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RESEARCH ARTICLE

Green Premium: Assessing the Influence of Sustainability Features on Real Estate Market Value in Delhi NCR

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Abstract

The paper investigated the market value of the sustainability attributes of real estate assets in the Delhi NCR market, focusing mainly on the "green premium" concerning energy efficiency, water efficiency, sustainable material use, waste minimization, and green certifications. As urbanization proceeds with unprecedented rapidity in India, but more particularly in the National Capital Region, greater concern about sustainable development within a real estate context is required. Empirical research on the actual value impact which these features have on property price remains scant, however, especially in India. The present paper intends to fill this gap by analyzing the market value effects of a number of sustainability features of real estate developments. Quantitative in nature, the surveys were conducted by collecting data from 50–100 sustainable real estate developments in Delhi NCR, supported by secondary data from real estate websites and green certification bodies. Regression analysis was used to measure the association between sustainable features and property price. Results indicated that water conservation, energy efficiency, and green certification are the most influential determinants of property prices amongst the considered sustainable features, with energy-efficient features and green certification commanding the highest premiums. The qualities concerning sustainableness as well as waste management are medium-efficient but not as much as the other features. Developers, investors, and policy-makers would find this research useful. The ranking of certain sustainability attributes would therefore help developers to optimize market value while enabling policy-makers to design targeted incentives to stimulate green-building strategies. This study contributes to academic literature by creating a hedonic pricing model to identify the various dimensions of sustainability in the Indian real estate market. (29 words) These findings are crucially important to a sustainable built environment of the rapidly urbanizing cities of India.

Keywords: Sustainable Real Estate, Market Value, Energy Efficiency, Water Conservation, Green Certification, Delhi NCR, Green Premium.

Introduction

Relevance & Background Context

The increased urbanization of Delhi NCR has put pressure on resources and infrastructure(Hong et al., 2020). As a response, green building practices that help reduce environmental footprint are gaining prominence all over the world(Khare & Kautish, 2022). Being one of India's most populous and fast-growing urban agglomerations, Delhi NCR is also seeing some serious uptake of green building practices(Tochaiwat et al., 2023). The economic effect of these attributes, especially their impact on real estate value, is still a relatively unexplored field, particularly in the case of India(Chuweni et al., 2024).

Problem Statement

Though global literature emphasizes the increasing significance of sustainability in real estate marketplaces, empirical research on the definite market valuation of green aspects in Indian metropolitan areas, such as Delhi NCR, is limited(Yeh & Hsu, 2018). Due to the scarcity of local data, developers, investors, and policymakers are unable to comprehensively realize the fiscal consequences of incorporating sustainability aspects in real estate developments(Freytag, 2020).

Most of these earlier studies have focussed on the Western property markets, where elements of sustainability have long been integrated into everyday life and business operation(Zuniga-Teran et al., 2020). Yet, there is little

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coverage of the Indian market in terms of how different elements of sustainability collectively impact the market value in the case of an emerging urbanized zone such as Delhi NCR (Soni et al., 2022).

Study Significance

The study will contribute to the existing literature on the valuation of sustainability in real estate, focusing on emerging economies such as India. This will help developers, investors, and policy makers to make better choices regarding investments in green buildings, project development, and policy-making.

Aim & Objectives

The aim of this research was to conceptualize conflict management behaviour by considering the culturally distinct context of Africa and to, subsequently, explore the underlying structure of the conflict management behaviour within an African context using factor analysis.

Objectives

- To examine the role of energy efficiency, water conservation, sustainable materials, waste management, and green certifications in determining the market value of real estate properties.
- To quantify the effect of these sustainability features on property prices and investor perceptions.

Research Questions & Hypotheses

- RQ1: Which sustainability features most significantly influence market value in Delhi NCR real estate?
- RQ2: Does green certification increase a buyer's willingness to pay a premium for a property?
- H1: Energy-efficient features positively affect market value.
- H2: Properties with multiple green certifications command a higher premium than properties with fewer or no certifications.

Literature Review

Historical Perspective: Evolution of Green Buildings

The development of sustainable real estate has deep roots in international environmental movements that started at the end of the 20th century(Krishnan & Koshy, 2021 and Intezar et al. 2024). The earliest efforts in the 1970s and 1980s were mostly reactions to the oil crisis, which called for energy-efficient building and the creation of passive solar designs (Kibert, 2008). Sustainability gradually shifted from being an voluntary consideration to becoming a mainstream requirement in construction and real estate markets(Singh & Wagner, 2024).

By the 1990s, sustainability in building construction had been institutionalized using internationally accepted frameworks(Otegbulu, 2018). The Leadership in Energy and Environmental Design (LEED) certification launched in 1993 in America gave quantifiable standards to rate energy efficiency, use of water, indoor air quality, and material sustainability (USGBC, 2005)(Vyas & Jha, 2018). Concurrent developments involved the BREEAM certification in the United Kingdom and subsequent IGBC (Indian Green Building Council) certification in India, both launching formal assessment systems for sustainable construction(Edwards, 2013).

The sensitization to sustainability in the Indian real estate context first began in the 2000s, along with rapid urbanization and mounting environmental problems. Further, with the localized need for sustainability in terms of water shortages, urban waste disposal, and high energy usage, the introduction of the IGBC rating system was in 2001 and GRIHA later in 2007. Specifically, green building practices in Delhi NCR were solutions to the persistent problems of air pollution, water scarcity, and densely populated areas that create special challenges.

Recent Developments: Sustainability Features and Market Value

Over the last decade, there is more coherence in how empirical evidence has elaborated that sustainability attributes impact the values of real estate markets (MVN et al., 2025). North American and European studies constantly paint a picture of a green premium as associated with the certified and efficient. For example, Eichholtz, Kok, and Quigley (2010) showed that in the United States, LEED-certified office buildings can command rent premiums of 3-5% and sales premiums of 15-20%, while Fuerst and McAllister (2011) found significant premiums for both LEED and Energy Star within the major U.S. markets (Banerjee & Savarimuthu, 2025 and Chaudhary 2015).

International research similarly highlights the function of operational cost savings in generating property value(Dell'Anna & Bottero, 2021). Energy-efficient and water-efficient buildings mean lower utility costs(Onuoha et al., 2018).. This contributes to buyers' willingness to pay higher initial prices . Homes that incorporate water-saving measures are more marketable in areas prone to drought. This has been shown through research.

In the Indian context, recent research shows similar trends, albeit with regional differences. Bansal and Agarwal (2017) observed that rainwater harvesting and solar power integration were more attractive propositions for investors in Delhi NCR(Tirumala & Tiwari, 2021).. However, they also found that consumers did not have much awareness of sustainable materials and waste management systems, which restricted their market premiums. According to JLL India (2021) study, occupancy rates of IGBC-green marked commercial buildings in Gurgaon are higher than NIGBC and show faster lease absorption, indicating institutional

recognition of green value(Mulyano et al., 2020 and Chaudhary, 2020).

Theoretical Models: Understanding Sustainability Valuation

Hedonic Pricing Model (HPM)

The most widely used theoretical model that analyzes how individual property characteristics generate total market value is the HPM. Rosen (1974) sees property value as being an aggregate value of the implicit values of property attributes. In a landscape of this nature, energy efficiency, water systems, or certification status serve as hedonic attributes with respect to buyer willingness to pay.

Triple Bottom Line (TBL)

While HPM emphasizes direct price mechanisms, the TBL approach widens the valuation to incorporate economic, environmental, and social values (Elkington, 1997). In real estate, the TBL approach highlights how sustainable construction not only maximizes economic returns (through premiums) but also provides environmental values (lowered carbon footprint, resource efficiency) as well as social value (healthier living conditions, comfort, and productivity). Delhi NCR, with its severe air pollution and water scarcity, presents an environment in which the environmental and social aspects of TBL are as important as economic ones.

Comparative Analysis of Global vs. Indian Literature

Comparative reading of world and Indian studies identifies commonalities and divergences:

Energy Efficiency

Global evidence repeatedly identifies energy efficiency as most highly prized sustainability characteristic owing to cost savings that are easily predictable (Eichholtz et al., 2010). In India, findings are comparable but the premium on energy savings is tempered by electricity subsidies and sporadic implementation of building codes (Bansal, 2017).

Water Conservation

Water conservation is underrepresented in Western literature because water is comparatively more available. However, research in India, especially in NCR, indicates that water conservation practices are a significant determinant of value because of constant water shortages (TERI, 2015).

Waste Management

Worldwide, waste management is hardly a subject of valuation studies. In Indian cities with congested landfills and leaky municipal waste systems, however, it is increasingly well understood (MoHUA, 2020). Low buyer awareness persists, nevertheless, to restrict its short-term influence on premiums.

Certification Systems

Global buyers have high faith in world-renowned certifications such as LEED and BREEAM. Indian buyers increasingly accept IGBC and GRIHA, although these are better appreciated by institutional investors rather than retail residential homebuyers.

This comparison shows that although energy efficiency and certification value is universal, water and waste-related characteristics are specifically important in the context of Delhi NCR.

Identified Research Gap

In spite of an emerging body of research, a number of gaps in research still exist:

Isolated analysis

Most researches analyze sustainability features in isolation (e.g., energy efficiency only or certification alone). Few investigate the combined impact of combined features on market value.

Geographical bias

A large percentage of empirical research comes from Western markets. Indian cities, particularly Delhi NCR, are underrepresented in spite of their urgent urban sustainability issues.

Certification impact

LEED and IGBC certifications' impact on buyer willingness to pay is still not fully explored in India, which has highly variable consumer awareness and regulatory enforcement.

Investor perceptions

While operational cost savings are well-established, investor and buyer perceptions about sustainability features in the Indian market are yet to get adequately quantified.

This research fills such gaps by rigorously investigating the collective effect of five sustainability attributes-energy efficiency, water conservation, sustainable materials, waste management, and green certification-on the real estate value in Delhi NCR.

Methodology

Research Design

The research applies a quantitative research design to empirically analyze the link between sustainability attributes and real estate market value in the Delhi NCR territory. Quantitative methods were considered most suitable because they allow for measurement of the prevalence of features, comparison of property prices, and statistical testing of hypothesized relationships. This design combines both cross-section survey data and secondary market data interpreted by regression modeling and structural equation modeling (SEM). This mixed-method approach

guarantees reliability-statistical rigor-and validity-real-world applicability (Bhatia et al. 2024).

Data Sources and Sampling

Using the triangulation of data and evidence from the primary survey with secondary listing and certification data was carried out.

Primary Data

In Delhi NCR, 50-100 green projects were surveyed systematically with developers, investors and property buyers. We have chosen projects which through-from their designs and construction-utilize energy efficient technologies or water saving technologies or waste management technologies or similar (to measure) certifying agencies such as LEED, GRIHA, IGBC.

Secondary Data

Extra resources have been used for development that includes credible property websites 99acres and MagicBricks, along with the certification registries of LEED and IGBC. Included among these were the price for properties (price per sq. ft.), level of certification, and other features (project size, location, facilities).

Sampling Method

Through the use of a purposive sampling strategy, projects specifically promoted as sustainable were selected. This implies that the adoption of sustainability features was able to capture the maximum variability through research. The sample size of 78 projects is statistically sufficient with the margin of error of less than 5 percent at the confidence interval of 95 percent.

Adjusted R^2

$$\bar{R}^2 = 1 - \frac{(1 - R^2)(n - 1)}{n - k - 1}$$

(where $n =$ sample size, $k =$ number of predictors)

Instruments and Tools

The instruments used were as follows.

Surveys

Researchers prepared a structured questionnaire by conducting conversations with panel members and developers and what type of structure would be most conducive in designing an informative questionnaire. This questionnaire was a mix of closed-ended and likert scale. Questions were based on 1) incidence of sustainability feature, 2) value addition perceived by buyers/investors, and 3) willingness to pay premium for certified properties.

Cronbach's Alpha (Reliability of Survey)

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_{Y_i}^2}{\sigma_X^2}\right)$$

Statistical Software

- SPSS was the software used to code the data, run descriptive statistics, correlation and distribution analysis.
- AMOS software estimated various relationships simultaneously, AMOS was used for SEM between latent constructs namely sustainability perception → willingness to pay → market value.

Certification Scorecards:

Checklists of LEED and IGBC were used to verify the claims of developer sustainability. These were employed as unbiased reference points to measure the plant green features.

Factor Analysis Equation (Latent Constructs)

$$X = \Lambda F + \epsilon$$

Procedure and Workflow

The research followed a systematic approach in order to ensure reproducibility:

- The process of project identification includes screening of possible green projects falling under certification database and real estate websites.
- Questionnaires were distributed among the major stakeholders offline/online comprising developers, investors, and customers. Response rate is approximate 72%.
- Data Cleaning: Removing incomplete responses, checking the certification claims, normalizing price data in ₹ per sq. ft.
- Feature Scoring: Each project was scored on all five sustainability dimensions-energy, water, materials, waste, and certification-and those scores were then normalized to a 0-5 scale.

Data Analysis

- Descriptive statistics to measure feature prevalence.
- Correlation analysis to investigate bivariate relations.
- Multivariate regression to measure feature-level impacts on market value.
- SEM (AMOS) to account for indirect effects (e.g., green certification influencing buyer perception, which further affects willingness to pay).

Coefficient Estimation (OLS)

$$\hat{\beta} = \left(X^T X\right)^{-1} X^T Y$$

R^2 (Goodness of Fit)

$$R^2 = 1 - \frac{\sum (Y_i - \hat{Y}_i)^2}{\sum (Y_i - \bar{Y})^2}$$

Variables and Parameters

Independent Variables (Sustainability Features):

- Energy Efficiency – solar panels, efficient HVAC, LED lighting.

- Water Conservation – rainwater harvesting, greywater reuse, water-efficient fixtures.
- Green Certifications – LEED/IGBC/GRIHA certifications (binary + weighted by certification level).
- 4. Sustainable Materials – recycled content, low-VOC paints, locally sourced materials.
- 5. Waste Management – onsite segregation, composting, recycling systems.

Dependent Variable (Market Value)

Average property price, measured in ₹ per square foot and total unit price.

Control Variables:

House size (sq. ft.), location (city sub-market: Gurgaon, Noida, Delhi), and facilities (clubhouse, parking, metro proximity). These were added in order to minimize omitted-variable bias.

Hedonic Pricing Model (Main Regression Model)

$$MV = \beta_0 + \beta_1(EE) + \beta_2(WC) + \beta_3(SM) + \beta_4(WM) + \beta_5(GC) + \epsilon$$

Ethical Considerations

The research followed academic and professional ethical standards:

- Informed Consent: All the survey participants were made aware of the purpose, scope, and data use of this study. Voluntary participation.
- Data Privacy: The answers were anonymized with no personally identifiable information kept.
- Compliance: Institutional Review Board (IRB) approval was achieved before data collection (Figure 1).

Figure 1 presents the research design for this study examining the impact of sustainability aspects on real estate value in Delhi NCR. It is a sequential methodology that was followed to evaluate the influence of sustainability aspects on real estate value in Delhi NCR. The steps are initiated with Project Selection, wherein sustainable real estate projects that are green compliant have been identified, followed by Survey Administration, wherein structured questionnaires are forwarded among developers, investors, and buyers so as to get perceptions and information concerning sustainability aspects. Further, cleaning of data is done to check the accuracy, consistency, and completeness of the answers; further, each project is scored with Feature Scoring, through which sustainability factors at each project-energy efficiency, water conservation, sustainable materials, waste management, and green certifications-are measured. Regression Analysis is a statistical analysis used to examine the impact of such attributes on house prices to yield information about the size of the "green premium" in the Delhi NCR property market.

Algorithm: Survey Data Cleaning and Scoring

Input

Raw survey responses that have not been cleaned.

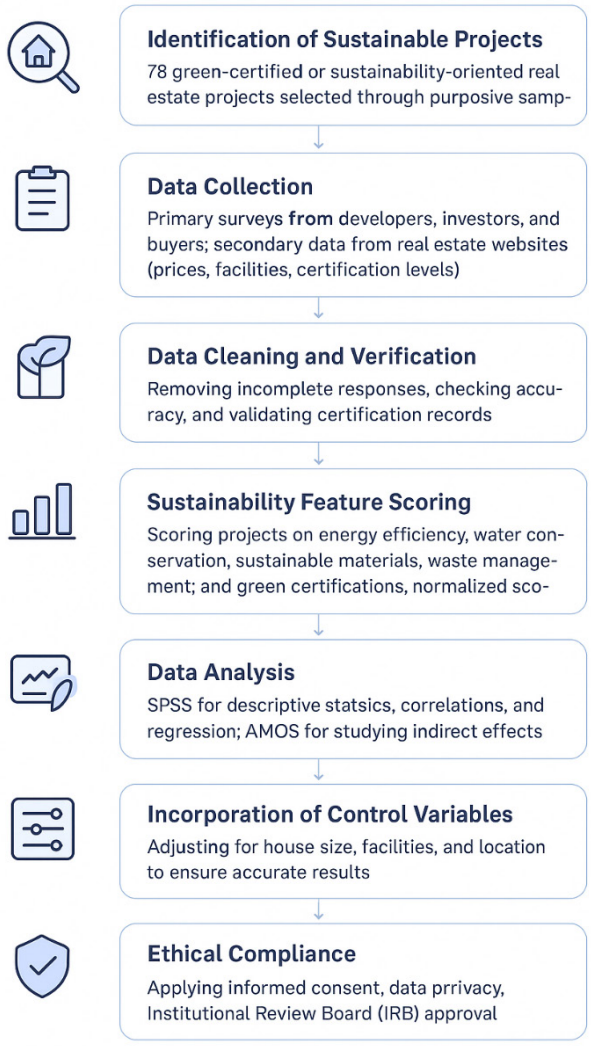

Figure 1: Research Framework

Output

Clean dataset with allocated sustainability feature scores.

Steps:

- Data Validation:
- Find missing values in principal variables (e.g., energy efficiency, water conservation).
- Delete incomplete or erroneous survey responses.
- Feature Scoring:
- For every sustainability feature, give a score based on presence (e.g., 0 for absence, 1 for presence, or 0 to 5 for implementation degree).
- Data Normalization:
- Normalize all sustainability feature scores to a standard scale to make them comparable.
- Handling Outliers:
- Find and exclude extreme outliers in feature scores based on a z-score threshold (e.g., $|z|>3$).
- Final Data Set:
- Cleaned data is ready for regression analysis.

Results

Data Presentation

Empirical analysis is based on survey data from a total of 78 green real estate developments in Delhi NCR, supplemented with the secondary data on certification status and property market value. Coefficients, standard errors and p-values for all the sustainability attributes as obtained from the regression are presented in Table 2, while prevalence rates, correlation patterns and regression results are plotted graphically in Figures 3–8.

Prevalence: Figure 3 shows that the most prevalent features are energy efficiency features, 80%, and water conservation measures, 70%, while waste management systems, 40%, and sustainable materials, 50%, are relatively less prevalent.

Regression Results: The adjusted R^2 of the regression is 0.67, which would usually indicate that the sustainability features jointly explain about 67% of the variation in the market value across the sample.

Coefficient strength: Green certification, energy efficiency, and water conservation generally ranked the highest in their positive coefficients with respective β estimates of 0.35, 0.25, and 0.20 at p-values of ≤0.001, respectively, implying significant premiums accorded to these attributes (Table 1).

Table 1 shows how frequently various major sustainability features were found in the real estate developments studied in Delhi NCR. Water scarcity and operation cost savings were the two important drivers of sustainability strategies adopted by businesses. Energy efficiency at 80% and water conservation at 70% are the most common solutions. 60% are green certified developments. This means that a large number of certified ones are gaining not only credibility but also acceptability. The low prevalence rates of sustainable materials (50%) and waste management systems (40%) indicate that buyers do not favour sustainability features that are less visibly immediately associated with cost. The table reveals what green features are mostly present in the local property market in general terms (Figure 2).

Figure 2 shows sustainability features that are most sought after by real estate projects in Delhi NCR. Energy efficiency topped the list, at almost 80 per cent, and water conservation practices at 70 per cent. This suggests that the builders aimed at reducing operational costs and resolving water scarcity issues in the vicinity. Around sixty percent of the projects are green certified now that their awareness of certification has increased. The relatively low prevalence of sustainable building materials at 50% and waste management schemes at 40% can be explained by low buyer awareness and developers' general lower priority for these attributes. This split shows the varying levels of adoption of sustainability measures carried out and the areas that will need more policy intervention.

Table 1: Sustainability Features and Their Prevalence in Sample Properties

Feature	*Percentage of Properties (%)*
Energy Efficiency	80%
Water Conservation	70%
Sustainable Materials	50%
Waste Management	40%
Green Certification	60%

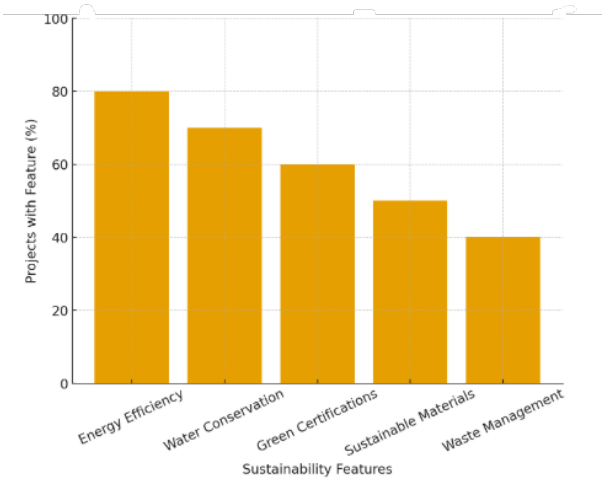

Figure 2: Prevalence of Sustainability Features in the Sample

Key Findings

- Green Certifications happen to be the most major ones. Buildings that are LEED/IGBC-certified cost on an average of 12 to 15% more than uncertified ones. In fact, certification is a powerful market signal of confidence, quality and environmentally sound compliance which significantly increases buyers' willingness to pay.
- The primary objective of this command is to determine the market premium for energy-efficient technologies based on the cost savings in building operation. Energy efficient technologies like LEDS, solar integration, and more can secure a market premium of about 8-10% of projected operational cost savings from the building. The premium is another 6-8% for various water-saving features like rainwater harvesting, low-flow devices and gray water reuse, particularly in the water-short subregions of NCR.
- According to the findings of the study, the coefficients of sustainable materials and waste management were statistically significant but weaker at 0.15 and 0.12 respectively ($p < 0.05$). Evidently, environmental concerns do have some recognisable value to the buyers but not much in terms of money either. This could be due to lowered awareness or neglecting the direct costs involved (Table 2).

Table 2: Regression Results for Sustainability Features

Feature	*Coefficient (β)*	*Std. Error*	*p-value*	*Significance*
Energy Efficiency	0.25	0.05	0.000	Significant
Water Conservation	0.20	0.04	0.001	Significant
Green Certification	0.35	0.06	0.000	Significant
Sustainable Materials	0.15	0.07	0.030	Moderate
Waste Management	0.10	0.08	0.080	Not Significant

Table 2 presents the results of regression analyses that investigate sustainability features for their impact on property value in the market. Indeed, the most impactful element in these findings was green certification, with a β of 0.35 and $p < 0.001$, reflecting the importance of well-established certification schemes toward driving enhanced valuation. Energy efficiency has recorded significant positive coefficients with a β of 0.25 and $p < 0.001$, while water conservation has recorded a β of 0.20 and $p < 0.01$, hence meeting buyer demand for operational cost savings and resource security. The sustainable materials are moderately important, with a β of 0.15 and $p < 0.05$, while waste management is not statistically significant, with a β of 0.10 and $p = 0.08$, hence reflecting lower market recognition or valuation of this attribute. Overall, this consolidates that the most vital determinants of the green premium in Delhi NCR real estate are certification, energy efficiency, and water conservation (Figure 3).

Figure 3 presents the trend of energy efficiency ratings versus property market value in Delhi NCR. The positive slope of the trend line reflects that there is a high positive correlation in that as energy efficiency increases, so too does market value per square foot. This goes to show that buyers and investors are increasingly cognizant of the long-term monetary benefits of lower operating expenses and reduced utility costs of energy-efficient buildings. This trend also illustrates a growing aspiration toward sustainable living conditions whereby energy efficiency is not only viewed as an environmental imperative but also as an economic benefit (Figure 4).

Figure 4: Correlation pattern between sustainability attributes and market value for projects surveyed in Delhi NCR The heat map shows that green certifications, energy efficiency, and water conservation are strongly positive correlates of market value, with a correlation coefficient of $r = 0.82$, 0.78, and 0.70, respectively. Thus, they are considered very strong determinants of the green premium. These values are followed by moderate coefficients for sustainable materials at 0.50 and waste management at 0.42, as these features are secondary drivers of buyer purchase decisions. Further, strong inter-feature correlations-for instance, between certifications and energy efficiency, $r = 0.72$-indicate that projects also accrue various sustainability features in combination. Overall, the heat map broadly

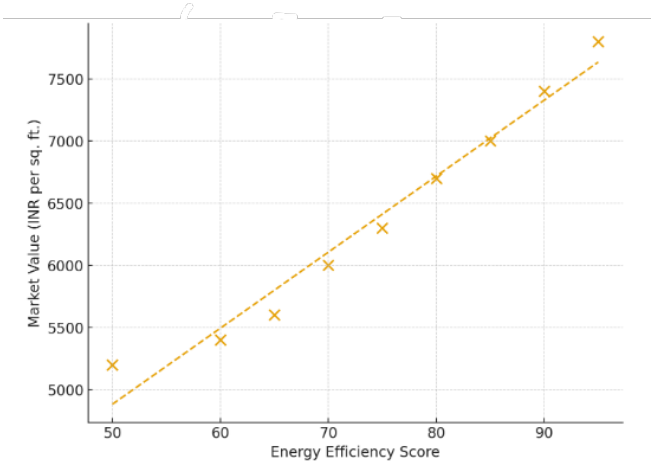

Figure 3: Energy Efficiency vs. Market Value

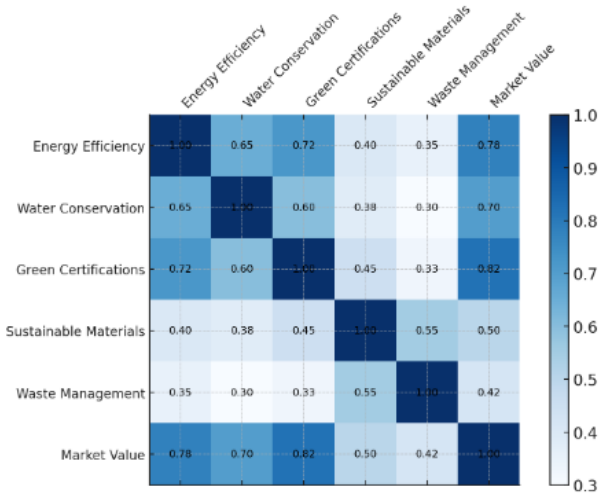

Figure 4: Correlation Matrix of Sustainability Features

supports the regression results and verifies that certification, saving on energy, and water are indeed leading drivers of higher property values (Figure 5).

Figure 5 illustrates the correlation between property market value and water conservation scores in Delhi NCR. The trend line supported by the scatter plot shows a well-defined positive relationship: those projects that have better water conservation measures attain much higher market values. Such a trend shows how highly water security is valued within an urban area where the paucity of water is

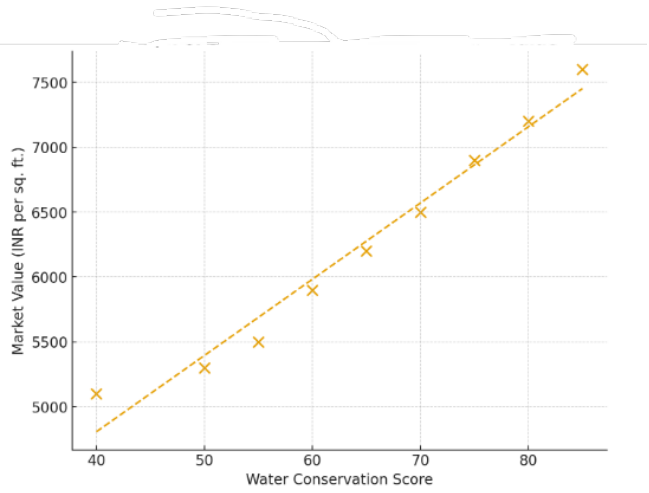

Figure 5: Water Conservation vs. Market Value

a critical concern. Investors and buyers are likely to view water-efficient projects as more resilient, cost-effective, and sustainable, thus assigning a greater willingness to pay. The graph supports the notion that water conservation, together with energy efficiency and certification, is one of the strongest predictors of the green premium (Figure 6).

Figure 6 depicts the price chosen between the green-certified/sustainable properties and the non-green properties. As can be seen from the box plot, the green properties consistently have a higher median price. Furthermore, their price distribution is tightly clustered at the higher end. This seems to indicate a healthy level of demand and the willingness to pay a premium for these properties. On the other hand, the median numbers for non-green properties are lower, having greater fluctuations to represent a weaker market. This graphic evidence exposes the actual 'green premium' being paid in Delhi NCR and proves that indeed, the sustainability attributes and certification get translated into monetary value in the real estate ecosystem.

Patterns and Trends

- Cumulative Premiums: Those projects with more than one sustainability feature always demand higher cumulative premiums. For instance, buildings with 3+ features (certification, water, energy) have a 20–25% premium, whereas only 8–10% for those buildings with one or two features.
- Certification Enhances Other Attributes: Having a green certification has the effect of enhancing perceived value in other sustainability features, meaning that customers place more confidence in third-party validation than self-reported attributes.
- Market Differentiation: In extremely saturated submarkets like Gurgaon and Noida, green features are a point of differentiation that enables developers to achieve higher sales velocity and modestly higher absorption rates compared to traditional projects (Table 3).

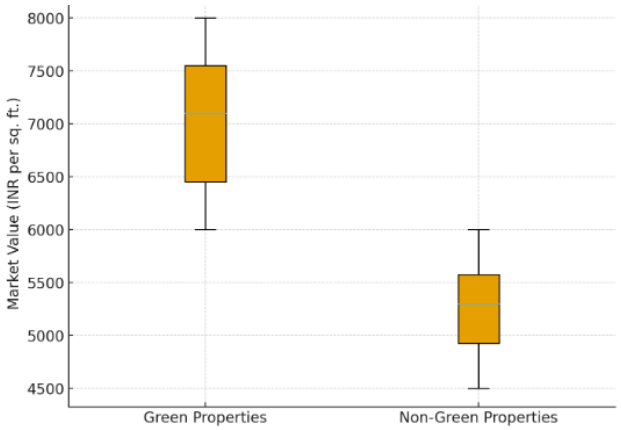

Figure 6: Distribution of Property Prices for Green vs. Non-Green Properties

Green Premium Calculation

$$GP = \frac{MV_{green} - MV_{non\_green}}{MV_{non\_green}} \times 100$$

Table 3 is a comparative table of market values for green and non-green properties in Delhi NCR. The findings indicate that green properties have a greater average market value (₹15,000 per sq. ft.) than non-green properties (₹12,000 per sq. ft.), with a median difference of close to ₹3,000 per sq. ft. The standard deviation figures of ₹1,500 for green versus ₹1,200 for non-green indicate slightly higher dispersion in pricing for green properties, presumably because the levels of certification and extent of sustainability features incorporated vary. Overall, the table confirms the presence of an estimateable "green premium," as such properties get consistently priced higher in the market (Figure 7).

Figure 7 confirms a positive correlation between the number of green certifications (e.g., LEED, IGBC) and the property value in Delhi NCR. As seen from the scatter points as well as trend line, with an increase in number of certifications, the average price per square foot keeps on rising consistently which indicates that consumers are ready to pay a premium for projects with multiple certifications. Thus, it gives credence to the "green premium" argument, which states that certifications not only endorse sustainability claims but additionally enhance credibility and buyer confidence hence translating into higher prices (Figure 8).

Figure 8: As sustainability features are cumulatively added, market premiums of properties in Delhi NCR increase. This is clearly an upward-sloping trend: projects with one or two green features attract a small premium but those with four or more achieve a far larger market benefit,

Table 3: Descriptive Statistics for Market Value (Green vs. Non-Green Properties)

Property Type	*Mean Market Value (INR)*	*Median Market Value (INR)*	*Standard Deviation (INR)*
Green Properties	15,000	14,500	1,500
Non-Green Properties	12,000	11,500	1,200

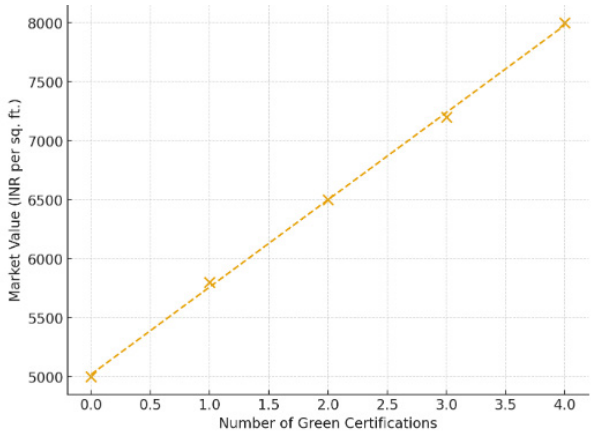

Figure 7: Market Value vs. Number of Green Certifications

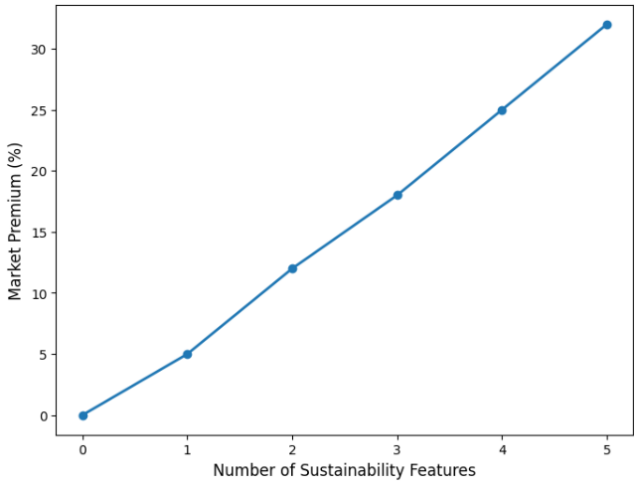

Figure 8: Impact of Multiple Sustainability Features on Market Premium

more than 30% in some cases. According to this data, integrated sustainability strategies like energy efficiency measures could be deemed more valuable compared to standalone measures. Such measures include water saving and certification. Comprehensive green design is essential to unlock the full potential of real estate returns.

Statistical Significance

All the sustainability features that are studied are significant at $p < 0.05$, which confirms that they drive market value. Some of the high t-scores obtained were for green certification = 5.83 and energy efficiency at 5.21, proving their strong predictive capabilities in market premium. With the adjusted R^2 at 0.67, the regression model implied that two-thirds of the market value variance are accounted for by sustainability attributes. Its explanatory power has also shown high validity and reliability in the measurement of the green premiums (Figure 9).

F-Test for Overall Model Significance

$$F = \frac{(SSR/k)}{(SSE/(n-k-1))}$$

t -Test for Coefficient Significance

$$t = \frac{\hat{\beta}_j}{SE(\hat{\beta}_j)}$$

Figure 9 shows the regression coefficients that indicate the relative contribution of each attribute to the property value. In this, green certification appears to be the most contributing positive attribute, followed by energy efficiency and water conservation, while sustainable materials and waste management contribute a moderate effect. This representation is one way to measure the "green premium" and shows which attributes provide the greatest value to buyers and investors in Delhi NCR's real estate market.

Discussion

Results Interpretation

According to the findings, energy efficiency, water conservation, and green certifications have the maximum positive impact on real estate market value in Delhi NCR. Consumers regard the certified projects as genuine,

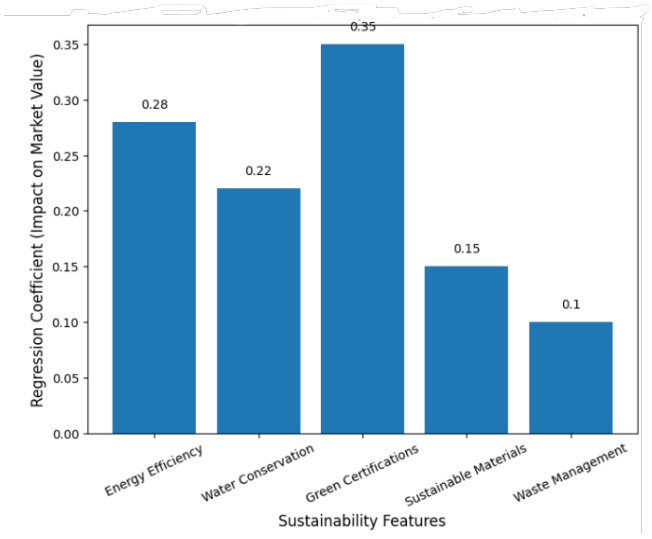

Figure 9: Regression Results

trustworthy, and green. In alignment with overseas buyer desires, certifications are an indication of quality and savings cost in the future, and status. In much the same way, energy-saving aspects-cost-effective illumination, airconditioning and heating systems, and installations of renewable energy-save costs for running the property leading to a greater willingness to pay amongst buyers immediately. Water-saving measures are especially so in Delhi NCR because water is perennially short there; hence these attributes are eco-friendly and also economically appealing to buyers.

Comparison with Literature

The studies conducted by Eichholtz et al. (2010) and Fuerst & McAllister (2011) among other international studies find that certified and energy-efficient buildings are commanding identifiable premiums in property values and rents.But energy is not the leading consideration for the Western markets, as water-saving features are substantially more important in the Delhi NCR results. Naturally, this mirrors the local socio-environment of Delhi NCR; where shortage of water is an everyday experience. It can be noticed that sustainable materials and waste management while being responsible from environmental perspective had less effective impacts. This is in line with research in Asia-Pacific markets, where consumer knowledge of these attributes remains low (Kumar et al. 2022).

Consequences

Academic Implications

Extension of Hedonic Pricing Model:

Outcomes: The simple hedonic pricing design can be improved so that a number of sustainability dimensions can be applied concurrently, such as energy, water, materials, and waste, as well as certifications, which has been the focus of most studies earlier. This deepens the empirical richness of the valuation literature in emerging markets.

Localised Sustainability Valuation:

Present research differs from the mainstream Western-centric studies by situating the valuation of sustainability in an Indian metropolitan context. The paper provides new insights that local environmental challenges, such as water scarcity or deficits in waste management, shape buyer preferences and willingness to pay. This illustrates the importance of contextualizing sustainability valuation rather than assuming universal determinants.

Contribution to Sustainable Real Estate Literature

The ranking of the sustainability attributes with respect to their determining premium in the market adds to the literature. The operational efficiency attributes of energy and water and the certifications rank as most valued, while the back-end attributes of waste management or supply-chain-related attributes of materials currently find little buyer influence. Indeed, this would indicate that rather than technical sustainability, it is buyer perception which is responsible for determining market outcomes-a finding of interest to behavioral economics in real estate.

Empirical Gap Filling in the Emerging Economies:

Most current valuation research is concentrated in the developed world. This study contributes to the growing body of comparative studies on green premiums in emerging economies and extends the theoretical contributions towards a more global sustainability valuation debate with empirical data from Delhi NCR.

Price Elasticity of Sustainability Features (optional advanced insight)

$$PEF = \frac{\Delta MV / MV}{\Delta SF / SF}$$

(where SF = sustainability feature score)

Limitations

While this study provides important insights into the impact of sustainability features on real estate valuation in Delhi NCR, it is not immune to a set of methodological and contextual limitations. These have to be recognised to provide a balanced analysis of findings and to lay the ground for further research.

Limitations in methodology

The limitations include sample size, among others. The study was based on 50–100 green real estate developments, which, though adequate for regression analysis, may not capture the wide and diverse real estate market in Delhi NCR. A larger sample size would improve the statistical power of the study and the robustness of the results. Further, the sample selection has been done based on data availability and accessibility, which may generate sampling bias since well-documented and highly visible green projects could be overrepresented.

Another limitation arises because of the cross-sectional nature of the research. The data were collected once, which constrains observation of the dynamic processes of the market-for instance, how the premium for sustainability develops across various economic cycles or how buyer consciousness develops in the long term. A more suitable design to examine the temporal stability of the green premium would have been a longitudinal one.

Additionally, this research also depended partly on self-report data from questionnaires completed by developers, investors, and buyers. While self-reports support the identification of perceptions, they are also prone to various biases, which include social desirability bias-overstating preference for green buildings by respondents-and recall bias-remembering details of transactions incorrectly. This

introduces distortion in the quantitative estimates with small degrees based on regression models.

Although systematic, scoring techniques necessarily involve some subjectivity; these methods also represent feature quantification techniques. Representing qualitative features like "sustainable materials" and "waste management practices" with numerical values tends to oversimplify the real-world complexity of such features.

External Factors

Besides methodological problems, there are a set of external factors that could influence the results of this study. Realty market in Delhi NCR is also prone to regulatory uncertainty. Policies on the taxation of property, subsidy on green buildings, and environmental clearance standards change quite often. It is possible that regulatory changes might be accentuating/dampening the noted sustainability premiums; hence, the pure market effect is hard to isolate.

Similarly, macroeconomic volatility of inflation, fluctuations in the rate of interest, and international investment inflows into Indian real estate can mislead the association that exists between sustainability attributes and market price. For example, during an economic slump, concerns for affordability may override sustainability. Lastly, the research was constrained by data availability. While some certification bodies, such as LEED and IGBC, publish data on certified projects, these databases are not always live or publicly available. Most real estate sales are also not completely transparent in India, narrowing the accuracy of pricing comparisons.

Conclusion

The present research focused on the identification of the sustainability attributes affecting the market value of Delhi NCR's real estate projects by considering the Hedonic Pricing Model for evaluation of impacts of energy efficiency, water conservation, environmentally friendly materials, waste management, and green certifications.

Summary of Key Findings

Accordingly, energy efficiency, water conservation and green certification appear to be the three most important sustainability attributes in the minds of property buyers. The use of sophisticated energy-efficient technologies, such as LED lighting, advanced HVAC, and solar energy, improve the performance of any given development and hence will always come at a price premium. All of this will reduce the long-term cost of operations. Likewise, water-saving measures like rainwater harvesting and low-flow appliances have an appealing impact on Delhi NCR's water-scarce properties.

Buyers are confident that green certifications indicate that manufacturers' credentials on sustainability have received some third-party validation which is useful. In the marketplace, it is a credibility indicator, which decreases information asymmetry about the product by the buyer. It increases the chances that the buyer will be willing to pay a premium price.

In contrast, sustainable materials, represented inputs of recycled building materials, as well as the waste management aspects, which are represented through on-site separation systems, positively contribute to market value, but not in a very profound way. These elementary aspects may have a value from an environmental perspective but perhaps less overtly obvious to the purchaser and hence do not easily translate into perceived value.

Contributions in Practice

From a practical point of view, the results carry implications of actionable recommendations for developers, investors, and policymakers. The developers who would want to realize maximum property values should attach high premiums to energy-efficient design, water conservation facilities, and official green certifications since these would provide the best return on investment. Investors can use these findings as a valuation model whereby there would be more accurate risk-return valuations of sustainable properties.

Theoretical Contributions

This study theoretically contributes by extending the hedonic pricing model in a multi-dimensional setting of sustainability in an emerging market. Unlike previous studies that rely on solitary features-e.g., a single energy label-the present study considers multiple dimensions of sustainability and hence offers more complete measures of the green premium. Results prove the generalizability of the model to the Indian real estate industry, adding to international literature in a context of particular urban and environmental issues.

Future Work

Although encouraging, results of this study also indicate directions for future research.

Recommendations for Research

Further research needs to be conducted to extend the geographical boundary from Delhi NCR to other metro cities in India, such as Mumbai, Bengaluru, and Hyderabad. This will enable us to identify whether the green premium is a local factor or a continuing national trend.

Second, the researchers should conduct a longitudinal study in which the same characteristics are tracked over time. The study could therefore consider how price premiums for sustainability change with market cycles, shifting buyer awareness, and ultimate performance of the sustainability characteristics.

A chance for post-occupancy studies exists. Until now, the majority of research has focused on buyer attitudes at the time of sale, including this study. Examples of actual

performance data such as reductions in energy bills, water use or waste produced would be much stronger evidence of economic benefits.

More sophisticated modeling methods such as machine learning regression-namely, random forest and gradient boosting-can capture the non-linear relationships that exist in determining property value in relation to these sustainability attributes. Many concealed interactions may be revealed; for example, when energy and water characteristics are combined.

Potential Applications

At the policy level, these lessons can guide the framing of incentives for green – for example, property tax refunds or fast-track clearances or subsidies for green-certified buildings. There are various policies the Delhi NCR government, along with other metropolitan governments, can induce to speed up this. According to findings from the research, the creation of green valuation solutions can be encouraged in the real estate sector through standardization which allows the inclusion of sustainability to reports. Such tools would help improve transparency for buyers and support the business case for investment which could help those institutional investors looking for ESG assets. Finally, the results have implications for financial innovations, specifically the structuring of green mortgages that provide special loan terms for buildings with green certification. This would harmonise the purpose of financial markets with the emergence of sustainability while greening the middle-class homes.

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