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Green Building Benefits: A Comparative Study of IGBC Certified and Conventional Residential Buildings: Navkar, Pune

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Abstract: This paper presents a comprehensive comparative study of an IGBC-certified residential building (NAVKAR Project) and same building as a conventional building in Pune, India. It analyses sustainability aspects such as energy performance, water conservation, materials usage, indoor environmental quality, and cost efficiency. The findings affirm that green buildings, though initially cost-intensive, offer superior long-term returns in terms of utility savings, reduced environmental footprint, and improved occupant health. This research contributes to policymaking, urban planning, and real estate investment decisions aimed at promoting sustainable development in Indian cities.

Keywords **- Green Building, IGBC Certification, Sustainable Architecture, Energy Efficiency, Water Conservation, Pune, Cost-Benefit Analysis, Environmental Impact.**

I. Introduction

The construction industry in India is experiencing a rapid transformation due to increasing urbanization and environmental concerns. Traditional buildings contribute significantly to energy consumption, resource depletion, and environmental degradation. In response, green buildings have emerged as a sustainable alternative. This paper introduces the IGBC certification system, outlines its principles, and discusses the rising relevance of sustainable buildings in urban centers like Pune. As green certification becomes integral to future urban planning, understanding its benefits and implementation is essential for stakeholders across the construction value chain.

I.1. Problem Statement

Despite the increasing popularity of green buildings, there remains limited empirical data comparing IGBC-certified buildings with conventional residential buildings. Many developers hesitate to pursue certification due to the perceived high costs and complex procedures, often overlooking the long-term savings and environmental benefits. This research seeks to bridge this knowledge gap by providing a comparative assessment of the environmental impact, energy performance, and economic viability of both building types.

I.2. Objectives

To assess energy and water consumption in IGBC and conventional buildings.
To study indoor environmental quality and health impacts on occupants.
To identify implementation challenges in green certification.
To suggest strategic recommendations for wider IGBC adoption in Pune's residential sector.

I.3. Significance of Study

This study provides key insights into the advantages of green buildings and the importance of IGBC certification. It aims to inform policy-making, influence construction practices, and raise awareness among homeowners and developers. By illustrating how sustainable building practices can mitigate environmental impact and enhance urban resilience, the study emphasizes the broader societal value of adopting green certifications.

II. Literature Review

Laura Almeida et al. (2023) Compared certified (LEED, BREEAM) and non-certified buildings on climate resilience. Found certified buildings better at managing energy, water, and heat impacts. However, generalizability was limited due to case-specific focus.

Sanket Agrawal et al. (2020) Conducted a detailed water audit of a high-rise building. Identified leakage and inefficiencies; proposed low-flow fixtures and rainwater reuse. Relevant to water-stressed cities like Pune. Limitation: only one building studied.

Srinidhi S.V. et al. (2020) Compared non-rated and SVA-GRIHA certified residential buildings. Highlighted higher initial costs but long-term savings and sustainability benefits. Limitation: analysis limited to two buildings.

Vishnu Vijayan et al. (2020) Explored environmental and economic benefits of sustainable materials and energy-efficient designs. Highlighted reduced energy and carbon emissions. However, lacked detailed real-world examples.

Dibas Manna & Sulagno Banerjee (2019) Reviewed India's green building movement. Discussed LEED, GRIHA, and their economic/environmental impact. Noted high ROI from green practices. Lacked region-specific case applications.

Mahesh Hople (2017) Focused on post-construction performance of green buildings. Found strong benefits in energy, water savings, and comfort. Emphasized importance of maintenance and monitoring. More case data needed.

Anshul Gujarathi & Vasudha Gokhale (2018) Highlighted long-term cost savings of green buildings in India despite higher initial investment. Stressed importance of sustainable practices in urbanizing regions. Suggested deeper case-based analysis.

III. Methodology

This study employs a case-study approach. Data was collected from the NAVKAR IGBC-certified residential building, including architectural drawings, material specifications, and environmental performance metrics. A similar-sized conventional building was selected for baseline comparison. Metrics include energy use intensity (EUI), water usage per capita, IGBC point rating, and lifecycle costs.

III.1. IGBC Certification Overview

The IGBC Green Homes Rating System evaluates residential buildings based on sustainable site planning, water efficiency, energy efficiency, materials usage, indoor environmental quality, and innovation. Buildings earn points that determine their certification level: Certified, Silver, Gold, or Platinum. The rating encourages the use of local materials, non-toxic products, and energy-saving technologies. In Maharashtra, incentives include tax rebates, fast-track approvals, and financial subsidies, making it more feasible for developers to embrace sustainability.

IV. Case Study:

Proposed Residential project NAVKAR is located at Bibwewadi in Pune (Warm and Humid Climate). Bibwewadi is well developed area in the Pune city. This area is surrounded by many basic amenities. The proposed project consists of standalone residential Building (G+4 floors). This project is being developed for the family use and not for the sale. All the flats will be occupied by the family. Proposed project falls under PMC (Pune Municipal corporation) limit. Project building has proposed to construct with the UDCPR bye-laws.

IV.1. Base Case (Residential Project: Navkar as a Conventional Building)

IV.1.1. Energy Efficiency

The building has a high RETV of 13 W/m², indicating poor insulation. It lacks solar energy systems and uses standard, non-efficient lighting and equipment. Daylighting is not utilized, leading to higher energy use.

IV.1.2. Water Conservation

Standard fixtures lead to high water use. There's no rainwater harvesting or greywater reuse, and irrigation is inefficient. Only one common water meter is installed, offering no consumption tracking.

IV.1.3. Material Use & Waste Management

Conventional materials are used without sustainability considerations. Waste is not segregated, and there's no recycling or composting system.

IV.1.4. Occupant Health, Comfort & Accessibility

Poor indoor air quality due to lack of ventilation and high-VOC materials. No emphasis on daylight or thermal comfort. Accessibility features are minimal and just code-compliant.

IV.1.5. Community & Lifestyle Amenities

Landscape is turf-heavy and water-intensive. There's no integration of native or edible plants, and no amenities that promote sustainable living or community well-being.

IV.1.6. Construction & Awareness Initiatives

Worker welfare is minimal with limited safety measures. No sustainability education or awareness programs are provided for residents or workers.

IV.2. Proposed Case (Residential Project: Navkar as a IGBC Certified Building)

IV.2.1. Energy Efficiency

NAVKAR integrates several passive and active energy-saving measures to achieve high energy performance: A rooftop solar photovoltaic (PV) system meets 100% of the common area lighting demand, reducing dependency on grid power. The project utilizes solar water heating systems to fulfill 100% of the domestic hot water requirement for all residential units. BEE 4-star rated appliances, LED lighting, high-performance insulation, and regenerative lifts collectively contribute to a 25% reduction in total energy consumption. The project achieves a Residential Envelope Transmittance Value (RETV) of 9.01 W/m², complying with IGBC guidelines for thermal efficiency. An integrated energy monitoring system tracks real-time performance of pumps, diesel generator (DG) sets, renewable energy generation, and other common utilities.

IV.2.2. Water Conservation

NAVKAR adopts a comprehensive water management approach aimed at reducing potable water consumption and promoting reuse:
Installation of low-flow plumbing fixtures results in a 40% reduction in potable water usage. A rainwater harvesting system with two recharge pits and a total storage capacity of 9.98 m³ enhances groundwater recharge and reduces runoff. Smart water metering systems are installed at the dwelling, inlet, and landscape levels to monitor consumption effectively. Drip irrigation combined with moisture-based sensors ensures efficient water use for landscape areas.

IV.2.3. Material Use and Waste Management

The project emphasizes sustainable material selection and responsible waste handling: Construction used **recycled** content, local materials, and certified green products to minimize embodied energy and transportation impacts. Low-VOC paints and adhesives improve indoor air quality during and after construction. Construction waste was segregated and managed onsite, and provisions are in place for organic waste composting post-occupancy.

IV.2.4. Occupant Health, Comfort & Accessibility

Daylighting simulations reveal that 87.08% of common areas receive natural light levels above 110 lux, reducing the need for artificial lighting during the day. Passive design features such as cross ventilation and orientation respond to local climatic conditions, ensuring thermal comfort naturally. Six mature trees were preserved onsite, providing shade, supporting biodiversity, and enhancing the site's microclimate. The building is universally accessible, with non-slippery ramps, Braille-enabled signage, and audio-equipped elevators to support differently-abled residents.

IV.2.5. Community and Lifestyle Amenities

NAVKAR includes thoughtfully planned open spaces such as a **tot-lot**, **seating areas**, and **outdoor activity zones**, enhancing resident interaction and leisure. A **no-smoking policy** and seamless access to landscaped areas and terraces promote wellness and a healthy lifestyle. Electric vehicle charging points for 30% of the parking spaces and proximity to essential amenities (schools, markets, healthcare) promote sustainable urban living.

IV.2.6. Construction and Awareness Initiatives

Construction practices adhered to National Building Code (NBC) guidelines, providing safe worker housing, proper personal protective equipment (PPE), adequate lighting, and dust suppression mechanisms. A mobilization plan, wheel washing setup, and on-site awareness signage were implemented to minimize pollution and site disruption. Residents are engaged through green living awareness programs and receive detailed guidelines on sustainable living post-occupancy.

V. Cost Comparison:

V.1. Initial Investment

Estimated Cost	Base Case	Proposed Case	Additional Cost	Additional %
cost of construction materials	11049800	12223160	1173360	10.62
cost of Amenities, Products & Equipment	395000	1165000	770000	194.94
TOTAL	**11444800**	**13388160**	**1943360**	**16.98**

Table 1 Initial Investment Cost Analysis

Total initial cost of IGBC Certified Building is higher 16.98 % as compared to the conventional base case.

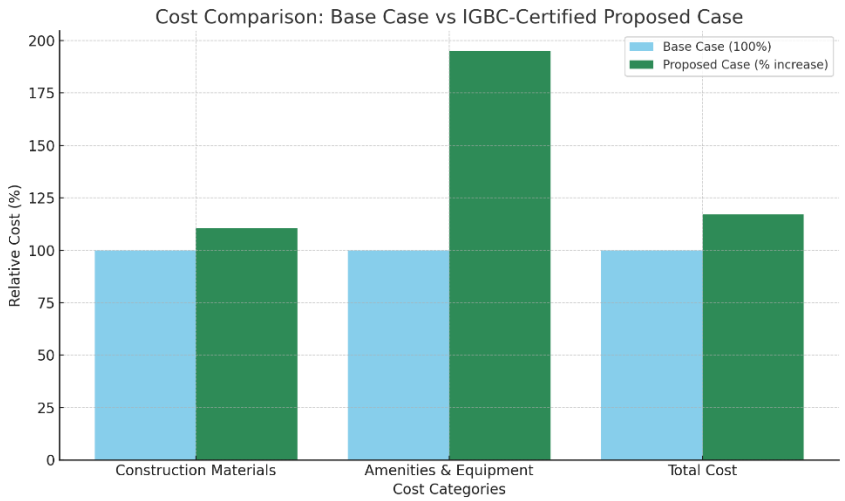

Fig.1 Cost comparison between a conventional residential building and the IGBC-certified NAVKAR project

The cost comparison between the IGBC-certified green building and the conventional base case reveals an additional investment of ₹1,943,360 in the green project. This increase is primarily due to the use of sustainable construction materials and energy-efficient amenities.

The cost of construction materials in the green building is about 10.6% higher, while the cost of amenities, products, and equipment is nearly 195% higher than in the base case.

IGBC-certified green building incurs total an initial cost premium of 16.98% compared to the conventional base case. Despite this increase in initial investment, the green building offers substantial long-term advantages. These benefits make the higher upfront cost economically viable over the building's lifecycle.

V.2. Annual Operational Savings

this investment is quickly offset by substantial operational savings. The proposed green building incorporates several sustainability measures, such as energy-efficient lighting, solar water heating systems, low-flow water fixtures, and native landscaping, all contributing to significantly lower utility costs.

Feature	Annual Saving (INR)
Energy Efficiency (Solar + Equipment)	75,700
Water Efficiency	5,869
Waste Management (OWC)	10,000
TOTAL	**91,570**

Table 2. Annual Operational savings in IGBC certified Building

These combined savings of Rs. 91,570 not only offset the higher initial investment but also ensure long-term cost efficiency.

V.3. Payback Period

The additional investment of ₹1,943,360 is recovered through annual savings of ₹91,570, resulting in a payback period of approximately 21 years:
Payback Period = 1,943,360 / 91,570 ≈ 21 years

VI. Environmental Benefits:

In the proposed case, shifting from a conventional building to a green certified building brings significant advantages. While conventional buildings tend to consume more water and energy due to standard systems and materials, the proposed green building design incorporates sustainable practices—like efficient water fixtures, rainwater harvesting, and energy-saving lighting, optimizes natural light and ventilation, and promotes better indoor air quality.

Category	Base Case (Conventional Building)	Proposed Case (IGBC-Certified Building)	Environmental Benefit
Energy Efficiency	Standard building envelope, no RETV optimization, lighting with higher LPD, conventional electrical systems	RETV of 9.01 W/sqm, efficient lighting, solar PV for 100% common lighting, BEE 4-star pumps, gearless lifts	25% energy savings; reduced GHG emissions
Water Conservation	Conventional plumbing fixtures, no reuse system, no rainwater harvesting	40% water savings using low-flow fixtures, rainwater harvesting (9.98 cum), drip irrigation, smart metering	40% potable water savings
Waste Management	No segregation, no OWC, standard municipal disposal	In-unit and common area segregation, OWC for wet waste, tie-up with recyclers and e-waste vendors	Diverts waste from landfill, reduces pollution
Materials & Resources	Use of non-certified, potentially high-emission and resource-intensive materials	49.18% cost-based use of certified green products, low-VOC paints, sustainable procurement policy	Lower embodied carbon, improved indoor air quality
Indoor Environmental Quality	No daylight or ventilation strategy, standard paints, no air quality monitoring	87.08% areas daylight compliant, low-VOC paints, natural ventilation design	Improved occupant health and comfort

Landscape & Heat Island	Turf-heavy landscaping, no rooftop treatment, minimal tree cover	76.8% native landscaping, 95% roof with SRI tiling + solar panels, 100% non-roof reflective	Local cooling effect, less irrigation, reduced heat absorption
Renewable Energy	No renewable energy system	100% of common area lighting met by solar PV	Energy independence, reduced reliance on grid electricity
Carbon Footprint	Higher due to inefficient systems and materials	Reduced via renewable energy, local sourcing, and low-carbon materials	Overall lower emissions
Water Reuse	No wastewater recycling or reuse	Not eligible for STP reuse, but extensive rainwater reuse + metering	Partial reuse via rainwater harvesting
Awareness & Education	No training, signage, or occupant guidance	Green education sessions for workers and family, signage on green features	Enhances awareness, ensures maintenance of green features

Table 3. Environmental benefits comparison between Conventional and IGBC Certified Building.

VII. Results & Finding:

In terms of energy efficiency, water conservation, material use, and indoor environmental quality, the IGBC-certified building significantly outperforms the conventional one.

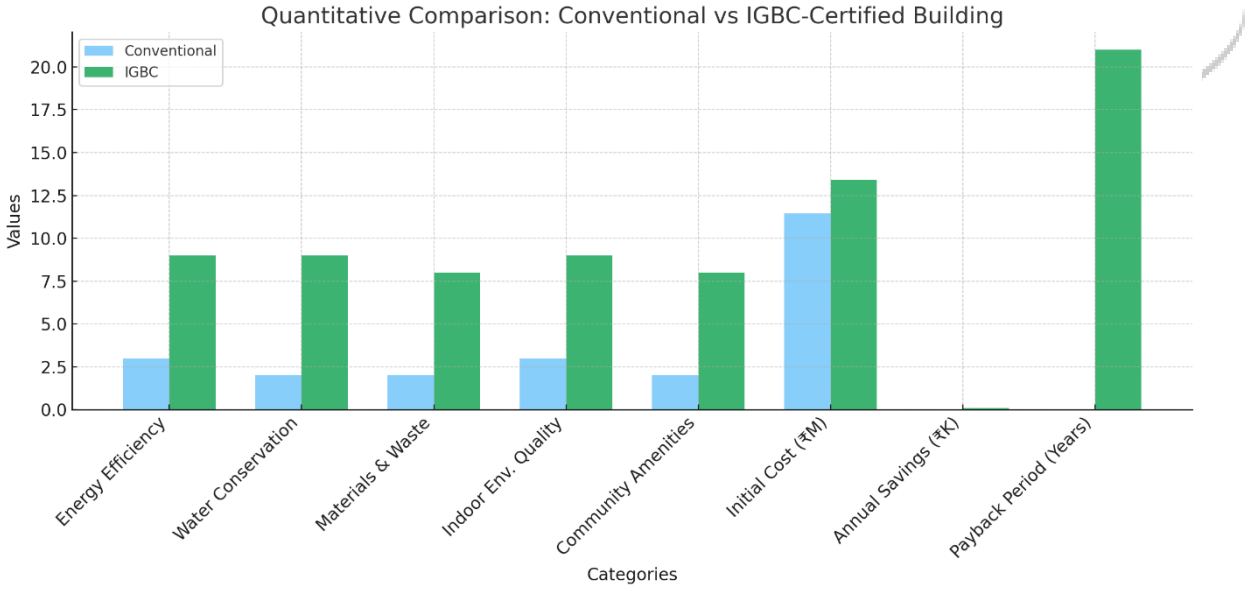

Fig.2 comparison between a conventional residential building and the IGBC-certified NAVKAR project

Energy Efficiency: IGBC building achieved 25% energy savings with solar systems, efficient lighting, and better insulation (RETV of 9.01 W/m² vs. 13 W/m² in the base case).
Water Conservation: 40% potable water savings through low-flow fixtures, rainwater harvesting, and drip irrigation.
Materials & Waste: Use of 49.18% green-certified materials, low-VOC products, and on-site composting significantly reduced environmental impact.
Indoor Environment: 87.08% daylight coverage in common areas and better ventilation improved occupant health and comfort.
Cost: Initial cost was 16.98% higher, but with annual savings of ₹91,570, the payback period is approx. 21 years.

Environmental Benefits: Lower carbon emissions, better resource efficiency, and improved urban sustainability.

VIII. Conclusion:

This study establishes that IGBC-certified residential buildings offer substantial environmental, economic, and social advantages over conventional constructions. While the upfront investment is higher, the long-term benefits—such as operational savings, improved occupant health, reduced environmental impact, and enhanced quality of life—justify the initial costs. The NAVKAR project demonstrates how integrating passive design, renewable energy, and sustainable materials leads to tangible improvements in building performance and sustainability.

Encouraging IGBC certification in housing can help cities like Pune grow in an eco-friendlier way. Green buildings save resources and reduce pollution. To make them more common, we need more awareness, government support, and help for builders and homeowners. Using IGBC standards widely can also support India's climate goals and make cities stronger and healthier.

IX. Acknowledgment

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