role in ensuring that all stakeholders are actively involved in decision-making right from the conception of the building project through its entire lifecycle (Eadie et al., 2013a). The major benefit of adopting BIM for waste management is that it enables the creation of a federated model that could be assessed and updated by all the project team. The use of BIM will also engender design coordination, task harmonization, clash detection, and process monitoring of construction waste management activities.

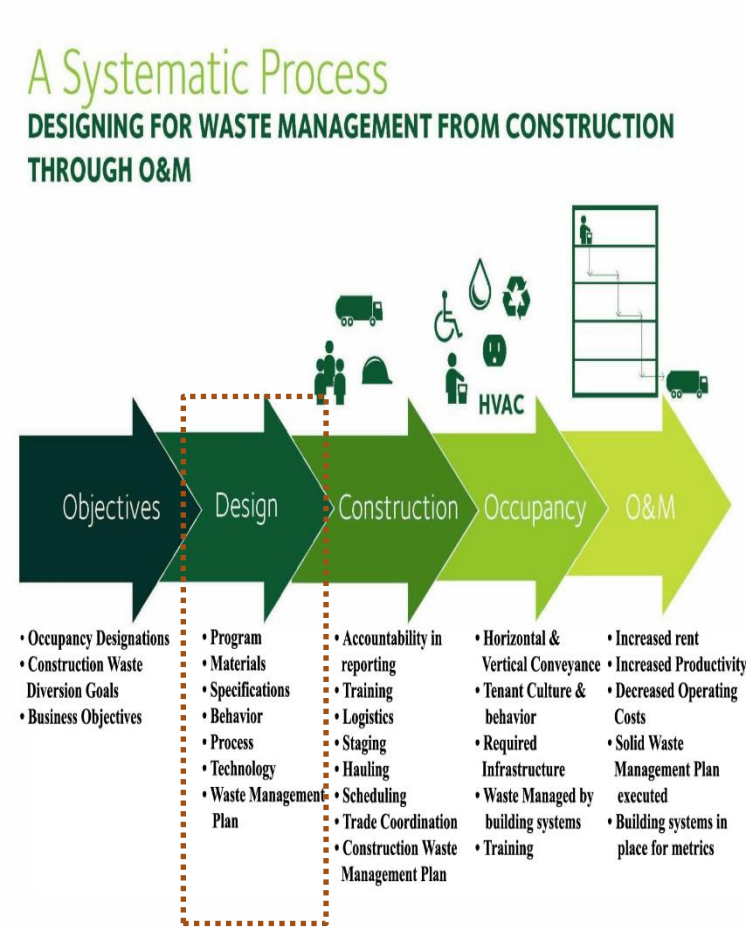


Figure 2.0 Systematic Processes (Design for Waste Management.

Causes and Types of Construction Waste

There are several reasons for the many wastes generated in the construction industry. These are related to; construction methodology and management; the architectural design and the specified material; working without a sequence steps and without planning. While significant amounts of waste are also produced because of inefficient design, incorrectly calculating the estimate for materials and quantities, design changes, poor storage, lack of skills and educations of workers and weak management and supervision. Table 1.0 lists the origins and causes of construction waste.

The types of construction waste divide into two principal groups; direct and indirect. The direct wastes are material wastes, which result from ordering incorrect quantities, producing more than is required, making wrong measurements and cutting, improper storage, manufacture errors and defects.

While the indirect wastes are come under the heading of time wastes, which comprise the waiting and stopping periods, variation orders and information, delay and not adhering to the planned activities, and shortages in equipment used.

Table 1.0: Origins and causes of construction waste (Dajadian & Koch, 2014) (Glass, J., Osmani, M., & Price, A., 2008)

Origins of Waste	Cause of Waste
Contractual	· Errors contract documents · Contract documents incomplete at commencement of construction
Design	· Design changes · Design and construction detail errors · Unclear unsuitable specification · Poor coordination and communication (late information, last minute client requirements, slow revision and distribution)
Procurement	· Ordering errors (i.e., ordering items not in compliance with specification) · Over all owances (i.e., difficulties to order small quantities) · Supplier errors
Transportation	· Damage during transportation · Insufficient protection during unloading · Inefficient methods of unloading
On Site Management & Planning	· Lack of on-site waste management plans · Improper planning for required quantities · Lack of on-site material control · Lack of supervision
Material Storage	· Inappropriate site storage space leading to damage or deterioration · Improper storing methods · Materials stored far away from point of application
Material Handling	· Materials supplied in loose form · On-site transportation methods from storage to the point of application · Inadequate material handling
Site Operation	· Accidents due to negligence · Equipment malfunction · Poor craftsmanship · Time pressure
Residual	· Waste from application processes (i.e., over – preparation of mortar) · Packaging
Other	· Weather · Vandalism

The various studies and research have estimated that 33% of construction waste enters into a project as the design stage, when the architect designers do not consider the implementation of waste reduction and minimization benefits as part of the designing of the project. On this point, the adopting of green building design and sustainability into the designing of the construction projects is useful for overcoming the negative impact of construction wastes, whether on the environmental side or on the monetary side, through the efficient use of energy, water conservation, material and resource management and construction waste management (USGBC, n.d.).

"Designing out Waste" Tool for Minimizing Construction Waste

The tool used in eliminating construction waste during the design stage is the designing out waste tool. This is a technique for minimizing waste by avoiding, eliminating and reducing waste at the earliest stage and at the resources for construction stage, during which the tool will be used by the design team to identify a waste reduction action plan (Figure 3.0) that will be implemented in the design stage and right up to last stage in the project life cycle (Dajadian & Koch, 2014).The designing out waste tool is achieved by conducting many workshops and brainstorming sessions, involving professionals and a team of experts from different design and construction disciplines.

Figure 3.0 Step for applying the design out waste in projects

This is based on five principles are listed below:

1. Design for Re-use and Recovery, by using the existing available materials generated from the existing building, recycling the waste or debris of the present materials on site and utilizing this asset to design and build the new project, such as adopting the principle that "Waste Equals Food". If reusable materials are not available, the designer is better to use 'new' materials that contain a high level of recycled material. This is achieved by conducting the site analysis and by making a visit to the site prior to the start of the designing stage.
2. The benefit of Design Off Site Construction and the trend toward prefabricated construction that plays an essential role in reducing waste also enhances the construction performance, as mentioned in the Egan Rethinking Report; off-site manufacture and prefabrication range from modern timber and light gauge steel framing systems, tunnel form concrete casting and pre- caste concrete, through to modular and volumetric forms of construction.
3. Design for Materials Optimization means using a design approach that considers the materials resource efficiency, while less material is used in the design, less waste is produced in the construction stage, without compromising the design concept or the project needs, by focusing on three significant activities: minimization of excavation, simplification and standardization of materials, and component choices and dimensional coordination.

4. Design for Waste Efficient Procurement is achieved by setting clear contractual clauses, prior to the formal appointment of a contractor, to the effect that this contractor should work in an environmentally friendly manner and have a good understanding of the concept of waste reduction. In this way, designers are able to sequence the effects of the construction waste generated and work with the contractor efficiently.
5. Design for Deconstruction and Flexibility focuses on using and understanding the life cycle of the materials used and how long they can be re-used, recycled or reduced during the building life cycle and maintenance. This is achieved by involving the materials scientists in the process of selecting materials, during the design stage.

Case Study: Hospitality Project

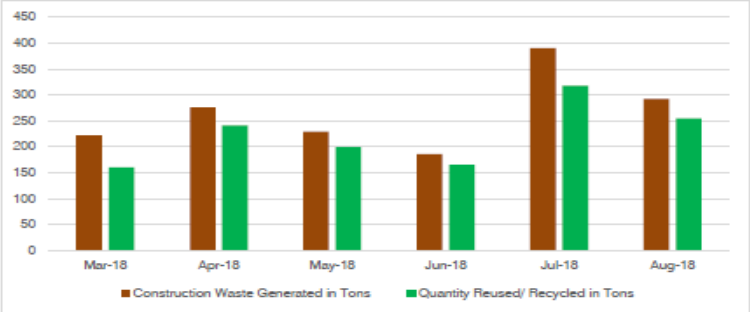
A study was carried out on the waste percentage one of the largest hospitality projects in Dubai with total BUA 70,000 m2.

The result showed that the current waste recycling rate is 84 % as reflected in (Table 2.0, Figure 4.0) which is meeting the Green building objective.

Table 2.0: Waste Management Summary

Month	Quantity of Construction Waste		
	Generated	Reused/Recycled	Percentage
March 2018	220.00	160.00	72.73%
April 2018	275.95	240.95	87.32%
May 2018	228.93	198.93	88.90%
June 2018	185.23	165.23	89.20%
July 2018	390.00	318.00	81.54%
August 2018	292.43	254.73	87.11%
Total	**1592.54**	**1337.84**	**84.0%**

Figure 4.0: Waste diverted from Landfills



Conclusion:

UAE construction industry is growing year after year, which can lead to large volumes of construction waste if not monitored, controlled or minimized through the design and construction process. The government bodies have been proactive in their approach to minimize construction waste by issuing various guidelines and regulations for the construction industry to follow, some as addressed below:

A. **Target Zero Construction Waste at Design Stage**

B. **Segregate Waste for re-use.**

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