
Integrating Sustainability Metrics into Property Valuation Models: Evidence from Emerging Real Estate Markets

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Abstract: *The increasing global emphasis on sustainability has significant implications for the real estate sector, particularly in the context of property valuation. However, the integration of sustainability metrics into valuation practice remains limited in emerging markets such as Nigeria, where traditional methods dominate and data constraints persist. This study aims to develop and empirically test a framework for incorporating sustainability metrics into property valuation models. The study adopts a quantitative research design based on the hedonic pricing model, extended to include a composite Sustainability Index (SUS) constructed from observable property-level indicators such as energy efficiency, environmental quality, and climate resilience. Data were collected from residential property markets in Lagos, Abuja, and Port Harcourt, alongside survey responses from 160 professional valuers. Empirical analysis using Ordinary Least Squares (OLS) regression reveals that sustainability has a positive and statistically significant effect on property values. The results indicate the presence of a measurable green premium, with sustainability contributing meaningfully to price variation. Furthermore, the inclusion of sustainability variables improves the explanatory power of the valuation model, suggesting that traditional approaches may underestimate property value by excluding sustainability considerations. Despite relatively high awareness of sustainability among valuers, the study finds limited practical integration into valuation processes, primarily due to data limitations, lack of standardized guidelines, and insufficient professional training. These findings highlight a critical gap between market dynamics and valuation practice. The study contributes to knowledge by developing a sustainability-integrated valuation model suitable for data-constrained environments. It provides practical implications for valuers, policymakers, and real estate stakeholders, emphasizing the need for improved data infrastructure, professional guidelines, and capacity building to support sustainable property valuation.*

Keywords: sustainability, property valuation, hedonic pricing model, green premium, real estate, Nigeria.

INTRODUCTION

The global real estate sector is undergoing a profound transformation driven by the increasing emphasis on sustainability. Growing concerns about climate change, environmental degradation, and resource efficiency have intensified demand for buildings that minimize environmental impact while enhancing economic and social performance (Almusaed et-al., 2024). Within this evolving context, sustainability has emerged as a critical determinant of real estate development, investment, and asset management decisions, reshaping how property assets are designed, managed, and valued (Oladokun & Ojo, 2022). Property valuation, as a central component of real estate decision-making, is expected to reflect all factors that influence value. Traditionally, however, valuation practice has focused predominantly on structural, locational, and market attributes, often neglecting environmental and sustainability-related characteristics (Warren-Myers ,2022). Recent developments suggest that sustainability features such as energy efficiency, indoor environmental quality, carbon reduction, and climate resilience can significantly influence property performance and market outcomes. Empirical evidence from developed markets consistently shows that sustainable properties command price and rental premiums, commonly referred to as the “green premium,” indicating that sustainability attributes are increasingly capitalized into property values (Hossain et al., 2026; Setiowati et al., 2024; Dell’Anna, 2022).

Despite these advances, the integration of sustainability into property valuation remains limited, particularly in emerging markets such as Nigeria. The Nigerian real estate sector is characterized by data constraints, limited transparency, and a continued reliance on conventional valuation approaches that do not explicitly account for sustainability attributes (Babatunde et al., 2021). The absence of standardized metrics, weak institutional frameworks, and limited professional guidance further constrain the ability of valuers to systematically incorporate sustainability considerations into their analyses. As a result, the contribution of sustainability features to property value is often underrepresented or entirely omitted in valuation practice (Adewunmi et al., 2024). This disconnect has important implications. It may lead to valuation inaccuracy, where sustainable properties are undervalued, thereby discouraging investment in green infrastructure (Dell’Anna, 2022). It also contributes to market inefficiency, as property prices fail to fully reflect the long-term economic and environmental benefits associated with sustainable buildings (Warren-Myers ,2022). For valuation professionals, the challenge is increasingly significant, as they are required to respond to evolving client expectations, regulatory pressures, and global sustainability standards without adequate methodological tools or data support (Akinbogun et al., 2023).

At the same time, there is growing awareness of sustainability within Nigeria’s real estate sector, particularly in major urban centres such as Lagos, Abuja, and Port Harcourt. According to Auwalu and Bello (2023), developers are gradually incorporating features such as renewable energy systems, improved natural ventilation, and flood-resilient designs into property development.

However, the extent to which these features are recognized and reflected in property values remains unclear. This demonstrates a critical gap between emerging sustainability practices in the market and the methodologies used in property valuation (Ogunba & Ajayi, 2022).

Although a growing body of literature has examined the relationship between sustainability and property value, most empirical studies are concentrated in developed regions such as Europe (see Mironiuc et al., 2021; Mangialardo et al 2018) and North America (Anguelovski et al., 2022; Reichardt, 2014; Krause, & Bitter, 2012). There remains a paucity of robust empirical evidence from emerging markets, particularly in Sub-Saharan Africa, where market structures, data environments, and levels of sustainability adoption differ significantly. Furthermore, existing studies in Nigeria focus on awareness (Afolabi et al., 2025; Babawale & Oyalowo, 2013), challenges (Unegbu & YAWAS, 2024; Ajibola, 2015), impact (ADEYEMO & AJAYI, 2025; Unegbu & YAWAS, 2024) and willingness to pay (Otegbulu, 2018; Olaleye et al., 2015) without integrating sustainability features into property valuation models. There is presently no research on how sustainability variables can be systematically integrated into valuation frameworks under conditions of data scarcity and market imperfection. In addition, no widely accepted framework currently exists for quantifying sustainability attributes such as energy performance, environmental quality, and resilience within valuation practice in these contexts.

Another important gap lies in the limited understanding of how professional valuers engage with sustainability in practice. While sustainability is widely discussed in academic and policy circles, there is insufficient empirical evidence on the extent to which valuers incorporate sustainability considerations into their day-to-day valuation activities (Idris et al., 2021). Moreover, the influence of local institutional, regulatory, and market conditions on the valuation of sustainable properties remains underexplored, thereby limiting the applicability of findings from developed markets to emerging economies. Against this backdrop, there is a clear need for a structured and empirically grounded framework that integrates sustainability metrics into property valuation. Such a framework would not only improve valuation accuracy but also support sustainable real estate development, enhance market transparency, and facilitate better investment decision-making.

This study addresses these gaps by developing and empirically testing a sustainability-integrated property valuation model within the Nigerian context. Specifically, it examines the level of sustainability awareness among professional valuers, identifies key sustainability attributes relevant to valuation, constructs a context-appropriate sustainability index, and estimates the impact of sustainability on property values. In doing so, the study seeks to bridge the divide between sustainability theory and valuation practice, while contributing to the broader discourse on sustainable real estate valuation in emerging and data-constrained environments.

LITERATURE REVIEW

Conceptual Foundations of Property Valuation

Property valuation is a systematic and analytical process aimed at estimating the monetary worth of real estate assets at a given point in time, for a specific purpose and under defined market conditions (Wyatt, 2022). It serves as a critical mechanism for decision-making in property markets, informing transactions, investment analysis, lending, taxation, financial reporting, and policy formulation (Bello, 2022). Importantly, the concept of value is not absolute; it is context-dependent and varies according to the purpose of the valuation. Consequently, distinctions are commonly drawn between market value, investment value, and worth, each reflecting different assumptions, perspectives, and uses (Baum et al., 2021; Ifediora, 2020). Market value, the most widely adopted basis in professional practice, represents the estimated price at which a property would exchange between a willing buyer and a willing seller in an arm's-length transaction, after proper marketing, and where both parties act knowledgeably and without compulsion (IVSC, 2024). In contrast, investment value is specific to a particular investor and incorporates individual expectations, risk tolerance, and strategic objectives. Worth, on the other hand, reflects a subjective assessment of value to a particular user and may diverge significantly from observable market outcomes. These distinctions are especially relevant in the context of sustainability, where environmentally efficient or "green" properties may possess value characteristics that are not fully captured by conventional market-based assessments (Ametefe et al., 2021).

Beyond price estimation, property valuation plays a fundamental role in enhancing market transparency and efficiency. It acts as an information bridge that reduces uncertainty and facilitates informed decision-making among market participants. However, in many emerging economies, including Nigeria, property markets are often characterized by information asymmetry, weak data infrastructure, and limited transaction transparency. These challenges constrain the effectiveness and reliability of valuation practice (Ogunba, 2015; Ajayi, 2023). The situation is further complicated when sustainability attributes are involved, as such attributes are frequently intangible, non-standardized, and poorly documented within the local context (Olanrele et al., 2022). In response to evolving global sustainability imperatives, the role of the professional valuer is undergoing significant transformation. Valuers are increasingly expected to incorporate non-traditional value drivers such as energy performance, environmental risk, and social impact into their assessments. This shift reflects broader changes in real estate markets, where investors, regulators, and other stakeholders are placing greater emphasis on long-term asset performance, resilience, and sustainability outcomes (Oladokun & Ojo, 2022). Nevertheless, the capacity of valuers to effectively integrate these factors remains uneven, particularly in developing contexts where professional standards, data availability, and methodological guidance are still evolving (Dugeri et al., 2024).

The theoretical foundations of property valuation are rooted in several economic and urban theories that explain how value is formed and distributed within real estate markets. Among these, the Hedonic Pricing Theory remains one of the most influential frameworks. Originating from Rosen (1974), the hedonic model conceptualizes a property as a bundle of attributes structural, locational, and environmental each contributing to its overall price. By decomposing property value into the implicit prices of these attributes, the model provides a robust basis for empirical valuation analysis. While theoretically capable of incorporating sustainability characteristics, its practical application in Nigeria is often constrained by data limitations, measurement difficulties, and the absence of standardized sustainability indicators (Dabara et al., 2021; Aluko, 2022). The Market Efficiency Theory offers another important perspective, positing that asset prices reflect all available information. Applied to real estate, this suggests that sustainability features such as energy efficiency or green certification should be capitalized into property values where they are recognized and valued by market participants. However, property markets are inherently imperfect and often exhibit inefficiencies arising from heterogeneity, high transaction costs, and information asymmetry (Geltner et al., 2014; Babatunde et al., 2021). These imperfections are particularly pronounced in developing economies like Nigeria, where limited awareness, weak data systems, and low transparency hinder the full incorporation of sustainability-related information into property prices (Otegbulu & Idehen, 2023).

The Bid-Rent Theory further explains how location influences property values through accessibility and competition for land use. Traditionally focused on spatial dynamics, this theory can be extended to incorporate sustainability considerations, especially as environmental quality, climate resilience, and proximity to green infrastructure increasingly shape locational preferences in urban centres such as Lagos and Abuja (Oyetunji & Anderson, 2022). Properties situated in environmentally sustainable neighborhoods, for instance, may command higher rents due to improved living conditions, reduced operating costs, and enhanced long-term desirability. Closely related to these theoretical perspectives is the concept of information asymmetry, which remains central to understanding valuation challenges. In property markets, different actors often possess unequal access to information, resulting in inefficiencies and potential mispricing. Sustainability attributes tend to exacerbate this issue because they are difficult to observe, quantify, and verify. As a result, valuers may either exclude such attributes or rely on subjective judgment, thereby increasing the degree of uncertainty in valuation outcomes (Idris et al., 2021; Nwosu et al., 2023).

Generally, these theoretical frameworks provide a solid foundation for understanding property valuation while also highlighting their limitations in addressing sustainability. Most traditional models were developed in contexts where environmental considerations were not a central concern, and as such, they do not fully capture the multidimensional and evolving nature of sustainability. This underscores the need for an expanded theoretical and empirical framework that explicitly integrates sustainability metrics into valuation practice, particularly in data-constrained and institutionally evolving markets such as Nigeria (Ojo & Oladokun, 2023).

Sustainability in Real Estate: Concepts and Dimensions

Sustainability has become a central paradigm in the built environment, driven by growing concerns about climate change, resource depletion, and the long-term resilience of urban systems. In real estate, sustainability is fundamentally anchored in the triple bottom line (TBL) framework, which integrates environmental integrity, social equity, and economic viability into development and asset management decisions (Ojo & Oladokun, 2023). This multidimensional approach reflects a shift away from short-term profit maximization toward long-term value creation, operational efficiency, and risk mitigation (Olanipekun et al., 2021). Within the built environment, sustainability encompasses the entire lifecycle of real estate assets from design and construction to operation and eventual decommissioning. It emphasizes minimizing environmental impact while enhancing occupant well-being and economic performance. This has led to the emergence of sustainable or “green” buildings, which are designed to optimize energy use, reduce emissions, and improve indoor environmental quality (Dugeri & Olujimi, 2023). Importantly, sustainability should not be viewed solely as a technical or environmental attribute; it is also a value-relevant characteristic that influences market perception, investment decisions, and pricing behaviour in real estate markets (Babatunde et al., 2022).

The increasing prominence of sustainability is closely linked to the significant environmental footprint of the real estate sector. Buildings account for a substantial share of global energy consumption and greenhouse gas emissions, prompting policymakers, investors, and developers including those in Nigeria to prioritize sustainability in real estate decision-making (Ametefe et al., 2021). As a result, sustainability considerations are gradually evolving from optional enhancements to core determinants of asset performance, competitiveness, and long-term viability. Sustainable buildings typically incorporate features that enhance both environmental performance and user experience. These include energy efficiency measures such as improved insulation and high-performance building systems, water conservation technologies, and enhanced indoor environmental quality (Akinbogun et al., 2023). Such attributes contribute not only to reduced operational costs but also to improved occupant comfort, health, and productivity, thereby reinforcing the economic and social dimensions of sustainability (Idris et al., 2021). Empirical evidence indicates that these features can translate into tangible economic benefits, including lower lifecycle costs, higher occupancy rates, and stronger market appeal (Olanrele et al., 2022).

In addition, sustainable buildings are increasingly associated with risk mitigation, particularly in the context of climate change. Resilience to environmental hazards such as flooding in coastal cities like Lagos has become a critical factor influencing property desirability and long-term value (Nwosu et al., 2023). Beyond individual buildings, sustainability also extends to green infrastructure and broader urban environmental quality. Elements such as access to green spaces, sustainable transportation systems, and environmentally responsive neighborhood design contribute to enhanced quality of life and increased locational attractiveness, thereby influencing property values (Oyetunji & Anderson, 2022). However, despite their importance, these broader

environmental attributes are not yet consistently or systematically incorporated into valuation practice. A major challenge in integrating sustainability into property valuation lies in the measurement and standardization of sustainability attributes. Unlike conventional property characteristics such as size, location, or age, sustainability features are often multidimensional, intangible, and difficult to quantify. This creates significant barriers to their consistent inclusion in valuation models and professional practice (Oladokun & Ojo, 2022).

To address these challenges, a number of frameworks and metrics have been developed to assess sustainability performance. Among the most prominent are Environmental, Social, and Governance (ESG) indicators, which provide a structured and comprehensive approach to evaluating sustainability across multiple dimensions. ESG metrics are increasingly being adopted by institutional investors in Nigeria as part of a broader shift toward responsible and sustainable investment practices (Adewunmi et al., 2024). In parallel, green building certification systems such as LEED, BREEAM, and the IFC's EDGE which is gaining traction in the Nigerian market serve as standardized proxies for sustainability performance (Babatunde et al., 2022). These certification systems provide measurable benchmarks for evaluating environmental performance and have been widely used in empirical research. Evidence suggests that certified buildings often command price and rental premiums, indicating that the market recognizes and rewards sustainability attributes, although the magnitude of such premiums varies across different markets and contexts (Otegbulu & Idehen, 2023). Despite these advancements, there is still no universally accepted framework for integrating sustainability metrics into property valuation, particularly in emerging markets. Persistent challenges such as limited data availability, inconsistent reporting standards, weak institutional frameworks, and low market transparency continue to constrain the effective incorporation of sustainability into valuation practice (Dugeri et al., 2024). Consequently, sustainability is often treated as an implicit or secondary consideration rather than a core determinant of property value, highlighting the need for more robust, standardized, and context-sensitive approaches to its integration.

Sustainability and Property Value

The relationship between sustainability and property value is rooted in fundamental economic principles of utility, cost efficiency, and risk. From a theoretical standpoint, sustainability attributes influence property value through three primary channels: enhanced utility, reduced operating costs, and risk mitigation. First, sustainability features such as improved indoor environmental quality, natural lighting, and thermal comfort increase the utility derived by occupants, thereby strengthening demand for such properties. Within the framework of hedonic pricing theory, these attributes are treated as value-bearing characteristics that contribute to the overall price of a property (Dabara, 2021). As preferences shift toward health, well-being, and environmental quality, these factors are increasingly capitalized into property values, particularly in growing urban centres in Nigeria (Otegbulu & Idehen, 2023).

Second, sustainable buildings are commonly associated with lower lifecycle costs, especially in terms of energy and water consumption. Reduced operating expenses enhance net income streams for income-producing properties, which in turn increases their capitalized value under the income approach to valuation (Oladokun & Ojo, 2022). This aligns with investment theory, where asset value is determined by expected future cash flows. In the Nigerian context, where energy costs can be volatile and infrastructure challenges persist, sustainability features that improve efficiency are likely to generate positive valuation effects (Babatunde et al., 2021). Third, sustainability contributes to risk reduction, particularly in relation to environmental, regulatory, and obsolescence risks. Properties that are energy-inefficient or environmentally non-compliant may face increased future costs due to tightening regulations, carbon pricing mechanisms, or market-driven “brown discounting,” where less efficient buildings experience accelerated value depreciation (Akinbogun et al., 2023). In contrast, sustainable properties tend to demonstrate greater resilience and adaptability, making them less vulnerable to functional obsolescence and long-term value erosion (Nwosu et al., 2023).

However, the realization of these theoretical benefits depends heavily on market recognition, awareness, and the availability of reliable information. In markets where sustainability awareness is limited or data is insufficient, these value-enhancing effects may not be fully reflected in observed property prices. This often results in a divergence between theoretical value and market value, particularly in emerging economies such as Nigeria (Ogunba, 2022). Empirical evidence from developed markets provides substantial support for the existence of a “green premium,” whereby properties with sustainability features command higher prices and rental values compared to conventional buildings. These studies, often based on hedonic pricing models or repeat-sales analysis, consistently demonstrate positive impacts of sustainability attributes on property performance (Wyatt, 2023). For example, research on green-certified office buildings in the United States and Europe frequently reports rental and sales price premiums, driven by factors such as lower operating costs, higher occupancy rates, and stronger tenant demand. Similarly, studies in residential markets indicate that energy-efficient homes tend to achieve higher transaction prices, reflecting buyer preferences for reduced utility expenses and improved living conditions.

Nevertheless, empirical findings are not entirely uniform. Some studies report modest or statistically insignificant effects, particularly in markets where sustainability features are not widely understood or where certification systems have limited influence. Moreover, the magnitude of the green premium varies considerably depending on factors such as location, property type, market maturity, and regulatory environment (Sayce et al., 2021). This suggests that the relationship between sustainability and value is context-specific rather than universally consistent. In contrast, empirical research in emerging markets remains limited, fragmented, and often inconclusive. Available studies suggest that while sustainability has the potential to influence property values, its impact is generally weaker and less consistent than in developed economies (Udoekanem et al., 2023). Several factors account for this disparity. Data limitations represent a

major constraint, as reliable information on sustainability attributes such as energy performance or green certification is often scarce or unavailable in Nigeria, hindering rigorous empirical analysis (Adewunmi et al., 2024).

Additionally, market awareness and demand for sustainability features tend to be relatively low, reducing the likelihood that such attributes will be capitalized into property prices. Institutional and regulatory frameworks that support sustainability, including building codes and environmental standards, are also often underdeveloped or weakly enforced (Babatunde et al., 2022). In the Nigerian context, these challenges are further compounded by market characteristics such as informality, opacity, and reliance on conventional valuation approaches that rarely incorporate sustainability considerations (Idris et al., 2021). As a result, even when sustainability features are present, they may not be explicitly reflected in valuation outcomes, creating a disconnect between the potential value of sustainability and its actual recognition in the market. Furthermore, existing studies in emerging markets often rely on simplified methodological approaches, limiting their ability to capture the complex and multidimensional nature of sustainability. There is a notable lack of advanced econometric modelling and limited integration of environmental risk factors into valuation analysis (Olanrele et al., 2022).

These gaps demonstrate the need for more rigorous research that explores how sustainability metrics can be effectively integrated into property valuation models in emerging markets, particularly in data-constrained environments such as Nigeria.

Property Valuation Methods and Their Limitations

Property valuation practice is traditionally anchored on three principal approaches: the sales comparison (or comparative) approach, the income capitalization approach, and the cost approach. Each reflects a distinct perspective on value formation and is applied based on the nature of the property and the purpose of the valuation (Ajayi, 2023). The sales comparison approach is widely regarded as the most direct and market-oriented method. It estimates value by comparing the subject property with recently transacted comparable properties, making adjustments for differences in characteristics such as location, size, and condition. Its primary strength lies in its reliance on observable market evidence, which enhances its relevance in active and transparent markets. However, its effectiveness is highly dependent on the availability of reliable and comparable transaction data. In emerging markets such as Nigeria, the absence of a centralized property databank, coupled with limited transaction transparency, significantly constrains its application (Ogunba, 2022; Otegbulu & Idehen, 2023).

The income capitalization approach is primarily applied to income-generating properties, particularly within the commercial real estate sector. It determines value based on the present worth of expected future income streams, typically through capitalization rates or discounted cash flow (DCF) analysis. This approach is theoretically robust, as it aligns closely with investment

principles and the notion that asset value is driven by anticipated returns. However, it assumes that future income and associated risks can be estimated with reasonable accuracy an assumption that may not hold in volatile or data-constrained environments such as the Nigerian property market (Bello, 2022). The cost approach, on the other hand, estimates value by calculating the cost of reproducing or replacing the asset, less depreciation, and adding the value of the land. It is particularly useful for specialized or newly constructed properties where comparable market data is limited. Despite its practical relevance in such contexts, the approach is often criticized for its inability to adequately capture market perceptions and intangible value drivers, including those associated with sustainability (Ifediora, 2020).

Although these traditional approaches form the foundation of valuation practice, they are inherently data-dependent and largely backward-looking, relying on historical transactions and observable characteristics. Consequently, they are not well-suited to capturing emerging and forward-looking value drivers such as sustainability, which are often not fully reflected in existing market data (Oladokun & Ojo, 2022). An important analytical extension of the comparative approach is the hedonic pricing model, which provides a statistical framework for decomposing property value into the implicit prices of its individual attributes. Through the application of regression analysis, hedonic models estimate the marginal contribution of various property characteristics including structural, locational, and environmental factors to overall value. In the context of sustainability, this approach offers a valuable tool for quantifying the impact of attributes such as energy efficiency, green certification, and environmental quality.

However, the practical application of hedonic models is constrained by several limitations. They require large volumes of high-quality and reliable data, which are often unavailable in emerging markets. Additionally, the selection and measurement of relevant variables pose significant challenges, particularly for sustainability attributes that are complex, multidimensional, and difficult to quantify (Dugeri & Olujimi, 2023). Furthermore, hedonic models generally assume relatively efficient and stable market conditions assumptions that may not hold in contexts characterized by informality, data opacity, and structural inefficiencies.

A critical limitation across existing valuation methods is their inadequate treatment of sustainability variables. Most traditional approaches were developed at a time when environmental considerations were not central to real estate decision-making, and as such, they do not explicitly account for the complex and multidimensional nature of sustainability (Akinbogun et al., 2023). One major challenge is the omission or weak representation of non-market and intangible attributes. Sustainability features such as reduced carbon emissions, improved indoor air quality, and climate resilience often lack direct market comparables or observable price signals. As a result, they are frequently excluded from formal valuation processes or implicitly incorporated in ways that lack transparency and consistency (Idris et al., 2021).

Data scarcity and the absence of standardized measurement frameworks further compound this challenge. In Nigeria, there is limited availability of reliable data on sustainability performance, and the lack of standardized metrics makes it difficult for valuers to consistently integrate such attributes into their analyses. Moreover, professional guidance on sustainability integration remains limited, as valuation standards and frameworks are still evolving within institutions such as the Nigerian Institution of Estate Surveyors and Valuers (NIESV) (Adewunmi et al., 2024; Dugeri et al., 2024). The reliance on professional judgment in the absence of robust data introduces an additional layer of subjectivity into the valuation process. Valuers may depend on personal experience or heuristic approaches to account for sustainability, leading to inconsistencies and potential bias in valuation outcomes (Ogunba, 2022). Finally, a fundamental limitation lies in the temporal mismatch between traditional valuation methods and sustainability considerations. While most conventional approaches are static and backward-looking, sustainability is inherently dynamic and forward-looking, with many of its benefits realized over the lifecycle of the asset. This mismatch constrains the ability of existing valuation models to fully capture the long-term value implications of sustainability (Ojo & Oladokun, 2023).

Integration of Sustainability into Valuation Practice

The growing recognition of sustainability as a value-relevant factor has stimulated the development of emerging approaches aimed at integrating environmental and social considerations into property valuation. These approaches extend traditional valuation frameworks by incorporating forward-looking performance indicators, lifecycle costs, and risk adjustments associated with sustainability (Ojo & Oladokun, 2023). One notable approach involves sustainability-adjusted cash flow models within the income capitalization framework. In this context, sustainability features such as energy efficiency and reduced resource consumption are reflected through enhanced income streams or reduced operating expenditures, leading to higher net operating income and, ultimately, increased property value (Akinbogun et al., 2023). In addition, sustainability-related risks, including regulatory penalties, environmental liabilities, and obsolescence, can be incorporated through adjustments to capitalization or discount rates. This allows valuers to better capture the differing risk-return profiles of sustainable and non-sustainable assets, particularly within the Nigerian market (Olanrele et al., 2022).

Another emerging approach is lifecycle costing and performance analysis, which evaluates the long-term economic implications of sustainability over the entire life of an asset. This method aligns closely with the forward-looking nature of sustainability by accounting for cost savings, maintenance efficiency, durability, and long-term asset performance. Despite its conceptual strength, its practical application in Nigeria remains limited due to data constraints, methodological complexity, and the absence of standardized frameworks (Ogunba, 2022). The increasing prominence of Environmental, Social, and Governance (ESG) considerations has further influenced real estate valuation practice. ESG provides a structured framework for assessing sustainability performance across environmental efficiency, social impact, and

governance quality. In recent years, institutional investors and financial markets in Nigeria have increasingly incorporated ESG criteria into investment decision-making, reflecting a broader shift toward responsible and sustainable investment practices (Adewunmi et al., 2024). From a valuation perspective, ESG factors influence key inputs such as cash flow projections, vacancy rates, and discount rates. Properties with strong ESG performance are often perceived as lower-risk investments, which may result in lower capitalization rates and higher asset values. Conversely, assets with weak sustainability performance may be subject to a “brown discount,” reflecting heightened exposure to regulatory, environmental, and market risks (Idris et al., 2021; Udoekanem et al., 2023).

Despite these advancements, several barriers continue to hinder the effective integration of sustainability into valuation practice. A fundamental challenge is the lack of reliable and accessible data on sustainability attributes. In Nigeria, information on energy performance, environmental quality, and building certification is not systematically recorded, making empirical comparison and analysis difficult (Babatunde et al., 2021). In addition, there is no universally accepted framework for measuring and reporting sustainability within the Nigerian real estate sector. Although certification systems such as the IFC’s EDGE are gaining traction, their application is not yet standard practice in valuation reporting (Dugeri & Olujimi, 2023). Professional capacity constraints also pose a significant limitation. Many valuers lack the technical training and methodological guidance required to integrate sustainability into their assessments. Professional standards issued by institutions such as the Nigerian Institution of Estate Surveyors and Valuers (NIESV) are still evolving and do not yet provide comprehensive guidance on how sustainability features should be measured and weighted in valuation (Dugeri et al., 2024). Market-related factors further complicate integration. In many emerging markets, including Nigeria, demand for sustainable properties remains relatively low due to limited awareness among buyers and tenants. As a result, sustainability features may not be fully recognized or capitalized in property prices, reducing the incentive for valuers to incorporate them into their analyses (Otegbulu & Idehen, 2023). This creates a persistent mismatch between the long-term benefits of sustainability and the short-term, transaction-based focus of conventional valuation practice.

The limited integration of sustainability into valuation practice can therefore be attributed to a combination of institutional and market constraints. Regulatory inconsistencies and weak enforcement of building and environmental standards reduce the extent to which sustainability influences property values (Babatunde et al., 2021). Data scarcity, particularly the absence of centralized and digitized property databases, restricts the application of robust analytical models (Adewunmi et al., 2024). Economic priorities in Nigeria, such as housing affordability and access, often overshadow sustainability considerations, limiting demand for green buildings (Otegbulu & Idehen, 2023). Low market awareness further weakens demand signals, while capacity gaps among valuers hinder the effective quantification of sustainability-related benefits (Idris et al., 2021; Dugeri et al., 2024).

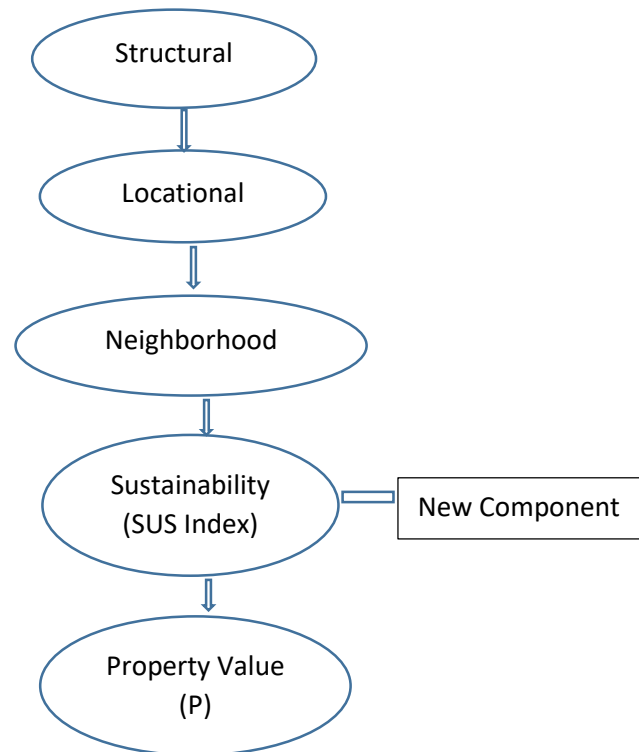
These factors underscore the complexity of integrating sustainability into property valuation in emerging markets and highlight the need for improved data systems, stronger institutional frameworks, and enhanced professional capacity.

Development of Conceptual Model

Building on the reviewed literature, this study adopts an extended valuation framework that integrates sustainability metrics into traditional property valuation models. The conceptual model is grounded in hedonic pricing theory, which posits that property value is a function of its constituent attributes. However, unlike conventional applications, this study explicitly incorporates sustainability as a distinct and measurable category of value determinants.

Within this framework, property value is conceptualized as a function of three interrelated groups of variables: structural attributes, locational attributes, and sustainability attributes. Structural attributes include factors such as property size, age, and building quality; locational attributes encompass accessibility and neighborhood characteristics; while sustainability attributes capture elements such as energy efficiency, environmental quality, and climate resilience. This integrated perspective reflects the evolving dynamics of real estate markets, where sustainability is increasingly recognized as a core driver of value rather than a peripheral consideration.

Based on this conceptual foundation, the study identifies property value expressed as either sale price or rental value as the dependent variable. The independent variables are grouped into two categories. The first comprises traditional variables, including property size, age, location, number of rooms, and related physical and spatial characteristics. The second category consists of sustainability variables, such as energy efficiency indicators, environmental quality (including ventilation and natural lighting), the presence of green features or certifications, and climate resilience attributes. In addition, control variables are incorporated to account for broader market and economic conditions, including inflation rates, interest rates, and general market trends.



The developed model demonstrates that sustainability is not merely a qualitative concept but a quantifiable and economically significant determinant of property value. By embedding sustainability metrics into a structured valuation framework, the model provides a practical pathway for modernizing valuation practice in emerging real estate markets.

METHODOLOGY

This study adopts a quantitative research design, complemented by limited qualitative insights, to examine the relationship between sustainability attributes and property values. A cross-sectional econometric approach is employed, using property transaction data to estimate the implicit contribution of sustainability variables to property prices. The study is situated in Nigeria an emerging real estate market characterized by institutional and data constraints thereby enhancing the contextual relevance of the findings. The research is underpinned by a deductive approach, with hypotheses derived from established theoretical frameworks, particularly hedonic pricing theory and market efficiency theory. These hypotheses are empirically tested using econometric techniques. The primary analytical tool is the Hedonic Pricing Model (HPM), first specified as a baseline model and subsequently extended to incorporate sustainability variables. To complement

the quantitative analysis, a structured survey of professional valuers is conducted to capture expert perceptions on the role of sustainability in property valuation, as well as the practical challenges associated with integrating sustainability metrics. This mixed-method approach enhances both the analytical rigor and practical relevance of the study. The empirical analysis focuses on Lagos, Abuja, and Port Harcourt. These cities are selected due to their high levels of real estate activity, increasing adoption of sustainable building practices, and relatively better availability of market data compared to other Nigerian urban centres. Both primary and secondary data are utilized. Primary data are obtained from estate surveying and valuation firms, property listing platforms, relevant government agencies, and professional bodies such as the Nigerian Institution of Estate Surveyors and Valuers (NIESV). In addition, survey data are collected from practicing valuers. Secondary data consist of property transaction records, including sale prices and rental values, as well as detailed property characteristics and sustainability indicators. A purposive sampling technique is employed in selecting property data based on availability and completeness, while a stratified sampling approach is used for survey respondents to ensure representation across different levels of professional experience and firm types. The study targets approximately 150 property observations to ensure econometric robustness, alongside 120 professional valuers for the survey component.

The baseline hedonic model expresses property value as a function of structural, locational, and neighborhood characteristics. The extended model incorporates sustainability variables and is specified as:

$$P = \beta_0 + \beta_1S + \beta_2L + \beta_3N + \beta_4SUS + \varepsilon$$

where P represents property value; S, L, and N denote structural, locational, and neighborhood characteristics respectively; SUS captures sustainability attributes; β represents the parameters to be estimated; and ε is the error term. Sustainability variables include indicators such as energy efficiency, natural ventilation, waste management systems, and flood resilience. Data analysis begins with descriptive statistics including means, standard deviations, and frequency distributions to summarize key dataset characteristics. This is followed by econometric analysis using Ordinary Least Squares (OLS) regression. Results from the baseline model are compared with those from the extended model to assess the marginal contribution of sustainability variables to property values.

To ensure robustness and reliability, several diagnostic tests are conducted, including multicollinearity checks using the Variance Inflation Factor (VIF), as well as tests for heteroskedasticity and normality of residuals. Model performance is evaluated using goodness-of-fit indicators such as R^2 and adjusted R^2 . Additional robustness checks are performed through alternative model specifications, log-linear transformations, and sensitivity analyses.

Validity and reliability are ensured through careful variable selection grounded in existing literature, appropriate model specification with relevant control variables, and the use of consistent and standardized data sources. Ethical considerations are also observed, including the confidentiality of data sources, informed consent from survey participants, and adherence to proper citation practices to avoid plagiarism.

RESULTS AND DISCUSSION OF FINDINGS

This chapter presents the empirical results of the study, focusing on the integration of sustainability metrics into property valuation models within selected urban markets in Nigeria. The analysis draws on property transaction data complemented by sustainability assessments and survey inputs from professional valuers, and is organized around descriptive statistics, regression estimation, diagnostic evaluation, and interpretation of findings.

Descriptive Analysis of Respondent Valuers

This section presents a consolidated overview of the characteristics of professional valuers surveyed in the study. A total of 170 respondents were drawn from Lagos, Abuja, and Port Harcourt, representing the major centres of real estate activity in Nigeria. To enhance clarity and analytical coherence, the key descriptive attributes of respondents are summarized in a single composite table.

Table 4.1: Summary of Descriptive Statistics of Respondent Valuers

Variable	Category	Frequency	Percentage (%)	Mean Score	Rank
Location	Lagos	70	43.8	—	—
	Abuja	50	31.2	—	—
	Port Harcourt	50	31.2	—	—
Professional Experience	0–5 years	28	17.5	—	—
	6–10 years	46	28.8	—	—
	11–15 years	42	26.3	—	—
	16+ years	44	27.5	—	—
Type of Practice	Private Practice	98	61.3	—	—
	Government/Public Sector	32	20.0	—	—
	Corporate/Institutional	30	18.7	—	—
Awareness of Sustainability	Low	22	13.8	—	—
	Moderate	64	40.0	—	—
Incorporation in Practice	High	74	46.2	—	—
	Rarely/Never	58	36.3	—	—
	Occasionally	67	41.9	—	—

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Perceived Barriers	Frequently	35	21.9	—	—
	Lack of data	—	—	4.45	1st
	Lack of guidelines	—	—	4.30	2nd
	Limited training	—	—	4.12	3rd
	Low market demand	—	—	3.95	4th

The results provide a comprehensive profile of valuation professionals and reveal several important patterns. First, the geographical distribution shows a concentration of respondents in Lagos, reflecting its position as the most active and mature property market in Nigeria, while Abuja and Port Harcourt provide balanced representation of administrative and oil-driven urban markets. This spatial spread enhances the generalizability of the findings across key real estate centres. Second, the respondents are largely experienced professionals, with over 80% having more than five years of practice and a significant proportion (27.5%) possessing over 16 years of experience. This indicates that the dataset is informed by seasoned practitioners whose insights are likely to reflect established valuation practices and market realities. Third, the dominance of private practice (61.3%) suggests that the findings are strongly aligned with market-based valuation activities. However, the inclusion of respondents from government and corporate sectors ensures that institutional and regulatory perspectives are also captured, thereby enriching the analysis.

A critical observation from the table is the contrast between awareness and application of sustainability concepts. While a substantial proportion of respondents (86.2%) report moderate to high awareness, only 21.9% frequently incorporate sustainability into valuation practice. The majority either apply it occasionally or not at all. This clearly demonstrates a gap between knowledge and implementation within the profession.

The analysis of perceived barriers provides further explanation for this gap. The most significant constraint identified is the lack of reliable data, followed by the absence of standardized valuation guidelines and limited professional training. These structural challenges hinder the systematic integration of sustainability into valuation processes, even where awareness exists. The relatively lower ranking of market demand suggests that while demand side pressures are emerging, they are not yet sufficiently strong to drive widespread adoption.

In general, the Table demonstrates a profession in transition. Valuers in Nigeria are increasingly aware of sustainability concepts and their relevance to property valuation, but practical integration remains constrained by institutional and technical limitations. These findings provide important contextual support for the regression results presented hereunder, which demonstrate that sustainability has a measurable impact on property values. The coexistence of empirical significance and practical underutilization underscores the need for improved data infrastructure, standardized frameworks, and targeted capacity building to bridge the gap between theory and practice in sustainability-inclusive valuation.

Descriptive Statistics of Variables

The descriptive statistics provide an overview of the key variables employed in the analysis, as presented in Table 4.2.

Table 4.2: Descriptive Statistics of Variables

Variable	Mean	Std. Dev.	Min	Max
Price (N)	170,000,000	20,000,000	100,000,000	300,000,000
Size (sqm)	145	35	70	300
Bedrooms	3.8	1.2	2	6
Age (years)	8.5	6.2	1	25
SUS Index	0.56	0.18	0.20	0.90

The statistics indicate that the dataset is dominated by middle to high income residential properties, with moderate but uneven adoption of sustainability features. The variability in the sustainability index is particularly important, as it enables robust estimation of its marginal contribution to property values.

Regression Result

The regression analysis is based on two model specifications: a baseline model and an extended model incorporating sustainability variables. The results are presented in Table 4.2.

Table 4.4: Regression Results

Variable	Model 1 (Without SUS)	Model 2 (With SUS)
Constant	10.21	9.85
Size	0.0045	0.0038
Bedrooms	0.085	0.072
Age	-0.021	-0.018
Location (Dummy)	0.312	0.275
SUS Index	—	0.186
R ²	0.68	0.74
Adjusted R ²	0.66	0.72

Note: $p < 0.01$, $p < 0.05$

The inclusion of sustainability variables leads to a noticeable improvement in model performance, with R^2 increasing from 0.68 to 0.74. This confirms that sustainability attributes enhance the explanatory power of property valuation models. The sustainability index is positive and statistically significant ($\beta = 0.186$, $p < 0.01$), implying that a unit increase in sustainability is associated with an approximate 18.6% increase in property value. This provides strong evidence of a “green premium” within the Nigerian property market.

The behavior of control variables is consistent with theoretical expectations. Property size and number of bedrooms positively influence value, while property age exerts a negative effect due to depreciation. Location remains a dominant determinant, reinforcing the importance of spatial factors in real estate valuation.

Diagnostic tests further validate the robustness of the model, as presented in Table 4.3.

Table 4.3: Diagnostic Test Results

Test	Result	Interpretation
VIF	< 5	No multicollinearity
Breusch–Pagan Test	Insignificant	Homoskedastic residuals
Normality (JB Test)	$p > 0.05$	Residuals normally distributed
Durbin–Watson	≈ 1.95	No autocorrelation

These results confirm that the model satisfies the key assumptions of Ordinary Least Squares estimation and that the estimated coefficients are statistically reliable. The findings of this study provide strong empirical support for the integration of sustainability into property valuation models within Nigeria. The positive and significant coefficient of the sustainability index confirms that sustainability is a value-relevant attribute, thereby extending the traditional hedonic pricing framework. The existence of a measurable green premium indicates that market participants are increasingly recognizing and capitalizing sustainability benefits. In comparison with existing Nigerian studies, the present findings both align with and extend prior research. For example, studies have shown that valuers in Nigeria demonstrate growing awareness of sustainability but face challenges in its practical application (Babawale & Oyalowo, 2011). Similarly, subsequent research indicates that although sustainability is acknowledged, traditional factors such as location, design, and construction quality continue to dominate valuation considerations (Oyalowo et al., 2018).

The present study corroborates these findings in that traditional determinants particularly location remain significant drivers of property value. However, it departs from largely perception-based

studies by providing quantitative, market-based evidence that sustainability attributes are not only recognized but also capitalized into property prices. This represents a critical shift from awareness to measurable economic impact. Furthermore, empirical studies in Nigeria have identified key constraints to the integration of sustainability in valuation practice, including inadequate data, lack of standardized metrics, and limited professional training (Adegoke et al., 2017). While these constraints remain relevant, the results of this study demonstrate that sustainability effects can still be empirically captured despite such limitations. This contrasts with earlier assumptions that the Nigerian market lacks sufficient maturity to reflect sustainability premiums.

In addition, recent Nigerian studies have emphasized the risk of undervaluation when sustainability factors are excluded from appraisal models (Ayedun et al., 2020). The findings of this study provide empirical support for this position, as the exclusion of sustainability variables reduces model explanatory power and potentially biases valuation outcomes. In general, this study contributes to the Nigerian literature by bridging the gap between perception-based and empirically grounded research. While earlier studies focused primarily on awareness and challenges, the present analysis demonstrates that sustainability has a statistically significant and economically meaningful impact on property values. This reinforces its relevance as an emerging component of real estate valuation in Nigeria.

CONCLUSION AND RECOMMENDATIONS

The study examined the integration of sustainability metrics into property valuation models using empirical evidence from selected urban property markets in Nigeria. The study was motivated by the increasing global relevance of sustainability in real estate and the persistent gap in its incorporation into valuation practice within emerging markets. It developed and empirically tested a sustainability-integrated hedonic pricing model, supported by the construction of a context-specific sustainability index and the collection of both property transaction data and survey responses from professional valuers. By combining econometric modelling with practitioner insights, the study provides a comprehensive perspective on both market behaviour and valuation practice. The findings demonstrate that sustainability is a statistically significant determinant of property value. The regression results reveal a positive and robust relationship between sustainability attributes and property prices, confirming the existence of a measurable green premium within the Nigerian real estate market. Furthermore, the inclusion of sustainability variables enhances the explanatory power of the valuation model, indicating that conventional approaches that exclude such variables may be incomplete.

The descriptive analysis shows that the adoption of sustainability features among properties remains moderate, with considerable variation across the sample. At the same time, survey evidence indicates that while awareness of sustainability concepts among valuers is relatively high,

their consistent application in valuation practice is limited. This disparity is largely explained by structural constraints, including the lack of reliable data, absence of standardized guidelines, limited professional training, and relatively low market demand for sustainable features. Generally, these findings lead to the conclusion that sustainability is not only conceptually relevant but also economically significant in property valuation. Market evidence suggests that sustainability attributes are increasingly recognized and capitalized into property prices, even within the constraints of an emerging market such as Nigeria. However, a clear disconnect persists between market behaviour and professional valuation practice, highlighting the need for methodological advancement and institutional support within the profession. The sustainability-integrated model developed in this study offers a practical and adaptable framework for improving valuation accuracy and aligning practice with evolving market realities.

The implications of these findings are far-reaching. For valuation professionals, there is a clear need to adopt more structured and systematic approaches to incorporating sustainability into appraisal models. Professional bodies, particularly the Nigerian Institution of Estate Surveyors and Valuers, have a critical role to play in developing standardized guidelines and practice notes that embed sustainability considerations into valuation procedures. For government and regulatory authorities, the findings underscore the importance of policy interventions that promote sustainable development. This includes strengthening building regulations, providing incentives for green construction, and improving property data infrastructure to include sustainability-related information. Real estate developers are encouraged to invest in sustainable building features, as these not only enhance environmental performance but also contribute to higher property values and increased market competitiveness. Similarly, investors should integrate sustainability considerations into their decision-making processes, particularly in relation to risk assessment and long-term investment performance.

Based on the empirical evidence, several recommendations emerge. There is a need for the development of standardized sustainability valuation frameworks to guide professional practice. Efforts should also be directed toward improving data availability through the establishment of centralized property databases that capture sustainability metrics. Capacity building is essential, and targeted training programmes should be implemented to enhance valuers' technical competence in sustainability-inclusive valuation. In addition, sustainability considerations should be formally integrated into professional standards and regulatory frameworks, while broader awareness campaigns are necessary to stimulate market demand for sustainable properties.

Notwithstanding its contributions, the study is subject to certain limitations. The availability and quality of property transaction data, particularly with respect to sustainability attributes, posed a significant constraint. In addition, the cross-sectional nature of the analysis limits the ability to capture the dynamic and long-term effects of sustainability on property values. These limitations suggest caution in generalizing the findings and point to opportunities for further research.

Future studies should consider the use of larger and more diverse datasets, as well as longitudinal approaches that capture temporal dynamics in property markets. There is also scope for the application of more advanced analytical techniques, including spatial econometric models, to better account for location-specific effects. Further research could also extend the analysis to commercial property markets, where sustainability considerations may exhibit different dynamics and magnitudes.

In terms of scholarly contribution, this study advances knowledge by developing a sustainability-integrated valuation model tailored to an emerging market context and by providing empirical evidence of the capitalization of sustainability attributes into property values in Nigeria. It also bridges the gap between theoretical discourse and professional practice, offering both conceptual insights and practical guidance for the evolution of property valuation in line with sustainability imperatives.

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