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A Review Article on "Green Building"

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Abstract- Green building practices have emerged as a pivotal strategy in mitigating environmental impacts and promoting sustainability within the construction industry. This review article provides an in-depth analysis of the advancements and challenges in green building, encompassing various aspects such as design principles, materials, technologies, policies, and economic implications. The review begins by elucidating the fundamental principles of green building, emphasizing energy efficiency, water conservation, waste reduction, and indoor environmental quality. It explores innovative design strategies such as passive solar design, green roofs, and natural ventilation, highlighting their effectiveness in reducing resource consumption and enhancing occupant comfort. Furthermore, the review delves into the utilization of sustainable materials and construction techniques, examining their role in minimizing carbon footprint and promoting circular economy principles. It also discusses the integration of renewable energy systems, smart technologies, and building automation to optimize energy performance and operational efficiency. Moreover, the review critically evaluates the regulatory frameworks and certification systems governing green building practices, assessing their effectiveness in driving adoption and ensuring compliance with sustainability standards. It also explores the economic implications of green building, including cost considerations, return on investment, and market incentives.

Keywords- Green building, Sustainability, Energy efficiency, Sustainable materials, Renewable energy.

I. INTRODUCTION

The 21st century has ushered in an era where the imperative for sustainable development has become increasingly urgent. At the forefront of this global endeavor lies the construction industry, a sector historically characterized by resource-intensive practices and significant environmental impact. In response to growing concerns over climate change, resource depletion, and environmental degradation, the concept of green building has emerged as a transformative paradigm, offering a pathway towards a more sustainable built environment. Green building, also known as sustainable or eco-friendly building, represents a holistic approach to construction and design that prioritizes environmental responsibility, energy efficiency, and occupant well-being. It embodies a commitment to minimizing resource consumption, reducing carbon emissions, and enhancing resilience to environmental pressures. At its core, green building seeks to harmonize the built environment with the natural world, fostering a symbiotic relationship between human habitation and ecological systems. This review article aims to provide a comprehensive overview of the advancements and challenges in green building, drawing upon interdisciplinary perspectives from architecture, engineering, environmental science, economics, and policy studies. By synthesizing current knowledge and emerging trends, this review seeks to elucidate the multifaceted nature of green building and its implications for sustainable development.

The review begins by delineating the fundamental principles of green building, elucidating its core objectives and guiding principles. It explores key concepts such as energy efficiency, water conservation, waste reduction, and indoor environmental quality, underscoring their significance in shaping sustainable building practices.

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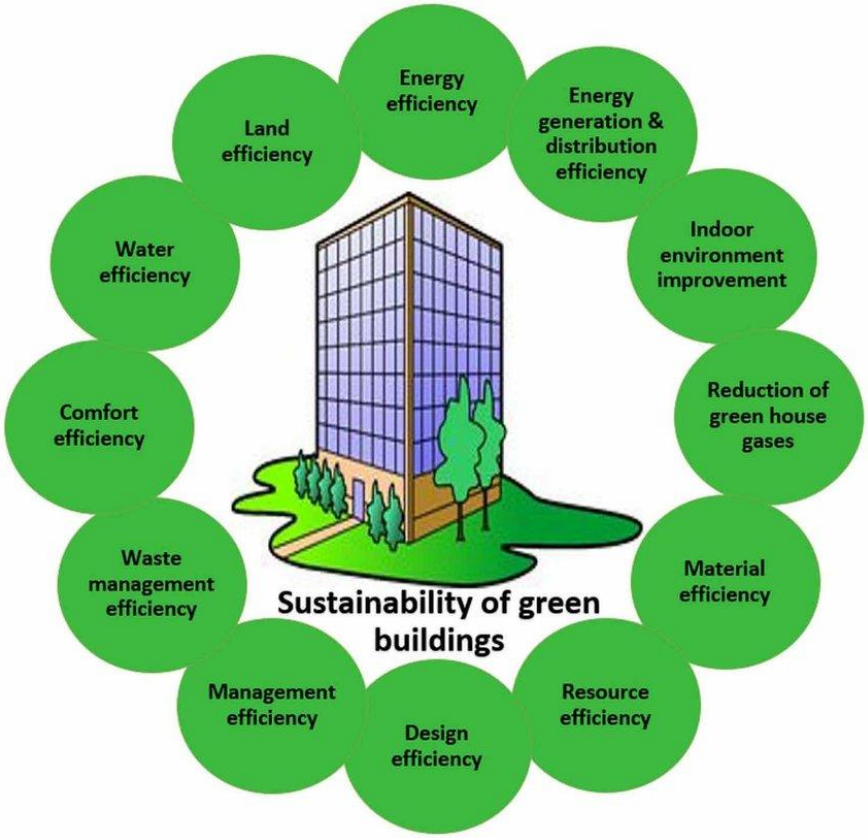
Subsequently, the review delves into the innovative design strategies and technologies that underpin green building, highlighting their potential to optimize resource utilization, minimize environmental impact, and enhance occupant comfort. From passive solar design and green roofs to advanced building automation systems, these strategies represent the vanguard of sustainable architecture and construction. Moreover, the review examines the role of sustainable materials and construction techniques in green building, assessing their environmental performance, durability, and cost-effectiveness. It also evaluates the regulatory frameworks and certification systems that govern green building practices, analyzing their efficacy in driving adoption and ensuring compliance with sustainability standards.

Green building, also known as sustainable or eco-friendly building, refers to the design, construction, and operation of buildings in a manner that minimizes their environmental impact and promotes resource efficiency, occupant health, and well-being. It encompasses a holistic approach to building design and management that integrates principles of sustainability across all stages of the building lifecycle, from planning and construction to operation and demolition.



Key principles and characteristics of green building include:

1. **Energy Efficiency:** Green buildings are designed to optimize energy performance and reduce energy consumption through measures such as high-efficiency heating, ventilation, and air conditioning (HVAC) systems, insulation, energy-efficient lighting, and passive solar design.
2. **Water Conservation:** Green buildings incorporate strategies to minimize water usage, such as low-flow fixtures, rainwater harvesting systems, greywater recycling, and efficient irrigation practices.
3. **Sustainable Materials:** Green building practices emphasize the use of environmentally friendly and sustainable materials, including recycled materials, renewable resources, and materials with low embodied energy and carbon footprint. Examples include bamboo, reclaimed wood, recycled steel, and non-toxic paints and finishes.
4. **Waste Reduction and Recycling:** Green buildings aim to minimize construction waste and promote recycling and reuse of materials. Strategies may include waste management plans, construction waste sorting, and incorporation of recycled content in building materials.

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5. **Indoor Environmental Quality (IEQ):** Green buildings prioritize occupant health and comfort by optimizing indoor air quality, natural daylighting, thermal comfort, and acoustics. Measures may include proper ventilation, use of low-emission materials, daylighting design, and control of indoor pollutants.
6. **Site Planning and Land Use:** Green building practices consider the environmental impact of site selection, land use planning, and site development. Strategies may include preservation of natural habitats, reduction of site disturbance, and implementation of sustainable landscaping practices.
7. **Renewable Energy Integration:** Green buildings incorporate renewable energy technologies such as solar panels, wind turbines, geothermal systems, and biomass energy to generate onsite energy and reduce reliance on fossil fuels.
8. **Lifecycle Assessment and Resilience:** Green building approaches consider the environmental impact of buildings over their entire lifecycle, including construction, operation, maintenance, and end-of-life disposal. Additionally, green buildings aim to enhance resilience to climate change and natural disasters through robust design and adaptive strategies.
9. **Certification and Rating Systems:** Various green building certification programs and rating systems, such as LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), and Green Star, provide frameworks for assessing and recognizing the sustainability performance of buildings.

Overall, green building practices are guided by the overarching goal of creating built environments that are environmentally responsible, resource-efficient, economically viable, and conducive to the health and well-being of occupants and communities. Through innovation, collaboration, and adoption of sustainable practices, green building plays a crucial role in addressing global challenges such as climate change, resource depletion, and urbanization.

II. LITERATURE REVIEW

[1] Green Buildings and Sustainable Construction (2017)
The issues of sustainable construction practices have been an emerging phenomenon in India. The increasing concern of harmful effects of construction related activities and need to address the same have regularly appeared in newspaper headlines. Considering the same government of India has already taken proactive measures to promote the concept of green building for better environmental and social protection. Rising concern of deterioration to the environment, developers should also rework on their existing construction practices and should adopt sustainable construction practices in their future projects. However, the speed with which all the associated developers and builders accept this aspect of construction depends upon the level of awareness, knowledge as well an understanding of the consequences of the individual action. Aligned with this objective, survey has been organized in the current study to assess the difference in level of knowledge, awareness and implementation of sustainable practices based on the perceptions of the project developers in India. To improve the acceptance and momentum of sustainable practice in the industry, appropriate actions are recommended towards improving this knowledge at all levels of developers.

[2] Green Building Construction Techniques (2012)
In today's age of urbanization, the environment is being ignored by human beings. Environmental imbalance is produced due to different activities made by us. Construction industry is doing a massive role in this. While construction processes and after construction due to faulty planning, pollution is created as well as lots of natural resources are wasted. Water scarcity is a major problem in front of society even though while using water for construction, gardening and other domestic purposes proper care is not taken, and water is wasted. In normal constructions proper care is not taken to save energy and energy is not efficiently used. As demand of energy is increasing rapidly therefore there is excessive load on big thermal power projects, which adds into the pollution. The water falling on the roof top is not utilized in normal buildings. The waste produced in homes is also contributing to pollution and in making unsanitary and unesthetic atmosphere. A Green Building design provides solutions to all above-mentioned problems and contributes to keeping the environment clean and green. The study shows that Green Buildings are only way to a sustainable future.

[3] Role of Green Buildings in Sustainable Construction Practices (2023)
The availability of natural resources in their pure form is limited. Human beings are responsible for the pollution and destruction of the land, air and water which have emerged as the nature's gifts upon the humanity to thrive upon. The concept of green buildings is a measure to alleviate the pressure put on by the building projects on the unscrupulous

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usage of resources on the society and the environment. Green buildings are the buildings certified by various rating systems built upon certain criteria based on conservation of natural resources and energy efficiency of buildings. This study focusses on the concept of green buildings in totality with a focus on the parameters for its consideration, benefits, applicability, scope of green buildings and green concepts in contrast to the conventional buildings. Upon having a clear understanding of the concept of green buildings and having understood the environmental concerns and importance of the green building concept, working out the cost benefit and addressing the feasibility issues, there is a dire need to shift to the construction of green buildings. On a broader perspective, adoption of green practices i.e. saving on to the natural resources, cutting down on the generation of waste, usage of greener materials with a low carbon footprint would make our planet a better place to live in. Thus, this study is a means to review the various aspects pertaining to the green buildings and highlight them to infuse confidence on the adoption of green building concept on a wider scale.

[4] Cost Effective Sustainable Green Building (2023)

Green building uses less energy, water, and natural resources, creates less waste and is healthier for the people living inside compared to a standard building. There is a rapidly expanding market for green building materials. Green building provides suitable environment by controlling solar radiation temperature, energy efficiency, water conversation using domestic treatment plant and indoor air quality. The main aim of green buildings is to reduce the environmental impact of new buildings. The sustainability in the environment can be well achieved by reducing the energy emission and consumption by the buildings. Sustainability means using the energy efficiently. Green building refers to a structure that is environmentally responsible and resource efficient throughout the building's lifecycle. The aim of this project is to conduct a comparative study on conventional and green residential building. The study consummates that as much as 40-50% energy saving is possible in green building. Green Buildings focus solely on the environment. Using less energy, water, natural resources, creates less waste, and is heal there for the people lining inside compared to a standard building. High initial investment. Unavailability of workers with experience. Longer time to build.

[5] Planning and Design of a Green Commercial Building by using Software (2022)

In today's world, where materials used in building construction are few, adopting greener and more environmentally friendly methods and materials has become a need. This study article examines the impact of adopting such technologies and materials over their traditional counterparts to reduce non-renewable resource abuse and the harmful impacts on our ecosystem. Several materials and procedures have been brought to light that have proven to be a viable alternative to the traditionally or commonly used methods and materials in the field of building construction. The implementation of these materials and methods will undoubtedly revolutionise the sector of building construction. These techniques could replace these conventional materials and also pave way for a greener way of building construction that will contribute towards rebuilding the planet's environmental health and put a stop to several destructive and hazardous calamities like the greenhouse effect and so on. We have replaced the conventional red bricks with compressed earth bricks and used sustainable concrete in place of conventional concrete. Non-conventional and renewable energy sources have been brought into application to achieve energy efficiency and optimize the energy performance in the building. A water harvesting system has also been installed for collection and storage of rainwater which can be used in future for various purposes or can be used for the refilling of ground water table which gets depleted due to the daily use of water for various requirements.

[6] A Review Paper on Green Building Research (2017)

Green building technology is one of the most trending topics all over the world which is been put forward to reduce the significant impact of the construction industry on the environment, society and economy. The globe is in an urgent need of sustainable and a smart development as the problem of pollution and global warming is rapidly increasing all over the world. A drastic climatic change also been noticed and being experienced all over the world due to increase in the Green House Gases (GHG's). In the developed countries like United States of America, Russia, Australia, United Kingdom, there are already strict measures been taken to achieve a sustainable development and also rules and regulations are being made by their respective governments to support and achieve a sustainable and an eco-friendly development of their nations. However, in the developing countries like India, China, Srilanka, Pakistan, etc., they are far behind in achieving a sustainable development and eco-friendly constructions. Also, there is a lack of awareness amongst the people about this global issue in these developing countries. The studies and the research work in these countries is also way far behind as compared to the developed nations in the world. This paper presents the need of sustainable development all over the globe especially in the developing countries like India and China which have a

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huge land mass and also developing rapidly and heading towards becoming the new superpowers of the world soon in the future. Also, it includes the sustainable and economic studies with references to the Indian contexts with a supporting live recent case study of a newly designed and constructed luxurious residential bungalow in a small town in India. The case study is specially selected as a residential bungalow which is designed and constructed as a sustainable and a green structure in a small town in the state of Maharashtra in India as India is also known as a country of villages with a second largest population in the world. According 20 the 2011 census of India, 68.84% of Indians i.e. around 833.1 million people live in 6,40,867 different villages. This paper will help Indian villages and their residential buildings develop sustainable and green by implementing easy, simple and economic techniques.

[7] Research on the Sustainability in Green Building (2022)

In the era of rapid development of architecture, green buildings have emerged as a sustainable development path with many urgent problems, the quality of the building and the subsequent maintenance management aspects are not fully implemented. This study is based on literature research on green buildings, analyzing the current development of green buildings and proposing existing problems and future directions for development. The analysis shows that there is a lack of management planning for the whole process of green buildings, and therefore proposes ideas for a green building management planning system that will allow for sustainable development of green buildings from design to completion. Sustainable green development is the theme of our time and green building is the embodiment of this concept in the field of architecture. The goal of green architecture is to provide a harmonious and green living environment that can effectively reduce global carbon emissions and work tirelessly to combat global warming. In recent years, the state has attached more importance to the development of green architecture, and the rapid development of green architecture requires contemporary designers to carry out in-depth analysis and research. However, in this development process, the problem of difficulty in harmonizing design with reality has arisen, and the supervision of the whole process of green buildings is still inadequate. Therefore, for the long-term development of green buildings, the focus needs to be on the aspect of city-wide management and subsequent maintenance. The idea of a green building management system can go some way to solving the various problems before and after construction and ensuring the viability and practicality of green buildings, but it still needs to be supported by policy and a green building construction system. This study only provides a macro view of the whole process of green building but does not provide specific solutions to specific case studies, so the next study will focus on how the green building management system can be set up and running smoothly.

[8] The Green Building for Sustainable Development in India (2023)

The green building movement has gained significant traction as a means to address the environmental impact of buildings and promote sustainable development. This research paper examines the application of green building practices in the context of sustainable development in India. Buildings in India account for a substantial portion of resource consumption, energy use, and carbon dioxide emissions. Uncontrolled urban development has further intensified these environmental challenges. Recognizing the need for a more sustainable approach, the green building movement has emerged as a solution to minimize the environmental footprint of buildings. This paper explores the key principles and objectives of green building practices, including energy efficiency, resource conservation, water management, and indoor environmental quality. It highlights the significance of sustainable site selection and life cycle assessment in the context of green building development. A comprehensive review of the green building institutions and organizations in India, such as the Indian Green Building Council (IGBC) and Green Rating for Integrated Habitat Assessment (GRIHA), sheds light on their role in promoting and certifying green buildings. These institutions have developed rating systems and guidelines specific to the Indian context, fostering sustainable building practices and creating awareness among stakeholders. The findings of this study emphasize the crucial role of green building practices in achieving sustainable development in India. By reducing resource consumption, mitigating greenhouse gas emissions, and improving indoor air quality, green buildings contribute to environmental preservation, energy savings, and occupant well-being. The paper concludes with recommendations for policymakers, professionals, and stakeholders to further promote and integrate green building practices into the Indian construction industry, facilitating a more sustainable built environment.

[9] Sustainability Considerations of Green Buildings: A Detailed Overview on Current Advancements and Future Considerations (2022)

The concept of green building has gradually formed with the increase in public awareness of environmental protection, which also covers a wide range of elements. The green building is the fundamental platform of sustainable development. This review paper provides solutions for the multi-dimensional and balanced development of green

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building. Since green building is the development trend of the construction industry, it presents an opportunity to mitigate global warming and accomplish energy efficiency. However, the problem is that the development of green building's implementation is restricted by the lack of government policies, imperfect technical abilities, and unreasonable economic benefits. One conclusion drawn from the results shows that the benefits of green building implementation include environmental, economic, social, and health and safety aspects. Moreover, it is crucial to improve the awareness of stakeholders to promote the development process of green building. The government should launch campaigns to encourage developers and tenants to embrace green building, which can add value to buildings. The novelty of the paper provides a more systematic review on the sustainable considerations of green building than previous efforts in the literature. Bibliometric analysis is conducted through VOS viewer software. This review paper discusses the relevant benefits and challenges of green building through a critical review of existing research knowledge related to green building. The current advancements in green building are highlighted in this paper. Importantly, future recommendations for standards and policy formulation and future research directions are proposed in this review article. The current study provides a detailed review of the consideration of green building to achieve SDGs. A large number of definitions of green building are expressed according to different characteristics such as general definition, energy and resource focused definition, and comprehensive definition. The green building achieves good performance in energy conservation and reducing CO_2 emissions. The development of green building will promote the improvement of building regulations. The evaluation criteria can support the development of green building and be conducive to the goals of cost efficiency and project sustainability. The social advancement of green building contains the formation of corporate social responsibility. Meanwhile, green building can face economic implications during the development process, such as high initial investment costs and a lack of market demand. Additionally, a lack of awareness and public participation in green building are other social obstacles. The main institutional obstacles to green building development can be summarized as the lack of government financial incentives and fragmentation of legal and institutional framework. A lack of potential to enable effective collaboration with the various stakeholders is also a major obstacle to the development of green buildings. Therefore, the technological system of green building construction should be accelerated to adapt to the market demand in future. It is crucial to improve the awareness of stakeholders to promote the development process of green building. The government should launch campaigns to encourage developers and tenants to embrace green building, which can add value to buildings. The incentive policies might become a strong internal motivation to boost the popularity of green building. Additionally, legislation is a fundamental element to promote green building. The local economic development, weather conditions, regional resources, and construction level should be fully considered during the establishment and improvement of green building standards. Future studies should be focused on comparisons of green building performances among different counties under several categorizations. Although the implementation of green building faces various challenges, green building has a great potential to reduce energy consumption and the greenhouse effect.

[10] The Empirical Study of Green Buildings (Residential) Implementation: Perspective of House Developers (2015)

This paper presents a study of green buildings implementation from the perspective of housing developers. The agenda of green buildings is to preserve all natures from the destruction by human activities. However, not many of house owners know that their houses are degraded and produced CO2, roughly 10 to 30 tonnes annually. This means that our houses are one of the causes of the global warming and environmental pollution. Therefore, the green building concept for green residential is an alternative effort to decrease the effects of CO2. Green residential means applying the houses with a minimum energy, water and natural resources that provide good air quality and reduce wastes. This qualitative study aims to explore the perceptions of housing developers towards green residential development. Presently, the demand for green residential is very low because buyers hesitate to pay 30% more costs for a green residential than a conventional house. The data collections for the study area are throughout face-to-face semi-structured interviews, photo collections, and some observations with housing developers. There are twenty-two respondents involved during the data collection period from two home and property exhibitions. The study finds that 77% of respondents are aware of the green residential concept. The other 23% of respondents realize about the green residential concept and the perceived benefits but indistinguishable. Government roles are significantly crucial for flourishing the development of green building and technologies into the housing projects.

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CONCLUSION

In conclusion, this review article has provided a comprehensive overview of the advancements, challenges, and future prospects of green building. Through an analysis of the literature spanning various disciplines, including architecture, engineering, environmental science, economics, and policy studies, we have synthesized key insights into the multifaceted nature of sustainable construction practices. Green building represents a transformative approach to construction and design, guided by principles of environmental responsibility, energy efficiency, and occupant well-being. From innovative design strategies and sustainable materials to policy interventions and technological innovations, the review has highlighted the diverse avenues through which green building can contribute to a more sustainable built environment. Key findings from the review underscore the significant progress made in advancing green building practices, including improvements in energy efficiency, resource conservation, and indoor environmental quality. The integration of renewable energy systems, smart technologies, and green infrastructure has further enhanced the resilience and sustainability of buildings and communities. However, the review also acknowledges the persistent challenges and barriers hindering the widespread adoption of green building practices. From cost constraints and regulatory barriers to lack of awareness and technological limitations, addressing these challenges requires collaborative efforts among stakeholders, including policymakers, industry professionals, academia, and communities. Looking ahead, the review identifies several opportunities for future research and action to accelerate the transition towards a more sustainable built environment. These include advancing knowledge in areas such as sustainable materials development, innovative design strategies, and policy frameworks conducive to green building adoption. In conclusion, green building holds immense potential to mitigate environmental impacts, enhance resilience, and foster sustainable development. By embracing the principles of sustainability and leveraging innovative solutions, we can create built environments that not only meet the needs of the present but also safeguard the well-being of future generations. Through continued research, collaboration, and commitment, we can realize the vision of a greener, healthier, and more sustainable world.

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