

# Architecting a Sustainable Tomorrow: Principles of Green Building Design

Hamza Ali Chowdhry  
The Total Office

**Abstract:-** The concept of sustainability became a predominant part of modern society by the end of the twentieth century. As in many other fields, sustainability has also become a vital component in architecture.

Sustainable architecture is the perfect blend of aesthetics and ecology, creating resource-efficient structures that benefit the overall well-being of their inhabitants. Sustainable design can significantly enhance the quality of life for individuals who reside within these buildings and, more importantly, it can have a profound impact on the environment (Ugreen).

The term 'sustainable architecture' places a strong emphasis on the latter, with a primary focus on the discipline itself and the products that result from it. The definition of sustainability centers around two crucial factors: the fundamental 'needs'—such as food, shelter, and clothing—and the other 'needs' that enable individuals to lead ethical and comfortable lives (Terry Williamson et al., 2003).

**Keywords:-** Sustainable Architecture, Sustainability, Principles, Healthy Built Environment, Ecology, Sustainable Development, Architecture.

## I. INTRODUCTION

Historically, conventional architecture adhered to a linear model, which essentially transformed valuable resources, such as fresh air, energy from fossil fuels, and clean water, into detrimental elements like stale air, smoke, noise, and environmental pollutants. This conventional approach paved the way for a new wave of construction planning (Lanyi, 2007).

The concept of sustainability, which first appeared in 1972, has undergone various interpretations and applications. Thirty scientists initially used the term to advocate for smaller, de-industrialized communities as a means to improve the quality of life. Among the numerous definitions, Bruntland's stands out: "to meet the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987).

Since the onset of the twenty-first century and the era of globalization, cultural and ethical dimensions of sustainability have permeated virtually every aspect of daily life, including architecture. Rapid development has given rise to concerns about the greenhouse effect, a consequence

of excessive carbon dioxide emissions resulting from the overconsumption of fossil fuels. What may not have been immediately apparent was that globalization and global warming became intertwined due to the overconsumption of industrialized society (Keeney Frampton, 2020). As both Daly Cobb and Max-Neef have articulated, economic growth in developed countries is no longer intrinsically linked to increased well-being.

The Department of Trade and Industry has laid out a set of action themes for the construction industry, emphasizing design for minimum waste, lean construction practices, energy efficiency in construction and use, environmental preservation, biodiversity conservation, water resource conservation, community respect, and comprehensive monitoring and reporting.

Sustainability should not be viewed merely as an academic or professional pursuit; instead, it should be embraced as a way of life that influences every facet of individual behavior and decision-making.

## II. PRINCIPLES OF SUSTAINABLE ARCHITECTURE

The Royal Institute of British Architects has identified key parameters that define sustainable design, categorizing them into six main groups: land and ecology, community, health, materials, energy, and water. Each of these categories outlines specific procedures for achieving optimal benefits. For example, within the land and ecology category, you'll find a range of activities such as the use of brownfield sites, the reuse of existing buildings, considerations for appropriate density, investment in landscaping, and more (Paola Sassi, 2006).

In the pursuit of sustainable architecture, two overarching goals have been proposed. The first goal centers on minimizing the environmental impact of construction, while the second emphasizes the positive and appropriate contributions that buildings should make to the social environment (Ibid). Sustainability, a subject of paramount importance to humanity, bears the responsibility of preserving our planet. Sustainable and eco-friendly architecture represents a significant step toward achieving a better existence (Mahdavejad, 2014).

Green architecture offers a host of benefits, including environmental, social, and economic advantages. Environmentally, it aids in reducing pollution, conserving natural resources, and preventing environmental

degradation. Economically, it lowers operational costs for water and energy, simultaneously enhancing the productivity and well-being of those who occupy these spaces (Thomas, 2009). Moreover, green buildings are designed not only for functionality but also with aesthetics in mind, all while minimizing their impact on local infrastructure, thus contributing to social improvement.

The principles of sustainable architecture can be distilled into five major elements: sustainable site design, water conservation and quality, energy and environment, indoor environmental quality, and the conservation of materials and resources. As demonstrated throughout this research, water plays a pivotal role not only in sustaining life on Earth but also in realizing the concept of sustainability in architecture. Water protection and conservation can be achieved throughout a building's life cycle, through practices like dual plumbing for water recycling in toilet flushing or employing rainwater for vehicle washing (Stephen & Harrell, 2008).

Natural building methods stand as an approach to achieving sustainability, focusing on durability and the use of minimally processed materials. Natural constructions prioritize durability and promote the utilization of renewable resources, recycled materials, and salvaged components. As Michael G. Smith suggests, local ecology, which reflects the relationship between the building site and the needs and values of the builders and users, becomes a guiding principle.

Green construction often relies on renewable resources and is hailed as ecologically responsible due to its ability to estimate a product's life cycle. Additionally, green construction can lead to reduced maintenance and replacement costs while enhancing occupant health (Cullen, 2010). While it's true that ecological buildings may initially incur higher costs due to their recyclable qualities and expected longevity, long-term expenses are significantly lower thanks to energy and water efficiency (Lányi, 2007). Careful planning and professional guidance can mitigate these upfront costs, ultimately making ecological buildings a cost-effective choice.

### III. LOCAL AND GLOBAL IMPACT OF SUSTAINABLE ARCHITECTURE

As the world's population grows and technology usage continues to expand, the demand for housing has soared, leading to the creation of increasingly complex structures like the Burj Khalifa. Alarming statistics indicate that the building and construction sectors are responsible for approximately 50% of the ecological imbalance and significant environmental consequences (Muimi, 2018).

The fundamental contrast between traditional and sustainable architecture lies in their priorities. Traditional architecture primarily emphasizes cost, performance, and building quality. In contrast, sustainable architecture encompasses human and environmental needs while considering climate responsiveness. It revolves around

resource conservation, the reduction of environmental degradation, the creation of healthy built environments, and the design for human health, comfort, and overall well-being (Sev, 2008).

According to Ayasin Sev, the contributions of construction to sustainable architecture can be categorized into three key areas: resource management, life cycle design, and design for human well-being.

The construction sector plays a pivotal role in both local and global economies. In some regions, such as Kenya, up to 40% of the economy relies on construction activities, signifying a significant energy consumption (Melissa and Theresa, 2008). In summary, the core elements that must be conserved to achieve a fully efficient sustainable reality are energy, water, materials, and waste.

An exploration of the past, particularly in cultures deeply connected to nature, such as indigenous cultures, offers valuable insights into traditional building techniques, culturally sensitive architecture, and community involvement. Embracing traditional construction methods allows for the preservation of heritage while promoting sustainability. For instance, mud brick construction, when adapted for modern designs, can produce aesthetic results without relying on energy-intensive equipment.

Cultural sensitivities also play a crucial role. An example is the Royal Palace in Phnom Penh, which integrates traditional Khmer architecture and French colonial influences, creating a structure that symbolizes Cambodia's history and culture while incorporating modern sustainable design elements.

Furthermore, green building practices are essential for reducing environmental damage and fostering eco-friendly social environments (Constructive Voices, 2022)

In summary, sustainable architecture delivers significant benefits at both the local and global levels. Locally, it improves the quality of life by mitigating environmental risks and enhancing energy efficiency. Moreover, it promotes resource conservation, leading to improved management of non-renewable resources and positive impacts on the local economy.

On a global scale, the adoption of sustainable architecture practices creates healthier built environments and contributes to the conservation and protection of resources. This, in turn, preserves sensitive ecosystems, forests, and watersheds.

### IV. RESULTS

Sustainable architecture boasts numerous and critically important environmental benefits. Extensive research demonstrates that green buildings can substantially reduce energy consumption by 30-40% when compared to their traditional counterparts. Additionally, they can curtail water

usage by 20-30% and cut CO<sub>2</sub> emissions by up to 35% (Mariotti, 2023).

Defining a green building has become increasingly subjective, rendering the assessment of their efficiency a matter of judgment. The effectiveness of green buildings depends on their proper execution and the strategic integration of mechanical, electrical, and resourceful systems (Arup et al., 2014). To ensure their efficiency, various certification systems have been established, including BREEM, LEED, and Green Star.

In this article, we examine two buildings to illustrate why they are considered eco-friendly constructions. The first, the Ausgrid Learning Centre in Australia, has achieved a certified 6-star rating under the Green Star system. It excels in various categories, such as indoor air quality, energy efficiency, transportation, water efficiency, the use of restorable materials, and land utilization. The Air Change Effectiveness meets the criteria for at least 95% of the designated area. Peak energy demand is reduced by an impressive 30%. External lighting efficacy meets AS1158 requirements for 95% of outdoor spaces. The building adopts 25% less than the maximum local planning. Potable water consumption is remarkably reduced by 90%, and a commendable 90% of the steel in the project is either reused or post-consumer recyclable.

Another exemplary eco-friendly construction is the Sheikh Zayed Desert Learning Centre in the United Arab Emirates, certified with 5 pearls under the Estidama Rating System. This building excels in indoor air quality due to a meticulous management plan that mitigated air quality issues during the construction process. It achieves energy efficiency through the implementation of LED lighting, underground air-cooling, an active solar cooling system, adiabatic cooling towers, and a soil-air heat exchanger. The transportation aspect is characterized by accessible stairs, energy-efficient lifts, escalators, and travellers. However, the most significant aspect is water efficiency, which is successfully addressed through water monitoring and leak detection facilities. This is particularly vital in the UAE, given the region's acute emphasis on water conservation.

## V. CONCLUSION

The green building industry is rapidly expanding as more individuals and organizations actively seek ways to reduce their environmental impact. As this industry continues to grow, it becomes increasingly essential to stay informed about the latest developments in the field of sustainable architecture.

The demand for green buildings is surging, with approximately 37% of companies planning to invest in green construction for existing buildings and retrofitting projects. Projections indicate that the Green Building Industry is poised to experience a robust 5.5% Compound Annual Growth Rate (CAGR), with its market size

increasing from \$288.9 billion in 2021 to \$377.2 billion by 2026. This trend is underscored by the decisions of the two largest global economies.

In 2021, China boasted the world's largest green construction market, with a value exceeding 178 billion US dollars, while the United States had a market worth roughly 83 billion US dollars. This highlights China's industry leadership and underscores the significance of investing in green building technologies and infrastructure to further enhance the industry's value.

In 2020, the global building efficiency market recorded a substantial \$341.8 billion in sales, indicating significant growth in this sector.

Given the unprecedented challenges brought on by a growing global population and the widespread use of technology, environmental concerns are compounding rapidly. In this context, sustainable architecture emerges as a fundamental pillar for the future of our planet. As analyzed in this article, architecture plays a vital role not only in terms of the economy but, more importantly, in addressing demographic and environmental challenges. By prioritizing sustainable architecture, we can drive positive changes on a global scale, addressing climate change and enhancing local well-being, both physically and mentally.

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