CHAPTER 113

Retrofitting of Conventional Building to Green Building

Jadhav Ranjeet Anil[1], Sangale Sagar Sharad[1], Rutvik Rajendra Gulalkari[1], Rushikesh Kishor Patil[2] and Shruti Vaishampayan1[3]

ABSTRACT

Retrofitting is an essential method of modernizing existing structures by substituting sustainable materials for antiquated ones, improving the building's functionality and occupants' quality of life. The commercial dynamics of converting existing buildings into sustainable constructions through retrofitting are examined in this study. By using renewable resources like solar systems, vertical gardens, LED lighting, vermicomposting, and grass pavers, the research aims to lessen the environmental impact of buildings. Additionally examined are a number of groundwater replenishment methods, such as the use of environmentally friendly materials and permeable concrete. The approach evaluates the financial viability of retrofitting projects by doing a thorough cost analysis of installation and construction. Results show that sustainable retrofitting decreases resource depletion, increases energy efficiency, and drastically lowers life-cycle costs. It also promotes ecological balance and improves urban beauty. The study emphasizes how retrofitting may be used practically to lessen the consequences of climate change, lower carbon footprints, and support sustainable building methods. In order to future-proof urban environments, traditional buildings must be converted into retrofit structures.

Keywords: Retrofitting; Sustainable construction; Renewable resources; Life-cycle cost reduction; Environmental impact.

1.0 Introduction

Global temperatures have risen by approximately 1°C in the past century due to extensive fossil fuel consumption, with projections indicating a potential 6°C rise by 2100 (Bradford, 2013). This escalation poses severe environmental threats, including rising sea levels and extreme climate events. Retrofitting existing buildings with energy-efficient features is a practical solution to mitigate climate change effects by reducing energy consumption, primarily from lighting, HVAC, and electrical appliances, which constitute up to 80% of a building's total energy demand.

[1]*School of Project Management, NICMAR University, Pune, Maharashtra, India*

[2]*Corresponding author; School of Project Management, NICMAR University, Pune, Maharashtra, India (E-mail: P2371144@student.nicmar.ac.in)*

[3]*School of Architecture and Planning, NICMAR University, Pune, Maharashtra, India*

DOI: 10.17492/JPI/NICMAR/2507113 *ISBN: 978-93-49790-54-4*

In India, retrofitting is gaining traction as a sustainable practice incorporating eco-friendly materials, energy-saving techniques, and operational upgrades. Despite initial costs, retrofitting yields long-term benefits such as lower energy and water consumption, reduced waste management costs, and enhanced environmental sustainability. Retrofitting involves upgrading structures with modern technologies and materials to improve energy efficiency, safety, and durability without complete reconstruction. Common retrofitting strategies include structural reinforcements for seismic resistance, energy-efficient HVAC systems, sustainable insulation, and code-compliant safety enhancements.

The benefits include resource conservation, cost-effectiveness, energy efficiency, improved safety, and adaptability to evolving needs. Retrofitted buildings feature optimized energy and water usage, renewable energy integration, sustainable materials, enhanced indoor air quality, and climate-responsive designs. In India, retrofitting performance is assessed through rating systems like the Indian Green Building Council (IGBC), Green Rating for Integrated Habitat Assessment (GRIHA), and Bureau of Energy Efficiency (BEE) ratings. This study aims to develop a sustainable retrofitting strategy for residential buildings to optimize energy and water efficiency, minimize environmental impact, and improve occupant well-being by evaluating conventional residential buildings, comparing design strategies, and proposing sustainable retrofitting methodologies.

1.1 Aim and objectives

Aim: This study aims to propose a sustainable retrofitting strategy for residential buildings to optimize energy and water usage, minimize environmental impact, and improve occupant well-being.

Objectives

- To evaluate the environmental impact of conventional residential buildings.
- To compare passive design strategies, material choices, energy consumption, and water management in traditional and retrofitted residential structures.
- To analyze sustainable retrofitting materials and methodologies and develop an optimized retrofitting proposal.

2.0 Literature Review

To examine how risk management functions in the procurement and project execution processes Examine how important risk management is to maintaining project effectiveness, cost containment, and schedule compliance. Determine the typical risk factors such as operational, financial, and regulatory compliance issues that have an impact on project execution and procurement. Examine the ways that proactive risk management techniques help to lower uncertainty and enhance project results. To investigate how risk software and tender analysis are integrated Examine how analytical software and digital tools can help modernize the processes

DOI: 10.17492/JPI/NICMAR/2507113 ISBN: 978-93-49790-54-4

used to evaluate tenders. Examine how risk software aids in assessing contractor bids by taking into account aspects like technical know-how, experience, and quality assurance in addition to cost. Determine which essential components of risk software such as scenario simulations, predictive analytics, and automated risk assessments improve decision-making. To investigate how data-driven risk assessment affects the evaluation of tenders Examine how prior project performance and data can be used to enhance contractor selection and tender review.

Analyze how well data analytics can forecast project hazards like overspending, poor quality, or inefficient contractors. Examine how businesses may use risk data to make procurement procedures more unbiased and transparent. To evaluate how risk software can increase project success rates Examine the ways in which risk-based tendering enhances decision-making and produces better project results in terms of budget, schedule, and quality. Examine how automation expedites the contractor selection process, improves efficiency, and lowers manual mistake rates.

Examine real-world examples or case studies where risk software has reduced interruptions and enabled successful project execution. To determine the obstacles and constraints associated with implementing risk software for contract evaluation Examine possible obstacles to risk software adoption, such as excessive installation costs, a lack of technical know-how, or change aversion. Evaluate how well the current risk software solutions handle the difficulties involved in tender review and procurement. Make suggestions for enhancing risk management software integration to optimize its advantages for businesses.

3.0 Selection and Investigation of the Site

Godrej Bhavan, Mumbai—A Retrofitting Case Study: The 1962 construction of Godrej Bhavan, a six-story commercial office building in South Mumbai, was chosen for retrofitting because of its strategic position, deteriorating infrastructure, high running costs, and compatibility with Godrej's sustainability objectives. 595,680 kWh of electricity were used annually, according to a pre-retrofit assessment, mostly as a result of inefficient water, HVAC, and lighting systems.

Opportunities for solar panels, rainwater collection, and wastewater recycling were found during structural and MEP assessments. A 4.7-year payback period and a 26.3% decrease in electricity expenses after the retrofit were projected via a cost-benefit analysis. In order to maximize efficiency, the feasibility study investigated integrating a contemporary Building Management System (BMS) and earning LEED Platinum certification. The Godrej Bhavan renovation serves as an example of how energy audits, sustainable modifications, and thoughtful site selection may improve building efficiency while lowering operating costs and environmental effect. Godrej Bhavan's retrofitting serves as an example of how energy audits and thoughtful site selection may increase sustainability, save operating costs, and boost building efficiency.

DOI: 10.17492/JPI/NICMAR/2507113 *ISBN: 978-93-49790-54-4*

4.0 Discussion and Results

Significant energy and financial savings were achieved as a result of the retrofitting of Godrej Bhavan in Mumbai in 2010. The retrofitting project focused on improving energy efficiency and sustainability. A high-efficiency Trane screw chiller with a coefficient of performance of 5.5 was installed in place of the antiquated DX system, which resulted in a reduction of 12% in the amount of energy that was consumed for cooling purposes. Improvements in lighting efficiency were made by switching from inefficient T-12 fluorescent lights to more efficient T-5 bulbs and using automated controls. Rainwater collection and water recycling systems were implemented for purposes that do not require potable water, hence reducing the amount of water that is required. For the purpose of the real-time monitoring and optimization of energy consumption, a Trane Building Energy Management System (BMS) was installed.

However, annual data indicates:

Before Retrofit: (Baseline Year): The building's annual electricity consumption was 595,680 kilowatt-hours (kWh).

After Retrofit:

- First Year (FY 2010-11): Consumption decreased to 527,160 kWh, an 11.4% reduction.
- Second Year (FY 2011–12): Decreased even further to 521,856 kWh, which is a 12.3% decrease from the baseline.

These improvements led to a 26.3% reduction in electricity costs in the first year and 28.6% in the second year, with the retrofit investment projected to be recovered within approximately 4.7 years. By retrofitting the building, the sustainability of the structure and its long-term operational efficiency were greatly improved.

Result: Specific annually energy consumption figures for Godrej Bhavan before and after its 2010 retrofit are as follows. However, annual data indicates:

Table 1: Energy Efficiency

Energy Efficiency				
Sr. No.	**Parameters**	**Before Retrofit (kWh/Year)**	**After Retrofit (kWh/Year)**	**Saving/Profit (kWh/Year)**
1.	Electricity Consumption	595,680	521,856	73,824

Table 2: Water Efficiency per Day

Water Efficiency				
Sr. No.	**Parameters**	**Before Retrofit (Liter/Day)**	**After Retrofit (Liter/Day)**	**Saving/Profit (Liter/Day)**
1.	Water Consumption	20,000	14,000	6,000

DOI: 10.17492/JPI/NICMAR/2507113 ISBN: 978-93-49790-54-4

Table 3: Water Efficiency per Year

Water Efficiency				
Sr. No.	**Parameters**	**Before Retrofit (Liter/Year)**	**After Retrofit (Liter/Year)**	**Saving/Profit (Liter/Year)**
1.	Rainwater Harvesting	-	2,125,000	2,125,000
2.	Wastewater Recycling	-	6,170,000	6,170,000

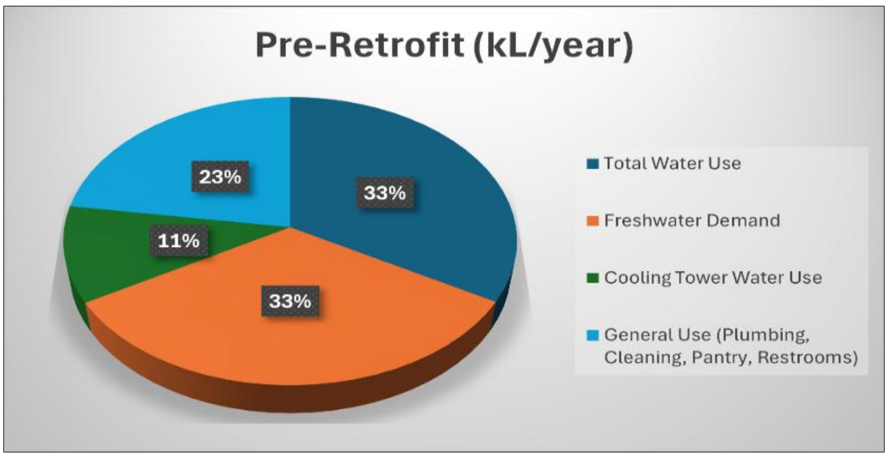
Table 4: Comparison of Retrofits Before & After

Parameter	Pre-Retrofit (kL/year)	Post-Retrofit (kL/year)	Reduction %
Total Water Use	10,750	7,777	27.6%
Freshwater Demand	10,750	0 (fully met by rainwater & recycling)	100%
Cooling Tower Water Use	3,490	2,795	20%
General Use (Plumbing, Cleaning, Pantry, Restrooms)	7,300	5,110	30%

5.0 Conclusion

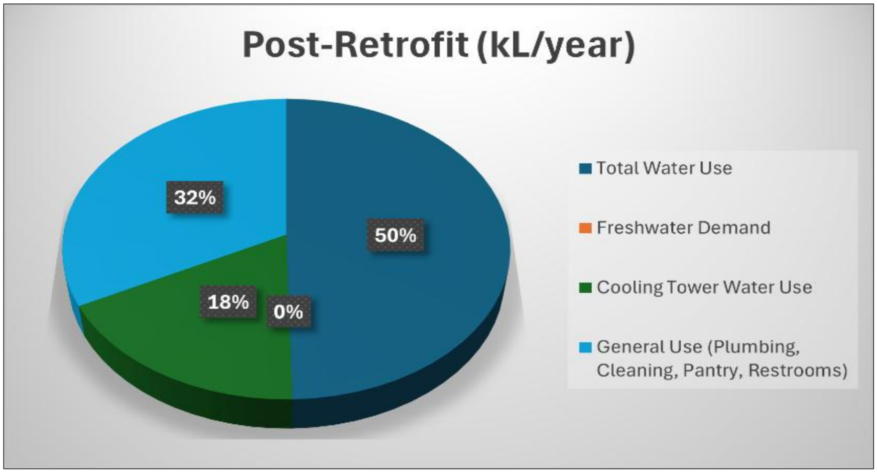
Retrofitting is a strategic approach to improving building safety, efficiency, and longevity by addressing structural deficiencies, upgrading systems, and enhancing energy performance, ultimately increasing property value and promoting sustainability. It significantly reduces energy consumption and operational costs through advanced HVAC systems, better insulation, and smart technologies while extending a building's lifespan by modernizing outdated systems.

Figure 1: Pre-Retrofit



DOI: 10.17492/JPI/NICMAR/2507113 ISBN: 978-93-49790-54-4

Figure 2: Post-Retrofit



Retrofitting enhances property value by making buildings more attractive to tenants and buyers and improves safety by strengthening structures against seismic activity and extreme weather. Environmentally, it reduces energy use, minimizes waste, and encourages sustainable materials, contributing to long-term sustainability. Additionally, retrofitting increases adaptability, allowing buildings to accommodate future needs, and offers long-term cost savings despite initial investment. The successful retrofit of Godrej Bhavan exemplifies these benefits, transforming an aging commercial structure into a sustainable green building through targeted efficiency improvements, leading to significant energy savings, reduced operational costs, and lower environmental impact.

References

Bisegna, F., Mattoni, B., Gori, P., Asdrubali, F., Guattari, C., Evangelisti, L., Sambuco, S., & Bianchi, F. (2016). Influence of insulating materials on green building rating system results. *Energies, 9*(9), 712. https://doi.org/10.3390/en9090712

Çiner, F., & Doğan-Sağlamtimur, N. (2019). Environmental and sustainable aspects of green building: A review. *IOP Conference Series: Materials Science and Engineering, 706*(1), 012001. https://doi.org/10.1088/1757-899X/706/1/012001

Ding, Z., Fan, Z., Tam, V. W. Y., Bian, Y., Li, S., Illankoon, I. C. S., & Moon, S. (2018). Green building evaluation system implementation. *Building and Environment, 133*, 32–40. https://doi.org/10.1016/j.buildenv.2018.02.012

Doan, D. T., Tran, H. V., Aigwi, I. E., Naismith, N., Ghaffarianhoseini, A., & Ghaffarianhoseini, A. (2023). Green building rating systems: A critical comparison between LOTUS, LEED, and Green Mark. *Environmental Research Communications, 5*(7), 075008. https://doi.org/10.1088/2515-7620/ace613

Li, X., Feng, W., Liu, X., & Yang, Y. (2023). A comparative analysis of green building rating systems in China and the United States. *Sustainable Cities and Society, 93*, 104520. https://doi.org/10.1016/j.scs.2023.104520

Song, Y., Lau, S.-K., Lau, S. S. Y., & Song, D. (2023). A comparative study on architectural design-related requirements of green building rating systems for new buildings. *Buildings, 13*(1), 124. https://doi.org/10.3390/buildings13010124

DOI: 10.17492/JPI/NICMAR/2507113 *ISBN: 978-93-49790-54-4*