Scientific Research

The Effect of Sustainable use of materials for construction

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Abstract

The choice of materials for a project requires considerations of aesthetic appeal and initial and ongoing costs, life cycle assessment considerations (such as material performance, availability and impact on the environment) and the ability to reuse, recycle or dispose of the material at the end of its life. Materials must be used sustainably – this means the present use will not compromise future use by running out or harming the environment at any time. Few materials fully meet these criteria. The aim when selecting materials should therefore be to use (materials from renewable or replaceable sources, recycled materials, materials that are in plentiful supply, materials with a lower environmental impact across their whole life cycle).

Keywords: Building Materials, Sustainability, Materials Life Cycle, reuse, recycling. Waist.

Introduction

The selection of building Materials for used to be based on economic and technical considerations, beside the planned life span of a facility and the requirements and codes it must meet. With the rapid development in the field of construction industry and the continuing need to use modern technologies in the construction of buildings, there is a need for a new way for selecting building materials depends on sustainability criteria to ensure optimal use of available resources. Hence the importance of this research to propose a new direction in the selection of building materials based on gathering the environmental, technical, economic, and social criteria into an index used to compare between material alternatives.

Construction performs an essential role in developing the basis infrastructure of the country. Nevertheless, the troublesome faced by the industry is the waste of construction material. Construction activities create extra waste Construction materials characterize as a major cost element of a civil engineering structure. The cost of construction materials could be more than 65% of the entire budget, acquired from the building of a Civil Engineering structure. Though, it is founded upon the kind of project, the construction method, technique, and the plant used.

Building industry practitioners have begun to pay attention to controlling and correcting the environmental damage due to their activities. Architects, designers, engineers and others involved in the building process have a unique opportunity to reduce environmental impact through the implementation of sustainability objectives at the design development stage of a building project. While current sustainability initiatives, strategies and processes focus on wider global aspirations and strategic objectives, they are noticeably weak in addressing micro-level (project specific level) integrated decision-making. Paradoxically, it is precisely at the micro-levels that sustainability objectives have to be translated into concrete practical actions, by using a holistic approach to facilitate decision making. Although new technologies such as Building Research Establishment Environmental Assessment Method (BREEAM), Building for Environmental and Economic Sustainability (BEES), Leadership in Energy and Environmental Design (LEED) etc., are constantly being developed and updated to complement current practices in creating sustainable structures, the common objective is that buildings are designed to reduce the overall impact of the built environment on human health and the natural environment (Ltd, BRANZ). This paper therefore compliments existing research in the field of sustainability by reporting the development a conceptual framework for implementing sustainability objectives at the project-specific level in the building industry from a life-cycle perspective. The framework contributes to the industry and sustainability research by demonstrating the scale of the issues involved, beginning with an assessment of the environmental challenges the industry faces. It puts forward strategies and methods to mitigate the environmental impacts of construction activities, thereby facilitating the sustainability of building projects.

1. Building Materials and Sustainability

Building materials have a basic role in achieving sustainability of buildings. They also participate in the economic growth. The use of construction materials affects the environment in many ways, basically due to the big consumption of the non-renewable resources and the amount of waste and pollutants that are generated through the life cycle of materials. In general, construction stakeholders began to recognize the importance of controlling the environmental impacts caused from construction industry. Selecting construction materials has got big attention to be improved so that the sustainability suitability of materials is considered while in fact factors like cost, availability and appearance were more efficient in the selection process of materials (Hammadi Mohsin & Sahib Ellk, 2018).

sustainable building materials are materials that "respect the limitations of non-renewable resources, work within the pattern of nature's cycles and inter-relationships of ecosystems, are non-toxic, are energy and water efficient, are made from recycled materials and are themselves recyclable". "Sustainable products may not necessarily be manufactured from sustainable materials. For example, low-e glass is considered a sustainable product because it reduces building heat gain. However, float glass is considered a sustainable material because it is highly recyclable unlike low-e glass, which is not, or is poorly, recyclable".

Another opinion supposes that "sustainability represents a system not a material or product and there are no sustainable materials but materials that are used sustainably. We may create outstanding environmentally preferable materials, but if we do not use them in a way that supports their use in line with sustainability principles (if wastes cannot become food for future materials for example), we fail" (Al-geelawee & Mohsin, 2016).

2. Environmental Impact of Construction

The construction industry considered one of the most resource-intensive industries. There is a growing Concern about the effects of building activities on human and environmental health. There is no doubt that there is an urgent need to make the construction environment more sustainable The effects of Construction activities on the environment are throughout the life cycle of a construction project. Life-cycle concept refers to all activities from extraction of resources through product manufacture and use and final disposal or recycle, i.e. from “cradle to grave” Generally construction buildings affect the environment in two main ways by consuming resources and creating pollutants and wastes (Ali & Hamadameen, 2020).

2.1 Resource Consumption

The physical environment principally linked to the construction sector by the demands made by the construction sector on global natural resources, and this assumes huge environmental significance with the rapid growth in global population and the attendant implications for natural resources.

This is especially the case with housing and infrastructure, which are very resource-intensive. The call for sustainable construction is in realizing the construction industry's capacity to make a significant contribution to environmental sustainability because of the huge demands it exerts on global resources **(**Terry, Alison, and others, 2009)**.**

2.2 generation of Pollution

Pollutants are produced during different phases of construction in many forms. Pitt defined Pollution from construction as "particles, noise, vibration and vaporous discharges” The construction industry considered as the biggest effector on the environment due to the quantities of materials it uses in construction. Environmental effects caused by building materials are resulted from raw materials extraction which contributes in pollutants accumulation to the atmosphere.

Also materials production and transportation as well as site activities release Dust and other emissions include some toxic substances which causing a serious threat to the natural environment (Hammadi Mohsin & Sahib Ellk, 2018)**.**

2.3 Waste Generation

The construction industry has been characterized as one that produces the highest amount of solid waste among all industries. Waste incurs additional cost either through it being carted away, or that which results from the actual rework.

Waste results from the production, transportation and use of materials According to the economic nature of the building industry, every stage of the construction period is minimized. In addition, time and quality are critical and virgin materials are considered superior to second hand products for these reasons alone Screening, checking and handling construction waste for recycling are time consuming activities and the lack of environmental awareness amongst building professionals may create significant barriers to the usefulness of recycling (Al-geelawee & Mohsin, 2017).

Most construction waste is unnecessary many construction and demolition materials have a high potential for recovery and reuse, implementing a waste management plan during the planning and design stages can reduce waste on-site by 15 percent, with 43 percent less waste going to the landfill through recycling, and it delivers cost savings of up to 50 percent on waste handling (Terry, Alison, and others, 2009).

Reuse: Materials that can be reused after the useful life of the building will reduce the need for new materials to be produced in the future. How materials are installed and fixed can have an effect on the ability to reuse them, so the shorter the expected life of the building, the greater should be the reliance on screw or bolt fixing rather than adhesive and other permanent fixings.

Recycling: Materials that can be recycled will reduce the need for new materials to be produced, and the energy required to reconstitute materials is generally much less than required for new production.

Waste disposal: Building design and site management should aim to minimise waste, thereby reducing waste disposal and the release of pollutants. The impact of the disposal of materials at the end of their serviceable life must be considered.

2.4 Energy Consumption

Construction industry consumes energy at each phase of its life-cycle. Energy is consumed during Material production, construction phase, and the operation of a completed building for heating, lighting, power and ventilation. Many techniques may be used to improve energy performance in construction building such as using insulation methods and development of an advanced energy monitoring and control (Al-geelawee & Mohsin, 2016).

3.Benefits of Using Sustainable Building Materials

selecting sustainable material can be one of the most difficult duties to be done in a construction project. Partially, this can be because: (Hammadi Mohsin & Sahib Ellk, 2018)

1. A Construction project involves various products that needed to be evaluated

2. Assessment parameters can vary according to material categories and manufactured countries

3. There is lack of sufficient information about manufacturing processes.

4. There is no agreed method to evaluate materials and products universally.

Despite that, using sustainable products for buildings can be useful to the triple bottom (TBL) which explained in figure (1), for many reasons:

1. In environmental term, using sustainable materials can reduce the environmental impacts of construction industry.

2. Economically, the use of sustainable products can reduce the operation costs.

3. Socially, using sustainable products and materials can improve the well-being of building occupiers and protect the natural environment

Figure (2): TBL description (Hammadi Mohsin & Sahib Ellk, 2018)

4. Materials Life Cycle

Materials affect the environment severely through its life cycle from "extraction of row materials through processing, manufacturing, using and demolition".

An ideal life cycle of a material is explained in Figure (2). At each step of the life cycle there is energy and resources consumption, and waste and pollutants generation to the environment. Yet, transporting materials require transport during their life cycle require more energy and produces more emission to the atmosphere. Environmental impacts of materials can be reduced through the recycling and reusing of materials which will reduce the need for manufacturing new materials (Terry, Alison, and others, 2009).

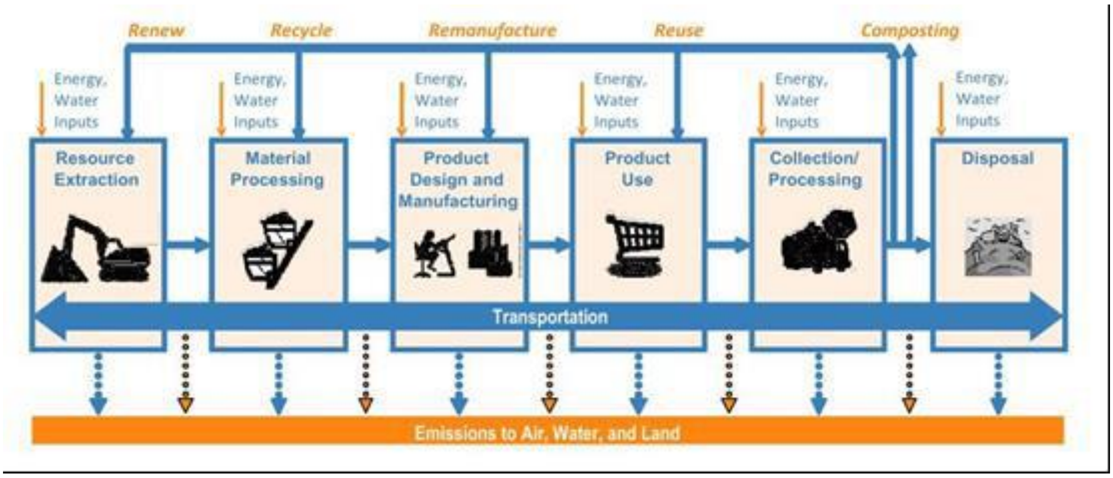

Figure (2): the life cycle of materials(Al-geelawee & Mohsin, 2016)

5.The importance of building material for a construction project

Materials constitute a considerable proportion of a project total cost. It is ranged between (20-50%) according to some studies. Others indicated that materials proportion of a project total cost can increase up to (60%) sometimes. In Iraq building and construction sector considered one of the most important sectors to the national economy. It plays a major role in the preparation of GDP (gross domestic product) and employment and providing the key indicators of national accounts. According to Central Statistical Organization in Iraq (CSO), the value of building materials that was actually used in building and construction during 2013 accounted (69.7%) from the total cost of building and construction projects. Materials are pivotal in any type of industries. building materials can affect a construction project in two ways:

1. Shortage or unavailability of materials can interrupt or even stop the work in the project which will cause extra costs due to the delay.

2. Too much quantities of materials can cause serious problems, thus it increases the cost of storing and handling materials(Al-geelawee & Mohsin, 2016).

6.Protecting Physical Resources

Protecting physical resources is one of the most important principles of sustainable design and construction. Consideration must be given to design that incorporate building resilience against natural and man-made disasters such as fire incident, earthquake, flooding and crime attack. Hazard mitigation planning is the process of determining how to reduce or eliminate the loss of life and property damage and the methods to achieve these tasks are as follows (Akadiri et al., 2012).

1. Plan for Fire Protection. The most crucial aspect of a building's safety involves a systems approach that enables the designer to analyse all of the building's components as a total building fire safety system package. As buildings become more complex and architects push

the design envelope ever further, it is vital to consider fire safety implications of new buildings or other construction or refurbishment projects at the concept design stage. An important precondition is that its fire safety facilities enable independent and adequate fire response performances by the building's occupants. The consideration of Fire Stopping and Passive Fire Protection measures are vital to the stability and integrity of a building or structure in case of fire. A fire strategy will only achieve maximum effectiveness if the passive fire protection measures, such as insulated fire-resisting partitions, cavity barriers, specialist fire-stopping of gaps in structure with their proven fire performance properties, are built into the fabric of a building. Passive fire protection not only maintains the stability of a building's structure during fire, they provide stability and separate the building into areas of manageable risk (Fire Compartments). These are designed to keeps escape routes safe and helps isolate and limit fire, heat, heat, and smoke allowing the occupants to escape and the fire fighters to do their job safely. Such protection is either provided by the materials from which the buildings was constructed or, have been added to reinstate or establish the fire integrity.

2. Resist Natural Hazards. Recent natural and human-induced events have highlighted the fragility and vulnerability of the built environment to disasters. In most of these cases, occupants are left to pay for the recovery effort, including repairing damaged buildings and infrastructure, from the impacts of hurricanes, floods, earthquakes, tornados, blizzards, and other natural disasters. Hazard resistance methods should be an important project design requirement in the same way that environmental considerations are now integral parts of project documents. For example, flood mitigation techniques include elevating buildings above floor levels in flood prone areas; making buildings watertight to prevent water entry, incorporation of levees and floodwalls into site design to keep water away from the building. Adding retrofitting techniques such as Ferro-cement veneer, vertical corner reinforcement embedded in mortar and introducing tie beams and adding buttress to brick masonry and mud-wall housing will also go a long way in protecting against natural hazards. For details of other hazards preventions methods, the reader is referred to Whole Building Design Guide by the National Institute of Building Sciences.

3. Crime prevention through architectural Design has emerged worldwide as one of the most promising and currently effective approaches to reducing opportunities for crime. The basic tenet of crime prevention through design in building is that proper design and effective use of the built environment can reduce the fear and incidence of crime and thereby improve the overall quality of life. Effective secure building design involves implementing countermeasures to deter, detect, delay, and respond to attacks from human aggressors. It also provides for mitigating measures to limit hazards to prevent catastrophic damage and provide resiliency should an attack occur. Crime prevention methods emphasize the following three design approaches: natural access control; natural surveillance; and territorial behaviour [89]. Access control uses doors, shrubs, fences, gates, and other physical design elements to discourage access to an area by all but its intended users. Surveillance is achieved by placing windows in locations that allow intended users to see or be seen while ensuring that intruders will be observed as well. Surveillance is enhanced by providing adequate lighting and landscaping that allow for unobstructed views. Finally, territory is defined by sidewalks, landscaping, porches, and other elements that establish the boundaries between public and private areas. These three methods work together to create an environment in which people feel safe to live, work, travel, or visit.

3-Conclusion:

Sustainable building is considered as a way for the building industry to move towards protecting the environment. The promotion of sustainable building practices is to pursue a balance among economic, social, and environmental performance in implementing construction projects. If we accept this, the link between sustainable development and construction becomes clear; construction is of high economic significance and has strong environmental and social impacts. With the growing awareness on environmental protection, this issue has gained wider attention from construction practitioners worldwide. Implementing sustainable building construction practices has been advocated as a way forward in fostering economic advancement in the building industry while minimizing impact on the environment. In order to reduce these detrimental impacts of construction on the environment and to achieve sustainability in the industry, three principles emerge: resource efficiency, cost efficiency and design for human adaptation. They form framework for integrating sustainability principles into construction projects right from the conceptual stage.

The sustainability requirements are to a greater or lesser extent interrelated. The challenge foreigners are to bring together these different sustainability requirements in innovative ways. The new design approach must recognize the impacts of every design choice on the natural and cultural resources of the local, regional and global environments. These sustainability requirements will be applicable throughout the different stages of the building life cycle, from its design, during its useful life, up until management of the building waste in the demolition stage. This framework lays the groundwork for the development of a decision support tool to help improve the decision making process in implementing sustainability in building projects.

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