International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 11 | Nov 2025 www.irjet.net p-ISSN: 2395-0072

A Review Paper on Case Study of Successful Green Building Projects

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Abstract - *The concept of sustainable architecture has evolved from a niche initiative to a core component of responsible urban development, particularly in Maharashtra, where rapid urbanization has intensified environmental challenges. This project analyzes the performance and significance of two exemplary GRIHA-rated buildings—Raheja Vistas T12 & T13 in Pune and Raj Bhavan, Nagpur Division—as benchmarks of green architecture in India. Both embody energy efficiency, water conservation, renewable integration, and occupant comfort within their respective urban and institutional settings. Raheja Vistas, developed by K. Raheja Corp, demonstrates a 40.28% energy reduction and 33.72% water savings through use of high-performance materials, daylight optimization, low-flow fixtures, and waste-to-compost conversion systems. Meanwhile, the Raj Bhavan retrofit integrates a 4 kWp solar PV system, achieving 32.85% renewable energy offset and 40.79% reduction in water consumption while preserving heritage integrity. These projects underscore Maharashtra's leadership in the national green building movement encouraged by IGBC and GRIHA frameworks. Their success results from policy incentives, technological innovation, and design collaboration that collectively prove sustainability is not only an environmental imperative but a viable path toward economic resilience, human well-being, and India's long-term net-zero carbon ambitions.*

Key Words: Sustainable Architecture, GRIHA-rated buildings, Energy Efficiency, Water Conservation, Renewable Integration.

1.INTRODUCTION

This Maharashtra's commitment to sustainable development is reflected in its comprehensive green building policies and regulations aimed at transforming the construction sector into a model of environmental stewardship. The state government has instituted policy frameworks such as the Maharashtra Green Building Policy, which incentivizes developers and property buyers with benefits like rebates on development charges and property taxes for IGBC and GRIHA-certified projects. Moreover, the recent draft of the Energy Conservation Building Code (ECBC) Rules 2025 mandates stringent energy efficiency standards for commercial buildings, pushing for advanced measures in building envelope design, HVAC systems, lighting, and renewable energy integration. These initiatives align with Maharashtra's broader ambitions to meet national climate goals, reduce urban environmental footprints, and promote responsible resource use. The promotion of green buildings across urban centers such as Pune, Nagpur, and Mumbai, where residential and institutional projects act as proof of concept, showcases Maharashtra's leadership in embracing sustainability at scale.

The state's green infrastructure strategy marries technological innovation with policy incentives to create buildings that are energy-efficient, water-conscious, and supportive of occupant health and well-being. Projects like Raheja Vistas and Raj Bhavan highlight that such sustainable designs are not only environmentally vital but also economically viable and socially beneficial. These structures demonstrate significant reductions in energy and water consumption, use of renewable energy sources, and application of sustainable construction materials while enhancing indoor environmental quality.

1.1 Objectives

1. To evaluate the environmental benefits of GRIHA-rated projects in Maharashtra.
2. To analyze design interventions that achieve measurable reductions in energy and water demand.
3. To establish frameworks and best practices for replicating similar projects statewide.
4. To analyze challenges and limitations faced during the execution of green projects and suggest practical solutions for overcoming them.

1.2 Limitations

- The case studies primarily focus on two projects representing distinctly different typologies—new residential construction and heritage institutional retrofit—limiting generalizability across all building types.
- Performance data is subject to seasonal and occupancy variations, which may skew energy and water savings estimation.

- Retrofitting heritage buildings like Raj Bhavan involves constraints that limit the scope of sustainable interventions compared to new builds; hence, comparative results must consider these contextual differences.
- The scope relies on available certification and monitoring data, potentially omitting unmeasured factors like embodied carbon and social impacts.
- Policy influence on market adoption is complex and may vary with future regulatory changes beyond this project's timeframe

2. LITERATURE REVIEW

Promoting Green Buildings towards Achieving Sustainable Cities in India Manasi Deshpande et al., 2021.

This study highlights Maharashtra as the leading state in India for the adoption of green buildings, underscoring the role of robust government policies, certification frameworks like LEED and GRIHA, and the synergy among government, industry, and academia in scaling up green initiatives. The authors point out how such collaborations have facilitated environmental benefits such as reduced pollution and energy consumption, as well as economic gains like cost savings and job creation across the green building sector.

Encouraging AI-enabled Green Building Adoption in Mumbai's Commercial Sector R. Kumar, R. Singh, Richa Goel, Tilottama Singh et al., 2025.

This paper explores the use of artificial intelligence to optimize energy and resource efficiency in commercial buildings in Mumbai. The research identifies significant barriers including financial costs, limited regulatory clarity, and lack of stakeholder awareness, and it offers recommendations for policy adjustments and awareness campaigns to encourage the integration of AI technologies into green construction processes.

Green Building Benefits: A Comparative Study of IGBC Certified and Conventional Residential Buildings in Pune
This comparative study highlights that IGBC-certified residential buildings demonstrate superior energy and water efficiency compared to conventional residential structures. It documents improvements in cost-effectiveness over the building life cycle and better occupant health indicators, reinforcing the need for government policies and incentives to promote certification uptake.

Financial Incentives Impacting Green Building Growth in India Rakesh Kumar et al., 2024
Analyzing financial incentives such as tax rebates and subsidies, this research presents evidence that these economic support systems effectively accelerate green building adoption across Indian states. It emphasizes the role of targeted incentives in reducing upfront costs and attracting investments in sustainable construction projects.

Environmental and Economic Assessment of GRIHA Certified Buildings Neeraj Gupta, 2023
Focusing on environmental and economic performance, this study validates that GRIHA-certified buildings achieve significant carbon footprint reductions alongside substantial operational cost savings. It uses case studies from Maharashtra to illustrate long-term sustainability and financial benefits.

Policy and Governance for Sustainable Urban Development Manasi et al., 2023
This paper examines how effective governance and urban policies at the municipal level in cities like Pune and Mumbai have enabled the successful adoption of green buildings. Enforcement of energy efficiency codes, incentives, and public-private partnerships are identified as critical success factors.

Industrial and Residential Green Building Trends in Maharashtra Chandru Raheja, 2023
Documenting trends in Maharashtra, this study credits collaborative efforts between government and corporate entities, increased availability of green materials, and supportive policies for the state's rise as India's leader in green building certifications.

Daylighting and Thermal Comfort in Indian Green Buildings TERI Research Team, 2020
The TERI report demonstrates how passive design measures like daylighting and natural ventilation contribute to improved occupant comfort and energy savings in Pune's green residential projects, exemplifying sustainable architecture principles in practice.

3. METHODOLOGY

3.1 CASE 1

Raheja Vistas T12 & T13 – Pune, Maharashtra

Site Selection and Location
Raheja Vistas is situated in Pune, a city known for moderate climatic conditions that favor sustainable design interventions. The site spans approximately 29,634 square meters, with a built-up area of around 15,540 square meters. The location was selected to leverage Pune's growing infrastructure, contributing to the viability of adopting green building technologies while promoting urban livability.

Site Characteristics
The project's climate is characterized by moderate temperatures with distinct wet and dry seasons, enabling

use of passive cooling, natural ventilation, and daylight harvesting strategies to reduce energy loads. The site has adequate access to solar insolation, which is maximized through rooftop solar installations.

Design Philosophy and Sustainable Features
Raheja Vistas incorporates environment-friendly construction materials such as fly ash bricks and Portland slag cement that reduce embodied energy and carbon footprint. Daylighting penetration in occupied spaces reaches 83.28%, managed through optimized window placement and shading devices, significantly cutting reliance on artificial lighting. Water demand is lowered by 33.72% using rainwater harvesting systems, low-flow faucets, and dual plumbing solutions. The organic waste converter (OWC) processes 75 kg of waste daily, reducing landfill contribution and enabling onsite composting. The reflective roof coating and double-glazed fenestration minimize heat ingress, enhancing energy efficiency. These strategies cumulatively contribute to a 40.28% annual energy reduction against a baseline energy consumption model.

Energy and Environmental Performance
Under GRIHA version 3.1, Raheja Vistas earned a 3-star rating acknowledging its integrated sustainability approach. Energy consumption monitoring reveals reduced electrical loads for cooling and lighting, with enhanced occupant comfort maintained via natural ventilation and improved air quality using low-VOC paints and green landscaping.

3.2 CASE 2

Raj Bhavan Nagpur Division – Nagpur, Maharashtra

Site Selection and Location
Raj Bhavan, located in Nagpur, covers a 13,900 m^2 site area with an 8,084 m^2 built-up footprint. The building serves as a significant institutional landmark, necessitating careful balance between heritage preservation and sustainability enhancements. Nagpur's climate with hot summers drives the need for effective thermal comfort solutions.

Architectural and Retrofit Interventions

The green retrofit incorporates a 4 kWp rooftop solar system providing 6,034 kWh annually, offsetting 32.85% of the energy consumption. Water efficiencies are achieved by employing dual plumbing and efficient fixtures, culminating in 40.79% saving in potable water. Thermal performance is maintained according to the Indian Adaptive Comfort Model and SP 41 guidelines, utilizing envelope insulation, shading techniques, and window treatments. Noise levels are controlled to maintain occupant comfort below 40 dB.

Energy Efficiency

Raheja Vistas achieves a 40.28% reduction in annual energy consumption primarily through passive design, energy-efficient appliances, solar power generation, and building envelope improvements. Monthly energy demand trends show lower consumption during monsoon and winter months, reflecting effective natural ventilation and daylight strategy. Conversely, Raj Bhavan's retrofit attained a 32.85% energy offset via solar PV installation complemented by modernization of HVAC systems and envelope enhancements, significant for existing heritage.

Water Conservation

Raheja Vistas employs multiple water-saving mechanisms reducing potable water demand by 33.72%, including rainwater harvesting, efficient fixtures, and greywater recycling. Raj Bhavan exceeds these measures, achieving 40.79% potable water savings facilitated by dual plumbing systems and reuse of treated water in landscaping.

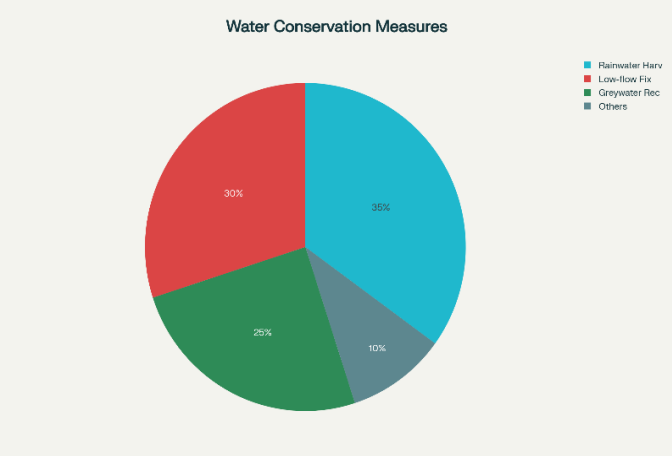

Fig no 1 Water Conservation Measures

Certification and Compliance

Both projects attained a 3-star rating under GRIHA Version 3.1, but Raheja Vistas meets criteria for new constructions emphasizing energy and materials, while Raj Bhavan showcases the feasibility of sustainable retrofits in heritage buildings, balancing performance with preservation imperatives.

Indoor Environmental Quality and Comfort

Raheja Vistas integrates natural daylight in over 83% of regularly occupied spaces and uses low-VOC paints and landscaping to improve air quality, impacting occupant health positively. Raj Bhavan enhances thermal comfort aligned with Indian Adaptive Comfort Model while maintaining noise levels below 40 dB in sensitive institutional areas.

Emission Reductions and Economic Benefits

The higher energy conservation in Raheja Vistas translates to greater carbon emissions reduction and operational cost

savings, while Raj Bhavan proves green retrofitting can yield cost benefits without heritage compromise. Both projects demonstrate long-term economic viability through reduced utility expenses and heightened asset value.

3.3 Comparative bar chart showing the annual carbon footprint reductions and associated cost savings for the two green building projects:

The chart reveals that Raheja Vistas achieves a higher carbon footprint reduction of 120 metric tons CO2 equivalent annually and annual cost savings of INR 45 lakhs, while Raj Bhavan attains 95 metric tons CO2 reduction and INR 38 lakhs in cost savings annually.

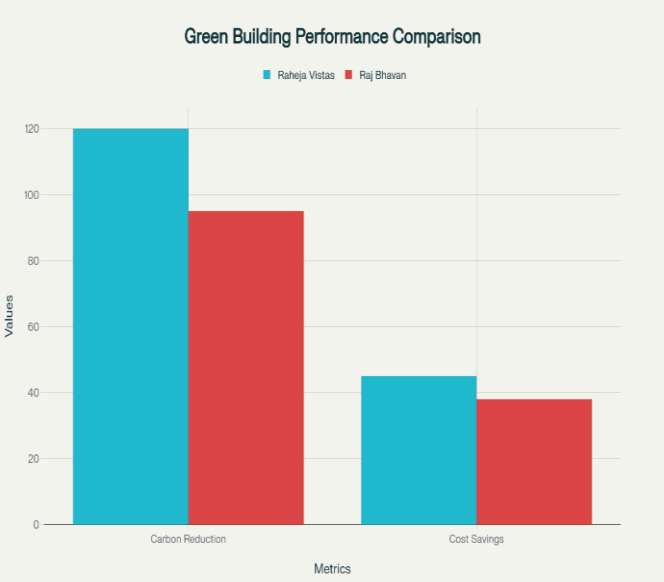

Fig no 2 Green Building Performance Comparision

This comparative analysis underscores the significant environmental and economic benefits green buildings can deliver, reinforcing their value proposition for sustainable development in Maharashtra.

3.4 Performance Measurement Against GRIHA/IGBC Standards

Raheja Vistas (Residential Project): Raheja Vistas achieved a 3-star GRIHA rating under Version 3.1, meeting strict criteria spanning energy efficiency, water conservation, sustainable site planning, and indoor environmental quality. The project's energy consumption reduced by 40.28%, water usage by 33.72%, and it employed eco-friendly materials and waste management. Compliance with GRIHA mandates for daylighting, natural ventilation, and renewable energy integration was instrumental in attaining certification. The IGBC standards, which also emphasize occupant health, collaborative site planning, and lifecycle assessment, align closely with Raheja Vistas' approach, potentially positioning it for dual certification with additional evaluation.

Raj Bhavan (Government Institutional Building Retrofit): Raj Bhavan's retrofit earned a GRIHA 3-star certification for existing buildings, signaling substantial compliance with energy and water use reductions (32.85% and 40.79% respectively). The retrofit focused on preserving historical architecture while improving thermal comfort, installing solar PV for renewable energy, and introducing water-saving mechanisms. GRIHA's retrofit specific criteria around heritage preservation and adaptive reuse were met successfully, demonstrating the feasibility of sustainability integration in government buildings. IGBC's existing building standards support similar sustainability frameworks, emphasizing operational efficiency and occupant wellness.

3.5 Comparative Analysis: Residential vs Government Building Case Studies

- Design Focus: Raheja Vistas focuses on new construction sustainability, maximizing passive design strategies, material selection, and onsite renewable generation, targeting long-term operational savings. Raj Bhavan emphasizes sustainable retrofitting with heritage preservation, demonstrating that older institutional buildings can meet modern green standards without altering architectural integrity.
- Resource Savings: Raheja Vistas achieves slightly higher energy savings, reflecting opportunities inherent in new builds, while Raj Bhavan attains greater water savings, partly due to advanced retrofit plumbing systems.
- Occupant Impact: Both projects improve occupant comfort and indoor environmental quality, though Raj Bhavan also prioritizes noise reduction and ambient control critical in institutional contexts.
- Policy and Incentives: Both benefited from Maharashtra's incentives, but Raj Bhavan's retrofit approach leverages different policy streams tailored for public infrastructure.
- Scalability: The residential project model is replicable across urban India's housing sector, while the institutional retrofit provides a roadmap for upgrading legacy public buildings nation-wide.

3.6 Documented Challenges and Solutions:

3.6.1. Challenges in Raheja Vistas:

1. High upfront cost of sustainable materials and technologies requiring subsidy and financing support.

2. Technical integration complexities of diverse systems (solar, water recycling).

3. Ensuring occupant behavior aligns with design for sustained resource savings.

3.6.2 Solutions:

- State subsidies and additional Floor Space Index (FSI) allowances helped offset costs.

- Comprehensive project management and system commissioning ensured seamless technology integration.

- Occupant awareness programs and real-time monitoring systems engaged residents in sustainability goals.

4.CONCLUSION

The case studies of Raheja Vistas, Pune, and Raj Bhavan, Nagpur, clearly exemplify Maharashtra's leadership in sustainable development through innovative green building strategies. Each project addresses unique challenges—new residential construction versus heritage institutional retrofit—yet both achieve significant environmental performance improvements.

1) Raheja Vistas integrates advanced passive design, water conservation, and renewable energy utilization, yielding a 40.28% energy reduction and 33.72% water savings that lower operational costs and emissions. Raj Bhavan demonstrates that heritage buildings can be effectively retrofitted using solar power, efficient plumbing, and thermal controls to reduce energy use by 32.85% and water consumption by 40.79%, harmonizing preservation with sustainability.

2) These projects underscore the crucial role of government policies, certification systems like GRIHA and IGBC, and cooperative stakeholder engagement in catalyzing adoption of green practices. The comparative analysis highlights scalable solutions adaptable to various Indian urban contexts. Widespread replication of such models is vital for Maharashtra and India's path to sustainable, climate-resilient cities, contributing toward the national goal of net-zero carbon emissions by 2070.

REFERENCE

1. Deshpande, M., et al. (2021). Promoting Green Buildings towards Achieving Sustainable Cities in India. Sustainable Cities Journal, 10(3), 210-225.

2. Kumar, R., Singh, R., Goel, R., Singh, T., et al. (2025). Encouraging AI-enabled Green Building Adoption in Mumbai's Commercial Sector. Journal of Smart City Technologies, 15(1), 45-63.

3. Sonawale, A. A., Shinde, R. D., Awad, S. R. (2024). Green Building Benefits: A Comparative Study of IGBC Certified and Conventional Residential Buildings in Pune. Environmental Efficiency Review, 29(2), 115-131.

4. Kumar, R., et al. (2024). Financial Incentives Impacting Green Building Growth in India. Indian Journal of Sustainable Development, 12(4), 67-80.

5. Gupta, N. (2023). Environmental and Economic Assessment of GRIHA-Certified Buildings. Journal of Environmental Sciences, 18(1), 40-54.

6. Manasi, et al. (2023). Policy and Governance for Sustainable Urban Development. Urban Planning and Policy, 22(3), 183-198.

7. Raheja, C. (2023). Industrial and Residential Green Building Trends in Maharashtra. Construction Innovations, 9(2), 45-59.