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Literature Review for Green Architecture

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Abstract

Green architecture, or sustainable building, is a concept that focuses on designing and constructing structures that align with environmentally conscious principles. It aims to limit resource consumption, reduce environmental impact, and minimize waste from building components. Green design requires resources like electricity, fresh material, and water, but also generates significant amounts of waste. To create environmentally sustainable and resource-efficient structures, it is crucial to implement green building systems. This review paper examines the concept of green architecture and emphasizes the need for incorporating environmentally friendly building practices and materials to achieve environmental and climate-related advantages. By implementing green building systems, we can create more sustainable and environmentally friendly buildings.

Keywords: Green architecture, Building, Environment, Materials

INTRODUCTION

In order to construct environmentally friendly buildings, green architecture focuses on ideas like water features, natural building design, passive solar design, green building materials, and living architecture. By choosing materials with minimal carbon dioxide emissions, architects can alter the entire building process thanks to the sustainable application of these principles. Globally, there are green building standards available for nearly all building types, encompassing every stage of a building's life cycle from design to destruction. Green buildings must have common components, such as energy efficiency, water use, environmentally desirable materials, waste minimization, good indoor air quality, and sustainable development. Reducing pollution, conserving natural resources, stopping environmental degradation, lowering building operator costs, and increasing productivity are only a few of the economic, social, and environmental advantages of green architecture. Additionally, green buildings are designed to be beautiful and minimally strain on local infrastructure, promoting sustainable development.

GREEN ARCHITECTURE

Green architecture is a sustainable approach to building design that focuses on reducing negative impacts on human health and the environment (Roy, 2008) [20]. It involves using sustainable materials and eco-friendly construction methods to protect air, water, and soil quality. Green architecture encompasses principles of environmentally-friendly building across all categories and is widely accepted. The process begins with a comprehensive understanding of the site, incorporating the ecological approach to design (Burcu, 2015) [1]. This approach aims to incorporate the functions of the natural environment on-site, such as providing habitat, tracking sun movements, purifying air, and capturing, filtering, and storing water. (Thomas, 2009) [23]

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Designers can incorporate features that mimic the functioning of specific ecosystems, promoting biodiversity and maintaining a robust ecosystem in urbanized regions.

GREEN BUILDING MATERIALS

Materials for construction that are made of renewable resources rather than non-renewable ones are considered environmentally responsible. USGBC, 2002 [24] These materials are also environmentally responsible since their consequences are assessed over the product's lifetime. In addition, the use of environmentally friendly construction materials typically results in lower costs for maintenance and replacement throughout the course of the building's lifetime, as well as higher levels of energy conservation, improved occupant health, and increased productivity. An evaluation of characteristics such as reused and recycled content, zero or low off-gassing of harmful air carbon dioxide emissions, maximum or minimal toxicity, sustainably and rapidly renewable harvested materials, high recycling capacity, durability, longevity, and local production allows for the selection of environmentally friendly building materials (Cullen, 2010) [10]. Clay and sand are two elements that are consistently used in a wide variety of natural building styles. The mixture has the potential to make cob or adobe (comprised of clay blocks) when it is combined with water and, typically, straw or another fiber. Land (in the form of rammed earth or earth bag), wood, rice hulls, straw, bamboo, and stone are some of the other resources that are frequently utilized in natural architecture. The use of a wide range of recycled or reused non-toxic materials is widespread in natural architecture. Some examples of these materials are urbanite, which is salvaged pieces of discarded concrete, automobile windscreens, and other recovered glass. Approximately fifty percent of the world's population resides or goes to work in structures that are made of earth. Construction with straw bales is currently experiencing a surge in popularity, and numerous counties in the state of California have adopted the Straw Bale Building Code recently. As a result of its local availability, ease of use, absence of harmful components, greater energy efficiency, and aesthetic appeal, natural construction is favored in green building design from the National Association of Home Builders (NAOHB, 1998) [18]. Because of the significant adverse effects that they have on either the environment or people's health, many practitioners of this building style are increasingly avoiding the use of a number of additional materials. Nguyen, H.-T.; Gray (2016) [19]. These include wood that was harvested in an unsustainable manner, wood-preservatives that are toxic, mixes based on Portland cement, paints and other coatings that emit volatile organic compounds (VOCs), and certain plastics, PVC & those that contain harmful plasticizers or formulations that mimic hormones.

Need of the Study

Urban areas house almost 50% of the global population and support a significant amount of a country's crucial economic endeavors (Balaban, 2017) [7]. The dense clustering of economic activities and population in metropolitan areas exerts a significant impact on the environment. The substantial escalation in carbon dioxide emissions resulting from human activities has exacerbated the disparity between current emissions and the objective of mitigating global warming. In 2012, global carbon dioxide emissions reached a total of 35.6 billion tons. China accounted for 28% of these emissions, the United States for 16%, the European Union for 11%, and India for 7% (Li, 2014) [17]. Buildings are the most substantial artificial structures that significantly contribute to substantial levels of carbon emissions. Furthermore, buildings constitute the most substantial energy-consuming entity within a metropolis, representing 40% of the overall world energy consumption (Sandanayake, 2022) [21]. Hence, the pivotal factor in mitigating the impact on the environment, economy, and society, as well as achieving SDGs (sustainable development goals), is in minimizing life cycle carbon emissions and energy consumption of buildings. structure emissions primarily pertain to the release of greenhouse gases that occur due to the utilization of resources over the whole lifespan of a structure (Table 1). Consequently, these emissions might impact the everyday activities and occupations of the building's occupants. Even a marginal decrease in energy consumption and carbon emissions in buildings can impact the favorable and sustainable lifestyles of its occupants. Hence, it is imperative in modern times to thoroughly explore all potential avenues for mitigating the environmental, economic, and social consequences of buildings throughout their lifespan.

Table 1. Green building Vs sustainable building.

Green Building	**Sustainable Building**
Green design or construction focuses solely on the environmental aspects.	Sustainable building focuses on all three sustainability pillars: people, planet & profit.
Focuses solely on best design and construction practices keeping environment in mind.	Aims to improve the quality of life of the occupants and economic sustainability.
Uses materials that are sustainably sourced or recycled.	Uses materials that are locally sourced to support the local economy.

The concept of "green building" has been created to mitigate the environmental impacts of buildings during their entire lifespan. Green buildings possess greater commercial value in comparison to conventional buildings, owing to their perceived less carbon emissions, energy conservation, and optimized economic advantages across the entire lifespan (Sun, 2019) [22].

Hence, including green construction practices may become a compulsory aspect of future urban architectural projects, aiming to mitigate environmental consequences and optimize economic and social advantages (Addy, 2010) [5]. A green building is classified as a climate-resilient structure that utilizes suitable technologies to minimize energy usage. It also employs locally sourced recyclable construction materials to achieve cost efficiency. In addition, green refurbished buildings can also achieve significant advantages in terms of energy efficiency and reduction of carbon dioxide emissions (Chen, 2016) [8].

According to Ghaffarianhoseini (2013), [14] a green building is typically defined as a structure that supports ecological practices, conserves energy, and is sustainable. Still, there are a lot of differences in what constitutes a "green building." Chi, B.; Lu, W.; Ye, M.; Bao, Z.; Zhang, X (2020) [9] The term "green" is used, according to architects Paola Soleri and Ian Lennox McHarg, to emphasize the significance of human-centered and sustainable development, which aims to build a harmonious and mutually beneficial interaction between humans, architecture, and nature. The basic tenet of green building is that ecological systems and the surrounding environment are now considered from the outset of development. To avoid misunderstandings about the notion, a number of scholars have worked to define a green building precisely. Researchers typically identify a green building as either an intelligent structure or a sustainable construction. The book stressed how important it is to distinguish between the terms "green," "intelligent," and "sustainable." In order to minimize waste diversion to landfills, green building optimization strategies emphasize the use of renewable energy sources, passive building design technologies, and scientific waste management techniques. According to Du Plessis (2010), [12] sustainable construction is a complete design approach that places an emphasis on achieving a balance between economic, social, and environmental advantages over the course of the structure's lifetime. According to Dwaikat and Ali (2018), [3] the terms "green building" and "sustainable building" can be used interchangeably, depending on the context, goal, and size of the structure's design, operation and construction.

According to the USGBC, green building is an approach to construction that is appropriate for the times and will only become more significant. It is not just a trendy development style. Goh, B.H.; Sun, Y (2016) [4]

- *Coziness:* A well-designed passive solar house or structure has no drafts since it is extremely energy efficient. Compared to a typical house, it is more cheery and comfortable in the winter because to the extra sunlight coming from the south windows (Kats, 2006) [15].
- *The financial sector:* Passive solar building can reduce fuel costs and need not be more expensive than conventional construction if addressed throughout the planning phase (Kats, 2003) [15].
- *Visual appeal:* Although passive solar buildings might have a traditional exterior, their interiors

are light and airy thanks to these elements.

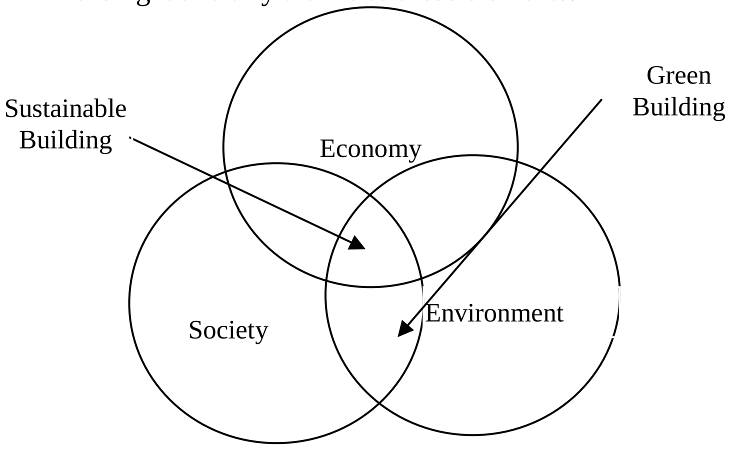

Figure 1. Roles of Sustainable and Green Building.

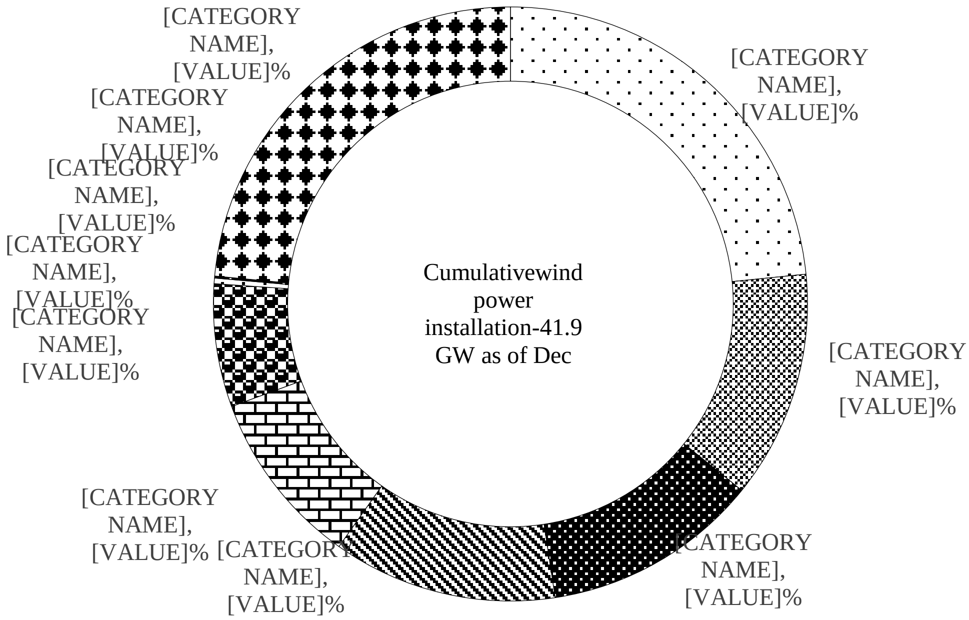

Figure 2. India: Cumulative power installations by states (%).

- *A conscientious environmentalist:* Homes that employ passive solar energy (Figures 1&2) can drastically reduce their consumption of electricity for lighting and heating. Summer air conditioning expenditures can also be decreased by incorporating passive cooling measures into the architecture.

Because climate change scenarios are unpredictable, individuals will be able to handle significant obstacles thanks to the environmental performance benefits of green building. The environment, which is thought to be the most crucial factor in reducing the impact of global warming on humans, is significantly impacted by the building sector (Darko, 2016) [11]. The foundation of the shift to green buildings is the enhancement of building energy efficiency and environmental performance (Wuni, 2019) [25]. As a positive performance construction, green buildings have little effect on the environment and can have a smaller environmental impact over its lifetime. Darko (2016) [11]. goes on to say that reducing construction waste and environmental impact is one of the main goals of green building. A key component in the creation of sustainable building design is the handling of trash from construction and deconstruction. Xie, B.C.; Zhai 2020 [26] Construction wastes should have a recovery rate of at least 90%, as this can significantly lessen the impact of waste formation (Asman,

2019) [6]. Furthermore, the substantial quantity of garbage generated by construction might contaminate the air and water. As a result, selecting construction materials is crucial to sustainable development and may contribute to the creation of safer and healthier environments. When used to create buildings, timber is an environmentally friendly material that uses less energy and produces fewer greenhouse gas emissions (Li, 2019) [16].

(Qiao, 2020) [2] The life cycle of building construction is linked to the use of energy and the release of greenhouse gas emissions. The construction sector is classified as a "resource-intensive industry" due to its significant annual consumption of energy and natural resources. This includes more than 40% of global energy, 40% of raw materials, 16% of water, and 25% of lumber. Recent studies have provided more evidence that more than 40% of global greenhouse gas emissions originate from the construction sector. Dwaikat (2018) [3] Green buildings offer significant advantages compared to regular buildings, typically resulting in superior performance in terms of energy efficiency, water conservation, and reduction of CO_2 emissions. Yadegaridehkordi, E 2020 [27] The green building can be regarded as a distinct embodiment of both energy efficiency and resource efficiency. Architects should acknowledge the energy efficiency of building designs in light of the growing recognition of climate change. Sustainable buildings have the capacity to save 40% more energy than typical structures, resulting in improved energy efficiency and reduced CO_2 emissions. Yas, Z.; Jaafer, K (2020) [28] Therefore, the design of these buildings should prioritize energy conservation and emission reduction. Furthermore, research has shown that the utilization of low-carbon materials in green building can effectively decrease the overall emissions produced by buildings throughout their whole lifespan by as much as 30% (Qiao, 2020) [2]. Hence, the utilization of the green building can facilitate the achievement of sustainable growth in low-carbon construction. Zuo, J.; Zhao, Z.Y (2014) [29] Quantitative assessment of energy usage in urban structures can be achieved by utilizing a spatial regression model to investigate the relationship between the rate of building greening and surface temperature. Moreover, green building might additionally help to the augmentation of urban biodiversity and the safeguarding of ecosystems by means of sustainable land utilization (Dwaikat, 2018) [13].

CONCLUSION

The construction process in modern buildings requires the use of sustainable materials, such as natural alternatives, to reduce environmental impact. These materials are just as strong and long-lasting as conventional materials, but they are also less expensive and better for the environment. The sustainable building process aims to use resources efficiently, such as energy and water, through ICT automation and new materials. While reducing adverse effects, this procedure also guarantees the health and welfare of the residents.

The importance of green building in achieving low-carbon construction and enhancing energy efficiency. The development of green buildings is a major global industry that focuses on improving buildings' energy and environmental performance. The construction sector significantly impacts the environment, which is crucial in minimizing global warming's impact. However, there is a notable disparity in construction waste reduction effectiveness between green building projects in the United States and China, particularly at lower certification levels. This may be because China has a low rate of construction component reuse. Green architecture embodies both energy efficiency and resource efficiency, offering significant advantages over standard buildings in areas such as energy conservation, water conservation, and CO_2 emissions reduction. Quantifying energy consumption in green buildings in metropolitan settings can be achieved using a spatial regression model. Thus, green building can be employed to achieve sustainable development of low-carbon construction and enhance energy efficiency.

Green building design is often influenced by financial constraints and health and safety considerations, but it should not solely focus on mitigating environmental effects. Contractors should consider economic advantages when deciding to build a green building, as regular maintenance can prolong the structure's lifespan and determine the duration of the building lifecycle. Calculating the expenses associated with green buildings, such as operational components, takes into account both direct and indirect advantages resulting from efficient resource use. Advanced integrated techniques and technology should be incorporated into green buildings in order to minimize their negative effects on the environment, maximize the use of resources, and improve the efficiency and return on investment of each building component.

FUTURE RECOMMENDATIONS

The government can implement promotional campaigns at the local, state, and national levels to advocate for the environmental, economic, and social advantages of green buildings. In addition, governments should implement awareness campaigns to promote the adoption of green building practices among developers and renters due to the rising value of these structures, reduced operational expenses, and enhanced community reputation. In the areas of finance, taxation, and economics, incentive policies ought to be strengthened. These incentive schemes have the potential to foster a robust internal drive across relevant departments to promote the advancement of green building. Green finance is a distinct financial practice employed to promote sustainable development. Projects focused on the development of environmentally-friendly buildings are eligible to apply for financial assistance, which can help alleviate the financial strain. Consequently, if the project being invested in is a green building, the government has the ability to reimburse some benefits, such as tax cuts, to both developers and customers.

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