CHAPTER 49

Design a Framework for Conversion of Existing Buildings into Green Buildings

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ABSTRACT

Conventional buildings, which frequently contribute significantly to energy use and resource depletion, are being reevaluated in light of the growing pressure to address environmental concerns. In order to maximize energy efficiency, lower operating costs, and lessen environmental effect, this research offers a thorough framework for transforming existing conventional structures into green buildings. This study's main goal is to create a workable solution that can be easily applied to many kinds of buildings and advance sustainability in the built environment. In order to determine practical techniques for retrofitting conventional structures, the research used a mixed-methods approach, analyzing case studies, existing literature, and expert interviews. Important conclusions show that incorporating green building principles, like water conservation, energy-efficient systems, and sustainable materials, can result in significant resource and pollution savings. In particular, putting these measures into practice not only improves a building's environmental impact but also provides owners and tenants with substantial financial gains. Homeowners, building managers, and legislators can all benefit from this paradigm, which offers practical insights into converting traditional buildings into sustainable settings. The goal of this research is to increase knowledge about green building techniques so that people and communities may make wise decisions that will lead to a more sustainable future.

Keywords: Green buildings; Retrofitting buildings; Energy efficiency; Effects on the Environment; Sustainable energy; Conserving water; Emissions of Carbon; Quality of indoor air; Changes in climate; Intelligent HVAC systems; Monetary rewards.

1.0 Introduction

Green or sustainable buildings try to make a lesser environmental impact by less dependence on fossil fuels, greater energy efficiency, water conservation, and sustainable material usage. These constructions put occupant health and comfort first, building environments that foster well-being while conserving resources.

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Due to urbanization, resource decline, and global warming, green building practices have moved from niche to mainstream in the construction sector. The construction sector has always been a contributor to environmental concerns such as pollution, global warming, and loss of natural resources because of unchecked development and growth in population. Green building methods were thus formed to minimize non-renewable resource use, reduce waste, and enhance energy efficiency. They employ renewable sources of energy, sustainable materials, and innovative technologies to design structures with a smaller environmental impact and optimal human health and productivity.

Green buildings are made energy-efficient by technologies like smart HVAC systems, improved insulation, and energy-efficient lighting. Water conservation is also an important aspect, attained through low-flow fixtures, rainwater harvesting systems, and drought-resistant landscaping. The use of sustainable materials, which are recycled, renewable, or locally available, also decreases environmental footprint by reducing waste and promoting a circular economy. Apart from environmental advantages, green buildings also yield considerable economic benefits.

Although construction costs are higher in the beginning, long-term energy consumption, water usage, and maintenance expense savings are considerable. Green buildings also command greater market value and are becoming highly desirable to tenants and customers who prioritize sustainability. Additionally, the green building industry generates jobs, boosts local economies, and saves operational expenses. Overall, society benefits.

Lastly, green buildings enhance community resilience by enabling sustainable urban planning and providing healthier, more comfortable working and living environments. They assist in developing social responsibility and environmental stewardship in communities, ensuring a quality life for future and present generations. As sustainable building continues to improve, it will continue to be an essential instrument in responding to environmental issues and creating a more sustainable future.

2.0 Literature Review

Several studies highlight that in order to prevent environmental deterioration and guarantee sustainable urban development, eco-friendly building techniques—such as energy efficiency, the use of renewable energy, and sustainable materials—are essential. Research highlights the benefits of subterranean construction in terms of preserving temperature control and conserving land, while green building technologies like BIM optimize water and energy use. Reducing resource use and reliance on traditional energy sources is made possible by green technology like recycled concrete and renewable power sources like solar energy. Designing a sustainable urban future that successfully addresses resource issues and climate change requires combining several techniques, such as the usage of Zero Energy Buildings.

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2.1 Green buildings

Pawar, (2012). Case Study 1st Internals-Alternative Building Materials-15CV653, March, CV. By emphasizing sustainability, green buildings seek to lessen the negative effects of construction on the environment and human health. The main goal is to reduce reliance on nonrenewable resources while increasing resource efficiency, which includes material reuse and recycling. The significance of green construction methods in advancing environmental sustainability is emphasized by the Journal of Engineering Research and Studies. In particular, energy saving, resource optimization, and the use of sustainable, alternative building materials are intended to lower the carbon footprint of buildings.

Green building approaches have been characterized as both exciting and demanding in India. On the one hand, the nation has made great progress in promoting the recovery and recycling of construction materials, which contributes to the preservation of natural resources and energy. However, there have been a number of obstacles to the shift to green buildings, such as logistical, financial, and technological ones. Notwithstanding these challenges, the government has played a critical role in raising awareness and encouraging energy-efficient building practices. This focus on sustainability in construction methods is part of a larger worldwide trend toward more ecologically friendly and sustainable building methods.

2.2 Evaluation of existing buildings

Bansal *et al.*, (2013). "Evaluation of existing buildings' green quotient." Volume 3, Issue 5, International Journal of Advanced Research (2013). A Delhi case study on an organization's strategies for enhancing a building's performance. The following issues were assessed: Water audit to identify the building's high water consumption locations and identify areas for improvement. Waste audit to determine how much solid waste is produced overall, how much is recycled, and how much is dumped in landfills and burned. Condition audit to ascertain the building's components' present state and anticipate remaining useful life. Thermal comfort, air quality, lighting levels, and noise levels are all included in the thermal audit. These were examined to determine their present performance and areas for improvement.

2.3 Green building energy conservation with solar photovoltaic systems

Pate *et al.*, (2013), "Energy saving of green building using solar photovoltaic systems." Innovative Research in Science, Engineering, and Technology: An International Journal (May 2013), (Vol. 2, Issue 5). The solutions for energy-efficient futuristic structures are outlined in the paper. Better, greener buildings will result from the use of the newest technologies in construction. The largest users of materials, energy, and water are buildings. The concept of green buildings encourages the use of recyclable and recycled materials as well as renewable energy. In comparison to normal buildings, green buildings must save 36-40% of water, 30-40% of energy, and 25-40% of material. High thermal insulation, rainwater collection, terrace gardening, ventilation, and energy-efficient equipment are characteristics of green buildings.

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2.4 Energy efficiency

Xia & Fan, (2018). Planning for energy-efficient building retrofits to comply with green building regulations. Environment and Building, (136, 312-321). In order to lower overall energy consumption, including operating energy as well as the embodied energy needed to extract, process, transport, and install construction materials, green buildings usually include a number of energy-saving strategies. Reducing air leakage via the building envelope—the barrier separating conditioned and unconditioned spaces—is one important tactic used by designers. Operating energy usage is greatly decreased by reducing this leakage. Designers frequently install high-performance windows and add more insulation to the building's walls, ceilings, and floors to further increase energy efficiency. Passive solar building design is a common energy-saving strategy in low-energy dwellings. In order to minimize the need for artificial heating and cooling, windows and walls should be positioned to optimize solar gain in the winter and to be shaded in the summer by porches, awnings, and trees. Furthermore, by letting more natural light into the structure, well-placed windows, sometimes known as "day lighting," can lessen the demand for electric lighting throughout the day. Solar water heating is another energy-saving feature that can further reduce energy costs by using solar energy for heating. The building's environmental effect can be considerably decreased by integrating on-site renewable energy sources like solar, wind, hydro, or biomass. However, the costliest part of the process is frequently integrating power generating into the building design. In the end, these tactics result in more sustainable building practices by increasing a building's energy efficiency and helping it satisfy green building compliance requirements.

2.5 Water efficiency

Sheth (2017). Water-efficient green construction technologies. International Journal of Scientific Research and Engineering Innovation, 1(3), (5–10). Two of the main objectives of sustainable building methods are water conservation and quality preservation. The demand for aquifers in many areas is greater than their ability to recharge, which presents a serious problem with water use. Water efficiency is therefore becoming more and more important in building design. To lessen reliance on outside water supplies, one important tactic is to rely more on on-site water collection, purification, and reuse, as much as is practicable. Facilities can, for example, install dual plumbing systems, which recycle water for flushing toilets and set aside water for things like washing cars.

Throughout the building's life, these methods aid in ensuring that water is used effectively. Additionally, by using less water for daily tasks, water-saving technologies like low-flow showerheads and ultra-low flush toilets greatly minimize wastewater generation. Additionally, by encouraging reuse and lowering the overall sewage load, bidets might lessen the need for toilet paper. Water conservation initiatives can be strengthened, and more environmentally friendly, sustainable water management solutions can be promoted by incorporating these technologies into building designs.

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2.6 Waste reduction

Reddy *et al.*, (2015). A method for achieving zero energy building standards is the hybrid solar and kitchen waste-based plant for green buildings. Journal of Engineering and Technology International Research (IRJET), 2. The environmental impact of water treatment plants and wells in green buildings can be decreased using a number of techniques. Using grey water, which includes wastewater from appliances like dishwashers and washing machines, is one such tactic.

After treatment, this water can be used for non-potable purposes like car washing or toilet flushing, or it can be used for subsurface irrigation. Additionally, rainwater harvesting systems reduce the demand for drinkable water by collecting and storing rainwater for later use. However, the cost and energy consumption of centralized wastewater treatment systems might be high. The transformation of waste and wastewater into fertilizer is an alternate strategy that reduces these expenses and offers additional advantages. To create liquid fertilizer, for instance, human waste can be gathered at the source and delivered to a semi-centralized biogas facility, where it is mixed with other biological waste. In addition to producing organic nutrients for the soil, this process produces carbon sinks, which take carbon dioxide out of the atmosphere.

3.0 Objectives of the Case Study

- To select and study the energy consumption of an existing residential building.
- To conduct a cost benefit analysis of an existing building after implementation of green building technologies.
- To develop a framework for converting an existing building into a green building.

4.0 Research Methodology

In order to create a sustainable transformation framework for Block A2 of Avon Vista Society with regard to waste management, HVAC systems, energy efficiency, and water conservation, this study uses a mixed-methods design. Interviews, focus groups, site observations, questionnaires, and secondary data (maintenance records, utility bills) will all be used to collect data. Quantitative data will undergo statistical analysis and cost-benefit analysis, while qualitative data will undergo theme and SWOT analysis.

The system includes improved waste management (segregation, composting), energy efficiency retrofitting (solar power, intelligent meters), water conservation measures (rainwater collection, greywater reuse), and HVAC improvements (smart thermostats, energy-efficient equipment). Expert and local input will verify that the system is workable and well received by the community for successful deployment.

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4.1 Data collection methods

4.1.1 Qualitative data collection

Interviews: Conduct semi-structured interviews with residents of Block A2, architects, engineers, and policymakers to obtain insights on:

- Current patterns of water and electricity usage.
- Practices related to waste management.
- Performance of the HVAC system and resident comfort levels.
- Challenges and chances related to retrofitting.
- Focus Group Discussions: Facilitate discussions with residents to gather their expectations, concerns, and recommendations for the framework.
- Site Observations: Perform physical inspections of Block A2 to evaluate:
- The existing systems for water supply and drainage.
- The electrical infrastructure and patterns of energy consumption.
- Mechanisms for waste disposal.
- The design and performance of the HVAC system.

4.1.2 Quantitative data collection

Surveys: Distribute structured questionnaires to all 84 flats in Block A2 to obtain data regarding:

- Monthly consumption of water and electricity.
- Habits surrounding waste generation and disposal.
- Residents' satisfaction with the HVAC system.
- Secondary Data: Gather data from:
- Utility bills (water and electricity) over the past year.
- Maintenance records of the HVAC system.
- Logs related to waste management.
- Energy and Water Audits: Perform audits to:
- Identify locations of high energy and water consumption.
- Assess the efficiency of the HVAC system.

4.2 Data analysis methods

4.2.1 Qualitative data analysis

- *Thematic analysis:* Assess interview transcripts and focus group discussions to pinpoint recurring themes, including:
- Elevated energy and water consumption.
- Ineffective waste management practices.
- Inefficiencies in the HVAC system and discomfort for residents.

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- SWOT Analysis: Execute a SWOT analysis to determine the feasibility of retrofitting Block A2, concentrating on:
- *Strengths:* Pre-existing infrastructure, residents' interest in sustainability.
- *Weaknesses:* Excessive energy consumption, outdated HVAC system.
- *Opportunities:* Possibilities for solar energy, rainwater harvesting.
- *Threats:* Financial limitations, resistance to change.

4.2.2 Quantitative data analysis

- Statistical Analysis: Evaluate survey data using statistical methods to:
- Determine average water and electricity usage per flat.
- Recognize trends in waste generation and disposal.
- Gauge resident satisfaction regarding the HVAC system.
- Cost-Benefit Analysis: Conduct a cost-benefit analysis for suggested retrofitting measures, which include:
- Installation of solar panels and energy-efficient lighting.
- Upgrading the HVAC system to enhance energy performance.
- Introducing water-saving solutions (e.g., low-flow fixtures, rainwater harvesting).

4.3 Framework design

The framework was crafted based on insights derived from data analysis and centers on the following essential areas:

4.3.1 Water conservation

- *Rainwater harvesting:* Create a system to gather and store rainwater for non-potable applications (e.g., gardening, flushing).
- *Greywater recycling:* Establish a system for treating and reusing greywater from sinks and showers.
- *Low-flow fixtures:* Suggest the installation of low-flow faucets, showerheads, and dual-flush toilets in every flat.

4.3.2 Electricity efficiency

- *Solar panels:* Design a solar energy system to be installed on the rooftop for generating clean electricity.
- *Energy-efficient lighting:* Recommend replacing standard lighting with LED options.
- *Smart meters:* Suggest the installation of smart meters to track and enhance energy consumption.

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4.3.3 Waste management

- *Waste segregation:* Create a system for separating waste at the source (organic, recyclable, non-recyclable).
- *Composting:* Formulate a composting system for organic waste.
- *Recycling partnerships:* Forge partnerships with local recycling organizations for effective waste management.

4.3.4 HVAC system upgrades

- *Smart thermostats:* Recommend the installation of smart thermostats for improved temperature regulation.
- *Improved insulation:* Plan enhancements to building insulation to minimize energy loss.

4.3.5 Implementation plan

- *Timeline:* Create a comprehensive timeline for the execution of the framework.
- *Budgeting:* Deliver a cost assessment for each element of the framework.
- *Monitoring and evaluation:* Develop a system for tracking and assessing the effectiveness of the retrofitting actions.

4.3.6 Validation

- *Expert feedback:* The suggested framework was validated through insights from specialists in sustainable architecture, green building design, and HVAC systems.
- *Resident feedback:* Shared the framework with residents of Block A2 and collected their input to ensure community acceptance and address any issues raised.

4.3.7 Ethical considerations

- *Informed consent:* Secured informed consent from all participants prior to conducting interviews and surveys.
- *Confidentiality:* Preserved the confidentiality and anonymity of participants by employing coded identifiers.
- *Transparency:* Ensured transparency during data collection, analysis, and reporting processes.
- *Bias mitigation:* Reduced researcher bias by utilizing standardized protocols and involving multiple researchers in the data analysis process.

4.3.8 Limitations

- *Scope:* The research is confined to Block A2 of Avon Vista Society, and the results may not be applicable to other buildings or communities.

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- *Financial constraints:* The effectiveness of the framework relies on the availability of financial resources for retrofitting initiatives.
- *Resident participation:* The readiness of residents to embrace sustainable practices is essential for the project's success.
- *Data accuracy:* Dependence on self-reported information from surveys and interviews may lead to biases.

5.0 Framework

The following are the main goals of the Avon Vista Wing A2 Green Building Conversion:

- *Energy efficiency:* Reduce energy use by 35% by implementing energy-saving measures such solar panels, LED lighting, double-glazed windows, high-efficiency HVAC systems, and battery storage. Conserve 40% of water by using rainwater collecting, greywater reuse, and energy-efficient fixtures.
- *Trash management:* Use a 3-bin system, compost, and recycle to reduce trash by 75%.
- *Indoor air quality:* Use IAQ sensors, low-VOC materials, and fresh air supplies to maintain WHO air quality requirements.
- *Sustainable materials:* Use at least 50% recycled or sustainable materials in concrete and green roofs, such as fly ash and recycled steel. 80% of the population should be involved in the community through workshops, feedback mechanisms, and rewards.
- *Certification:* Track waste, water, and energy metrics to earn LEED Gold certification in 18 months.

Implementation Plan:

- *Phase 1 (0–6 months):* Upgrade windows, lighting, insulation, and water and energy use.
- *Phase 2 (6–12 months):* Install waste management systems, solar panels, and rainfall collection.
- *Phase 3 (12–18 months):* Engage residents, track performance, and submit a LEED Gold application.

6.0 Conclusion

This study used a thorough methodology that included data collecting, observation, and analysis of appliance efficiency, overall energy demand, and usage patterns to successfully investigate the target residential building's energy consumption. By identifying peak usage periods, pointing out places where energy was being wasted, and highlighting conservation options, the thorough analysis yielded insightful information about the building's energy performance. The results demonstrated the possibility for large reductions in energy expenditures and environmental effects, and they emphasized the significance of optimizing

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energy consumption. The building's sustainability has been greatly improved by the incorporation of eco-friendly elements. Significant energy savings and a smaller environmental impact have been achieved by the installation of a 2.0 m² vermin composting system, a vertical garden, LED lighting, grass pavers, and a rooftop solar power system. In particular, the composting system saved ₹6,640 a year, while the vertical garden improved air quality and helped save ₹3,00,000. The solar system produced 9,000 kWh yearly, saving ₹31,708.8 in energy expenditure; LED lighting decreased power costs by ₹60,480; and the usage of grass pavers resulted in savings of ₹2,56,000. When taken as a whole, these eco-friendly projects saved more than ₹6,00,000, greatly increasing the building's energy efficiency.

Additionally, a comprehensive model for converting the building into a green building was developed as a result of the careful examination of energy usage trends. The concept emphasizes key sustainability components like increasing energy efficiency, using environmentally friendly materials, conserving water, and integrating renewable energy sources. The transition to a sustainable building is not only possible but also successful thanks to this organized framework, which offers a realistic, step-by-step method for transforming the building into an eco-friendly, energy-efficient structure.

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