

Construction Industry: Green Building

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Abstract

As a result of the advantages for the environment, economy, and society, recent developments in green building technologies (GBTs) have increased significantly. For projects to develop green buildings, technology is vital. A number of green building technologies, such as those that reduce temperature, have wastewater systems, are energy-efficient, and have cooling systems powered by solar energy, GBT has the ability to advance in the direction of sustainable development, with a focus on climate change. The basic goal of the GBT is to make use of water, electricity, and other resources efficiently and in an appropriate way. The environment will be improved as a result, such as by reducing pollution and the use of energy, improving productivity and wellness, and reducing maintenance and operating costs. There is a lack of critical analysis of either previous or current studies performed in the green building technology (GBT) industry to determine the future pathway for sustainable green building technologies. With the use of the appropriate research methods, a critical review was found. A building information model (BIM) and ontology are used in green buildings to handle multidisciplinary operations. The combination of SWRL and OWL models built on the Jess rule engine increases the building efficiency. Sustainable materials made from industrial scrap help to mitigate the environmental impact of carbon emissions. The use of various activators increases the flexibility, strength, and volume of these materials. Sensors, the environment, and other external forces all play a role in how smart materials function. This study summarizes the green building and their assessment tools, aspects, how much the green buildings are benefits to the environment, humans, and economy, the technologies used in green buildings in construction industries, and the factors that affect the green building technology.

Keywords: Green Building Technology, Building Information Model, SWRL, OWL, EPA.

1. Introduction

The concept of sustainability has been growing significantly. GBs perform an essential part in the sustainability concept. According to the Green Building Theory, all of our resources must be used economically and in a proportionate manner. This would help our environment and way of life. The operation of GBs helps ecosystem health by decreasing the strain on water, land, and energy resources. The Environmental Protection Agency (EPA) states that "green building refers to the process of designing, constructing, operating, maintaining, renewing, and deconstructing a building in a manner that is resource and environmental friendly. Green Building constructs these traditional buildings with a focus on comfort, practicality, and affordability. A green building is also called a “sustainable or high-performance building”. The design of green buildings is carried out in such a way that our way of life and environment get improved and updated by lowering environmental pollution, making effective use of natural assets, and enhancing productivity in the health sector [1]. To get the best performance out of green building, rating tools like Leadership in Energy and Environmental Design (LEED), Building Research Establishment, Environmental Assessment Method (BREEAM), and Green Building Council of Australia (GBCA) are constantly getting better and introducing new capabilities [2]. Three categories: behavioral, technical, and managerial can be used to accomplish green building. The Life Cycle Assessment (LCA), site and structure design efficiency, efficient materials, improvement of indoor air quality, energy efficiency, water efficiency, and waste reduction are the seven basic elements of green building. Figure 1 shows the components of a green building.



Figure 1. Components of Green Building.

2. Green Building

In order to qualify as a "green building," a structure must be constructed and resource-saving procedures must be used throughout all phases of a building's life cycle, including planning, design, construction, operation, maintenance, renovation, and deconstruction. Green building is becoming increasingly more popular. But there are numerous disagreements regarding what constitutes or should be included in a green building. Green building promotion and implementation are made more difficult by the lack of a precise definition of the term.

2.1 Tools for Evaluating Green Buildings

In order to support the development of green buildings, a number of assessment tools have been created. Which includes Leadership in Energy and Environmental Design (LEED, United States), Green Building Council of Australia Green Star (GBCA, Australia), Green Mark Scheme (Singapore), DGNB (Germany), BRE Environmental Assessment Method (BREEAM, United Kingdom), Hong Kong Building Environmental Assessment Method (HK BEAM), Comprehensive Assessment System for Built Environment Efficiency (CASBEE, Japan), Green Building Index (Malaysia), and Pearl Rating System for Estidama (Abu Dhabi Urban Planning Council) [3]. These green building assessment methods are all optional and not compulsory. To connect the initiatives of numerous green building councils around the world, the World Council for Green Building was created. These assessments are carried out by qualified experts who have been hired by the green building authority.

2.2 Technical Aspects

The technological aspects of sustainability are traditionally the focus of studies on green buildings. Using fewer resources, such as water, electricity, and materials, during the building process is the focus of green construction. It also makes use of smart energy-saving technology to construct zero-energy buildings with less negative environmental impact from greenhouse gases [4]. In order to save energy and restrict waste going to landfills, for example, fly ashes might be used as construction materials in green building designs. Like that, using precast or prefabrication technology significantly reduces the quantity of waste generated during building and deconstruction [5]. Prefabrication is one of the most popular ways to avoid accidents, especially those associated with sustainable features like "construction at height, overhead, with energized electricity, and in restricted spaces," according to design and construction

professionals. In Spain's Catalonia, 386 schools were built using green building materials: precast reinforced concrete panels and prefabricated steel.

2.3 Economic Aspects

The need for green buildings in terms of social and economic factors including accessibility, education, inclusivity, cohesiveness, cost effectiveness, financial benefit, effects on the local economy, indoor health, cultural perception, and creativity [6]. Energy-saving measures take into account both the cost savings from increased energy efficiency and the potential value addition to the property. This contributes to a shorter period of repayment for investments in energy efficiency measures. As a result, a green building might have either a narrow or broad meaning. Still, the importance of the economic, social, and cultural aspects of green building development and sustainability is very rarely highlighted. Despite a considerable number of studies highlighting the importance of these unusual characteristics of green building assessment, there is a general absence of in-depth empirical research.

3. Benefits of Green Building

Green building practices in the construction industry offer a multitude of benefits. Firstly, they significantly reduce the environmental impact of buildings by minimizing resource consumption and waste generation. Through energy-efficient designs, improved insulation, and advanced technologies, green buildings consume less energy, reducing greenhouse gas emissions and dependence on fossil fuels. Secondly, these sustainable structures prioritize occupant health and comfort. Incorporating natural light, proper ventilation, and non-toxic materials, green buildings create healthier indoor environments, leading to improved productivity and well-being. Moreover, green buildings often result in long-term cost savings by lowering energy and water bills [7]. Additionally, they enhance the overall value and marketability of properties, attracting environmentally conscious buyers and tenants. Ultimately, embracing green building practices not only supports environmental conservation but also promotes healthier living, economic efficiency, and sustainable development within the construction industry.

4. Technologies in Green Building Industries

Green building uses a variety of technologies to achieve sustainability and energy efficiency. Here are a few examples of green construction technologies: Solar Power Systems, Energy-Efficient HVAC Systems, Energy-Efficient Lighting, Advanced Insulation, Rainwater

Harvesting, Grey Water Systems, Building Automation Systems, Sustainable Materials, Passive Design Strategies, and Green Roofing. These technologies, among others, contribute to the sustainability, energy efficiency, and environmental responsibility of green buildings.

4.1 Solar Power Systems

In solar power system, photovoltaic (PV) systems absorb solar energy and turn it into electrical power. Concentrating solar power (CSP): the heat generated from sunlight is utilized for running utility-scale electric turbines. Solar heating and cooling (SHC) systems absorb thermal power for the purpose of providing hot water and cooling or heating the atmosphere. It will decrease emissions of carbon and dependency on traditional energy resources. Figure 2 displays the components and power-generating operation of the system.

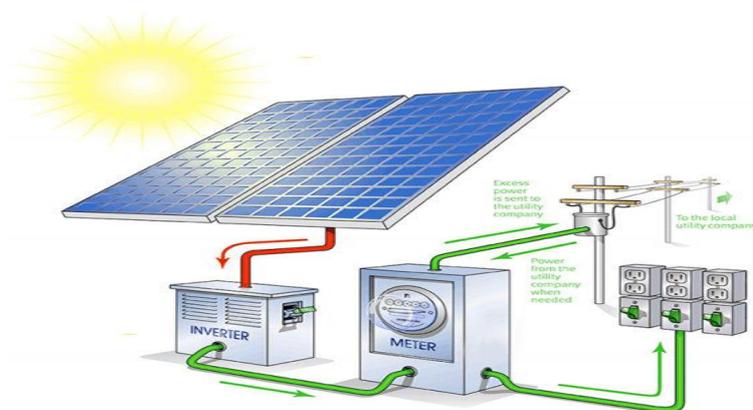


Figure 2. Solar Power Systems [9]

4.2 Energy-Efficient HVAC Systems

The HVAC system creates a perfect environment for plants with accurately controlled humidity, temperature, and airflow levels using a network of fans, heat pumps, air conditioners, humidification devices, purifiers of air, and carbon dioxide (CO₂) replenishment. The HVAC systems keep indoor comfort levels at their highest while consuming less energy. Figure 3 shows an energy-efficient HVAC system developed by Vista College.



Figure 3. Energy Efficient HVAC System [10]

4.3 Energy-Efficient Lighting

LED (light-emitting diode) lighting is a preferred option for green buildings. Its extended lifespan, low consumption of energy, adaptable lighting options, enhanced ventilation, and compatibility with smart technologies make it an essential component of attaining sustainability and environmental responsibility in building design. Figure 4 displays the various system parts and how they work together.

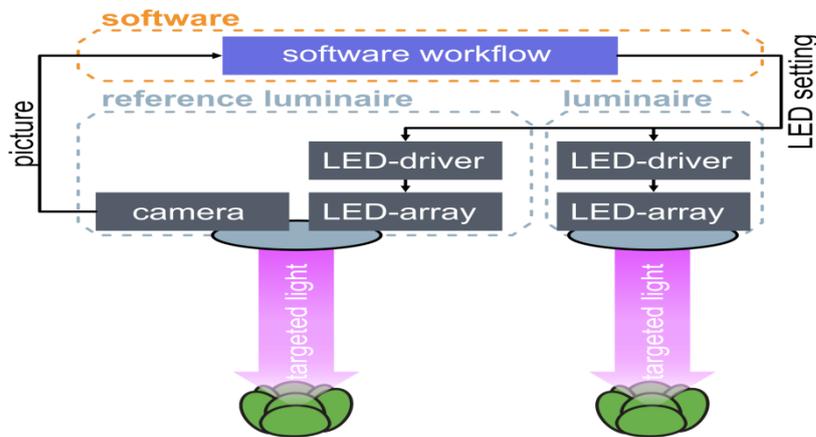


Figure 4. Energy-Efficient Lighting [11]

4.4 Advanced Insulation

The right insulation materials and methods help in maintaining stable interior temperatures. Insulation decreases the flow of heat (heating and cooling) across the numerous surfaces in a building, including the walls, ceilings, pipes, etc.

4.5 Rainwater Harvesting

Using this technology, rainwater from roofs as well as other surfaces is collected and stored for use in agriculture, sanitation facilities, and other non-potable purposes. In addition to conserving water and energy, rainwater collection can also increase resilience, enhance the quality of water, and add value to green buildings. And reducing dependency on municipal water supplies allows for resource conservation and carbon dioxide emissions reduction.

4.6 Grey water Systems

These systems collect and process waste water from bathrooms, kitchens, showers, and washing so that it can be used for flushing or watering outside areas. It decreases the amount of freshwater required to feed household appliances, reducing the amount of waste water that enters garbage.

4.7 Building Automation Systems

It allows an operator to access, manage, and keep an eye on all connected building systems via a single interface. Smart management systems for buildings use sensors and automated controls to adjust lighting, heating, cooling, and other building services for maximum effectiveness while also monitoring interior air quality.

4.8 Sustainable Materials

Sustainable materials management (SMM) is a methodical strategy for making better use of materials across their entire life cycles. The way our culture views the use of resources from nature and protecting the environment has changed as a result. Green building recommends the use of renewable resources, including recycled or salvaged materials, timber that has been sourced ethically, low-VOC paints and finishes, and harmless building materials.

4.9 Passive Design Strategies

To reduce energy requirements and increase occupant comfort in a building's cooling, heating, lighting, and air circulation systems, passive design concepts must be applied. These include maximizing natural lighting, utilizing natural ventilation, and optimizing building orientation.

4.10 Green Roofing

An area of vegetation grown on a roof is called a green roof. It provides insulation, decreases overflow of rainfall, absorbs heat, and improves air quality. Additionally, they add to the amount of green space in cities and help with energy efficiency. Figure 5 shows the types and layers involved in green roofing.

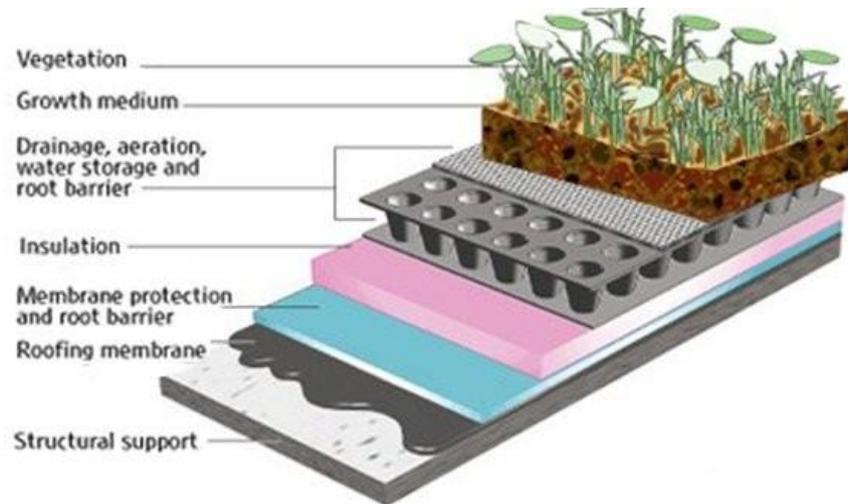


Figure 5. Layers in Green Roofing [12]

5. Affecting factors of Green Building Technology

There are many factors that affect the construction of green buildings. These elements can be classified into three categories: social, economic, and environmental [8].

5.1 Environmental Factors

- **Energy Efficiency:** Using energy-efficient insulating material, light, and HVAC systems to design and construct buildings that reduce energy consumption.
- **Environmentally Friendly Resources:** Using environmentally friendly and recycled materials during construction, reducing waste production, and taking into account the effects of products on the environment over their life cycles.
- **Renewable Energy Sources:** Integrating renewable energy sources, such as geothermal energy systems, windmills, or solar panels.

- **Efficiency of Water:** Applying techniques like efficient drainage systems, wastewater recycling, and rainwater harvesting to reduce water use and encourage preservation.
- **Choosing a Site and Preserving It:** Selecting areas that will have a minimal impact on the environment, protect natural ecosystems, and promote connections to transportation options.

5.2 Economical Factor

- **Life Cycle Assessment:** evaluating the long-term costs and advantages of green building projects, taking into account aspects such as reduced energy consumption, maintenance expenses, and potential subsidies or tax credits.
- **Profit from Investment:** Evaluating the economic viability of green building features and technology, taking into account their effects on property values and possible utility bill savings.
- **Value and Market Demand:** Resolving the increasing demand from customers for eco-friendly buildings may result in increased levels of occupancy and rents.

5.3 Social Aspects

- **Interior Comfort:** Creating structures that are thermally comfortable, naturally lit, and soundproof, boosts occupant contentment and efficiency.
- **Indoor Air Quality:** To enhance occupant health and well-being, emphasise healthy indoor settings by adopting low-emission materials, suitable ventilation methods, and pollution mitigation methods.
- **Collaboration in the Community:** Engaging surrounding communities as well as stakeholders in the design and development process, taking into account their needs and goals, and generating a feeling of responsibility and unity in society.
- **Health and Well-Being:** Incorporating ecologically friendly factors, providing a connection with nature, and encouraging exercise to improve occupant health and well-being.

All of these aspects are interconnected and must be carefully studied in order to create a comprehensive approach to green construction and the design of buildings. Green buildings can contribute to a more environmentally friendly future by reducing the use of resources, minimizing the impact on the environment, and offering healthy and more productive environments for occupants by addressing these concerns.

6. Conclusion

The growing necessity to address environmental issues and develop sustainable built environments has led to the emergence of green buildings as a prominent trend in the construction industry. This paper has highlighted the various factors that affect green buildings, including environmental, economic, and social aspects. By integrating energy-efficient technologies, utilizing renewable energy sources, implementing water conservation measures, selecting sustainable materials, and considering site planning, green buildings can minimize their environmental footprint and promote resource conservation. As the demand for environmentally conscious structures continues to grow, it is crucial for the construction industry to embrace green building practices, adopt innovative technologies, and collaborate across sectors to create a built environment that is not only sustainable but also conducive to a better quality of life for all.

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