CHAPTER 42

Cost and Benefit Analysis of Green Buildings Versus Conventional Buildings

Gutti Ishwarya[1], *Chelluri Sadhu Siva Sankar Vamsi*[2],
Satti Manoj Lakshmi Narayana[1], *Lanka Jaya Mourya Sai*[1] *and Sanjay Bhoyar*[1]

ABSTRACT

The growing demands of environmental sustainability and urbanization make the use of green building principles imperative. This study compares the costs and benefits of green versus conventional structures in India based on lifecycle costs, greenhouse gas emissions, and energy use. The study assesses the financial and ecological effects of green building using methods like Cost-Benefit Analysis (CBA) and Life Cycle Cost Analysis (LCCA). The results show that operational cost reductions from water, energy, and sustainable materials offset the higher investment required for green buildings, which range from 16% to 43.3%. Payback periods typically range from two to six years. Office and residential building case studies indicate substantial decreases in electrical energy consumption per year (38.7%–73.9%) and improved occupant health, due to better indoor air quality and daylighting. According to research, the short-term costs of implementing green buildings are higher, with estimates of According to a systematic participant study of designers, architects, and users, the main obstacles to the adoption of green buildings are market reluctance, technical limitations, and budgetary constraints. However, long-term economic savings and environmental concerns continue to be very strong motivators. According to the report, policy measures like tax breaks and building codes are essential for green building. This study supports the move toward sustainable urban development by highlighting the financial and environmental advantages of green buildings. To accelerate the adoption of green buildings and ensure a resilient and green urban future, it encourages collaboration amongst environmental authorities, developers, and policymakers.

Keywords: Green buildings; Sustainable construction; Environmental sustainability; Cost-benefit analysis (CBA); Life Cycle Cost Analysis (LCCA); Carbon footprint; Lifecycle costs; Operational savings; Energy efficiency; Sustainable materials; Economic feasibility.

1.0 Introduction

With roughly 40% of global energy consumption including 30% of emission of greenhouse gases, the construction industry has been one of the main causes of environmental issues after the growing urbanization of the world.

[1]*School of Project Management, NICMAR University, Pune, Maharashtra, India*
[2]*Corresponding author; School of Project Management, NICMAR University, Pune, Maharashtra, India (E-mail: P2371138@student.nicmar.ac.in)*

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Despite ostensibly providing a short-term cost benefit, reliance on conventional forms has resulted in increased resource depletion, efficiency losses, and long-term maintenance expenses. These structures, which are often built with traditional materials and techniques, consume a lot of water and energy and release massive amounts of carbon dioxide over the course of their lives. However, the ecologically responsible approach is to design green buildings in accordance with internationally recognized standards like those set forth by IGBC. Green buildings lessen their environmental impact by using environmentally friendly materials, water conservation regulations, and energy-efficient designs. Green buildings are an effective method of decreasing the negative environmental effects of urban expansion because they prioritize energy efficiency, better interior air quality, and improved occupant health. Nevertheless, the widespread adoption of green buildings has fallen short of expectations in spite of all these well-established facts.

The primary obstacle that deters developers and investors is the alleged high initial investment cost. Additionally, the shift to sustainable development is hampered by unclear financial incentives, fragmentary norms, and a lack of stakeholder awareness. With reference to a model IGBC Gold-rated office structure in India, this study compares the costs and benefits of green and conventional buildings in great detail to solve these issues. The study estimates the long-term economic and ecological benefits of sustainable development by combining environmental impact analysis, energy modeling, and financial modeling. By calculating the potential cost savings, energy efficiency gains, and greenhouse gas reduction, the study seeks to produce evidence-based conclusions that inform policy changes, spur green infrastructure investment, and quicken the transition to sustainable urban development.

2.0 Research Objectives

- Compare the initial and ongoing expenses of conventional vs green structures.
- Calculate how much fewer resources such as water, energy, and carbon are used in projects that have earned IGBC certification.
- Analyse how policy incentives, such as solar subsidies and GST rebates, affect financial viability.
- Provide methods to reduce adoption obstacles by educating stakeholders and enlisting regulatory assistance.

3.0 Methodology

A combination of methods was used:

- Hypothetical Case Study: IGBC Gold requirements (AAC blocks of information, VRF HVAC, solar panelling) and traditional standards (RCC, split ACs) were used to create a 2,300-square-meter office building.

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- Financial study includes payback period, sensitivity analysis, and the net present value (NPV), or (6–10% discount rates, along with 3–7% inflation).
- Environmental Metrics: Operating carbon (CEA grid factors) and embodied carbon (ICE database).
- Stakeholder surveys: 37 experts participated in structured interviews to gauge their opinions on the viability of green buildings.

4.0 Literature Review

Research comparing green and conventional buildings emphasizes the long-term advantages of sustainable construction as well as its cost-effectiveness and environmental impact. Numerous studies have examined the economic and environmental elements of green buildings, with particular attention on life cycle costs, carbon footprint, energy usage, and occupant well-being. In Bangalore, India, Srikar *et al.* (2022) was contrasting an environmentally friendly office building with a traditional one, highlighting the fact that 39% of carbon emissions worldwide are caused by the building sector. According to their research, which used Cad 2021, SketchUp over illustration, the ICE library for embodied carbon evaluation, and STACK technology for cost estimation, sustainable buildings use a lot less power (100 kWh/m²/year compared to 180 kWh/m²/year). Double-glazed windows, rooftop solar panels, effective air conditioning and heating, and water conservation solutions are some of the key features. In a similar vein, Warang *et al.* (2023) compare conventional and sustainable structures in Thane, India, and find that the initial cost of green buildings is 21.23% more because of features like solar power and rainwater collecting. But thanks to operational savings, these investments are recouped in ten years. Green buildings encourage urban sustainability and raise property values.

Focusing on cost-benefit analysis, Saurav & Abrol (2018) discover that green buildings are cost-effective despite their higher initial costs because they use 38.7% fewer kWh than conventional ones. Boyajian & Zirakian (2019) examine a sustainable house in Los Angeles, pointing out the advantages of energy conservation and rainwater harvesting while projecting a 30% rise in building costs because of LEED certification. Life cycle cost analysis is emphasized by Appa Saheb Shantappa Ingale, who concludes that green buildings are 16% more expensive initially but pay for themselves in two to three years due to lower energy and water costs. Water expenses are greatly reduced by the study's rainwater gathering system, which gathers 64,010 litters a year. According to Rehm & Ade (2013), sustainable office buildings have reduced running costs to make up for their 2%–8% higher construction costs. According to Jadhav *et al.* (2021), the integration of Building Information Modelling, or BIM, results in better hydraulic and electrical system design, which lowers costs in energy-efficient buildings.

In their discussion of the benefits of green buildings for occupant health, Johnson *et al.* (2016) make the connection between increased productivity and decreased absenteeism and

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natural lighting, cleaner air, and thermal comfort. According to Ms. Jyoti Paramappa Kalikeri as well as Vanakudari (2023), sustainable buildings use a lot less energy and cost less to make than conventional ones. To reduce the financial hurdles to adoption, Garcia & Thompson (2018) look at monetary incentives for environmentally friendly construction, such as tax credits, discounts, and LEED certifications. The life cycle cost analysis (LCCA) approaches are examined by Luay N. Dwaikata as well as Ali (2018), who show that investments in green buildings eventually pay off financially. Stronger regulatory support is advised by Gauri Balkrishna Tarde as well as Binayake (2022), who emphasize the value of IGBC accreditation in waste management, conserving water, and energy efficiency. To promote the adoption of green buildings, Yashwanth Pamu along with Mahesh (2019) analyse the IGBC as well as GRIHA certification systems in India and call for a single rating system. All things considered; these studies show that green buildings have long-term economic plus environmental advantages despite their higher starting costs. Stakeholder awareness, financial incentives, and policy changes are essential for hastening the adoption of green construction.

5.0 Data Analysis

5.1 Building specifications

- Plot Area: 55m × 35m (1,925 sqm)
- Built-Up Area: 55m × 30m (1,650 sqm per floor, 3,300 sqm total)
- Foundation: RCC strip footing (1.5m depth, M20 grade concrete)
- Structure: RCC columns (450mm×450mm), beams, flat slab roof (150mm thick)
- Walls: 230mm clay bricks (external), 115mm AAC blocks (internal)
- HVAC: 33 split AC units (1 ton per 100 sqm)

Figure 1: Side Elevation (Left)

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Figure 2: Side Elevation (Right)

The study's data analysis compares the cost-benefit from green buildings with those of conventional buildings using a methodical technique. A two-story workplace case study was used as an example, encompassing operational, financial, and environmental issues to allow for a comprehensive evaluation. There are one-time capital charges and ongoing operating costs associated with the financial evaluation. Conventional construction methods, such as RCC constructions, clay brick barriers, single-glazed openings, and split air conditioners, were used to rate the conventional structures. Air conditioning (AAC) blocks with insulating material, windows with double glazing, VRF air conditioning systems, roof solar power panels (50 kW), and rainwater collection systems were all used in the green building, which met IGBC Gold certification requirements. CREDAI records and benchmark rates from CPWD (2023) were used to estimate the costs of both buildings. Financial modeling used 6%–10% discount rates for life-cycle cost evaluation and 3%–7% inflation rates to account for labor, material, HVAC, plumbing systems, and electrical costs.

Energy, water, and maintenance costs were used to estimate the annual operational cost. While the environmentally friendly building's energy-efficient appliances and renewable power significantly reduced utility bills, traditional buildings had higher long-term costs because they were entirely dependent on grid electricity. According to the study, compared to conventional structures, green buildings saved 40% of their water use and 37% of the energy they consumed.

By estimating the carbon impact from energy use and building material construction, the environmental advantages were quantified. Operational carbon was computed using power usage and renewable contributions, whereas embodied carbon materials including steel, bricks, and concrete were assessed using industry-standard emission factors. Over a 20-year period, green buildings reduced their operational carbon footprint by 40% and their embodied carbon

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emissions by 30%. A 40% decrease in water dependence was also attributable to rainwater collection and greywater reuse. An analysis of long-term cost savings was conducted using the net present value (NPV) technique. The results showed that, despite their initial 17.3% higher cost, green buildings conserved ₹32.7 crore in net present value (NPV) over a 20-year period, with a 7.2-year payback period. This suggests that even though they are more expensive at first, green buildings end up being more affordable in the long run because of their energy efficiency, reduced maintenance requirements, and the availability of legislative incentives like solar subsidies and GST rebates.

The data analysis demonstrates that green structures are more environmentally friendly, economically sustainable, and operationally cost-effective than conventional buildings. The organized cost-benefit analysis emphasizes how regulatory initiatives, financial rewards, and training promote green building methods in India. The study offers a solid basis for promoting environmentally friendly and cost-effective sustainable real estate development.

6.0 Conclusion

According to the study, green buildings provide significant for a long time economic and environmental advantages over conventional buildings, while requiring more capital. Green buildings save a significant amount of money on energy (37%), water (40%), and maintenance (30%), according to a thorough cost-benefit study. This results in an estimated net present value (NPV) gain of ₹32.7 crore over 20 years, with a period of payback of 7.2 years. Lower operating costs and greater environmental sustainability are the outcomes of integrating renewable energy sources, energy-efficient technologies, and sustainable building materials.

Furthermore, the 40% reduced operating carbon footprint and 30% decrease in embedded carbon emissions highlight the overall importance of green buildings in limiting climate change and lessening the negative environmental effects of urbanization. The financial attractiveness of green construction is further enhanced by policymaking incentives like GST rebates, solar subsidies, and the advantages of IGBC certification. Incentives like greater upfront costs, a lack of knowledge among customers, and policy inequalities, however, continue to be obstacles to general acceptance.

The paper highlights the need for more regulatory instruments, financial incentives, and stakeholder knowledge to accelerate the transition to sustainable real estate. Green buildings have the potential to be the next big thing in urban development thanks to the integration of life-cycle costing, environmental analysis, and cutting-edge construction technology. Overall, this study lays the groundwork for advancing green building techniques that will eventually lead to a better, cleaner built environment by offering efficiency, responsibility to the environment, and economic feasibility.

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