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Quantifying the Implied Monetary Value of Specific 2-BDR Residential Property Attributes using Hedonic Pricing Model in UYO Metropolis

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Abstract
This study measures the implied monetary value of structural, locational, and environmental attributes for 2-BDR residential properties in Uyo Metropolis, addressing a critical practical gap in local real estate valuation. Utilizing a cross-sectional design and stratified random sampling of 387 households, the study employed Exploratory Factor Analysis (EFA), a disaggregated Hedonic Pricing Model (HPM), and Hierarchical Linear Modeling (HLM). Unlike constrained single-index models, the fully specified hedonic regression established that structural, locational, and environmental attributes collectively account for 71.4% ($R^2 = 0.714$, $p < 0.001$) of the variation in residential property rental values. Results establish that structural features serve as the primary value-determinants, while specific locational and environmental variables exhibit nuanced, significant impacts on market pricing. These findings challenge traditional valuation subjectivity, providing a data-driven framework for practitioners to enhance appraisal accuracy, stabilize market prospects, and inform sustainable urban land-use policies amid the city's rapid population growth.

Keywords: *Implicit Monetary Value, 2-BDR Residential Property Attributes, Hedonic Pricing Models, Real Estate Valuation, Uyo Metropolis.*

I. INTRODUCTION

Background of the Study

The real estate market is progressively driven by a multifaceted interplay of structural, locational, and environmental attributes that dictate residential values worldwide. Though global studies validate that structural features like floor area provide foundational value, the growing influence of environmental factors such as flood risk and neighborhood quality has significantly impacted property pricing in diverse urban landscapes. Within the African context, rapid urbanization is frequently disengaged from infrastructure provision, creating unique market dynamics where proximity to commercial centers and access to utility networks are dominant. In Nigeria, and specifically within Akwa Ibom State, the Uyo metropolis replicates these pressures as population growth surpasses the supply of quality 2-BDR residential units, leading to noteworthy price volatility. However, much of the existing research in this region emphasizes general urban growth rather than the precise, quantitative disintegration of attribute values. This study addresses the gap in the literature regarding the empirical quantification of how individual housing attributes contribute to market rent in Uyo Metropolis.

The problem centers on the historic failure of local valuers to precisely price property attributes in the face of rising environmental risks, such as erosion and flooding. Applying a properly specified Hedonic Pricing Model (HPM) and Hierarchical Linear Modeling (HLM), this study unravels the relative contributions of structural versus locational and environmental features. It seeks to answer: what are the key attributes influencing 2-BDR values, what are their marginal implicit prices, and how do neighborhood environmental factors impact pricing? The projected results provide a robust, data-driven framework that enables Estate Surveyors and Valuers in Uyo Metropolis to offer more precise valuations, thereby stabilizing market opportunities and informing improved urban land-use procedures.

Problem Statement

The real estate market in the Uyo metropolis faces critical valuation challenges, characterized by a significant lack of empirical price disintegration for residential attributes. Research indicates that approximately 65% to 75% of residential property valuations in developing urban centers like Uyo depend on traditional comparative methods rather than data-driven hedonic models. This dependence contributes to valuation inconsistencies frequently exceeding 20% to 30% between projected market values and actual transaction prices. Furthermore, environmental dangers pose a substantial financial risk; properties located within flood-prone areas,

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which account for nearly 40% of the city's expanding residential zones, suffer from a "flood discount" where rental values may be stifled by 15% to 25% compared to similar units in safe locations.

A major methodological pitfall in previous local approximations has been the improper aggregation or omission of multi-attribute variables, which previously led to underpowered model specifications. This research addresses this gap by utilizing a disaggregated hedonic framework capable of capturing the true multi-variable interactions of structural, locational, and environmental variables, which together clarify over 70% of the variation in residential rent. Without integrating these variables into a robust HPM, the sector risks continuous valuation instability, failing to reflect the true economic worth of residential assets amidst swift urban growth.

Objectives
The objectives of this study are:

1. To categorize the key structural, locational, and neighborhood/environmental attributes influencing 2-BDR residential property values within Uyo Metropolis.

2. To estimate the marginal implicit values of these selected 2-BDR residential property attributes using the Hedonic Pricing Model (HPM).

3. To determine the relative contribution of structural versus locational attributes to the total 2-BDR residential property price.

4. To examine the impact of environmental and neighborhood factors on the market value of 2-BDR residential properties.

Hypotheses
The following null hypotheses were tested:

- H_{01}**:** There is no significant agreement among real estate professionals regarding the classification of structural, locational, and neighborhood/environmental attributes as primary drivers of value in Uyo Metropolis.

- H_{02}**:** The selected structural, locational, and neighborhood/environmental attributes do not have a significant relationship with the property price of 2-BDR residential properties in Uyo Metropolis.

- H_{03}**:** There is no significant difference in the relative contribution of structural attributes compared to locational attributes toward the total market value of 2-BDR residential properties.

- H_{04}**:** Environmental and neighborhood-level factors have no significant impact on the variation of market values between neighborhoods in Uyo Metropolis.

II. LITERATURE REVIEW

The literature review was discussed using these sub-topics, namely;

i. Categorization of key structural, locational and environmental attributes influencing 2-BDR residential property values
Current literature highlights that residential property values are determined by a complex relationship of structural, locational, and environmental attributes, often examined through hedonic pricing models (Cai et al., 2024; Chmielewska et al., 2022). Structural characteristics, such as the number of bedrooms, floor size, and building condition, represent the primary physical determinants of value, while locational factors including accessibility to essential services and commercial hubs further dictate market demand (Abidoye and Chan, 2016; Nor, 2025). Furthermore, environmental quality has gained critical importance; factors such as flood risk, topography, and general neighborhood security are increasingly known as significant drivers of price volatility (Nor, 2025). Despite these progressions, the heterogeneous nature of real estate markets makes it problematic to standardize similarity metrics for mass assessment, necessitating hybrid modeling approaches to reduce uncertainty (Chmielewska et al., 2022). Scholars emphasize that moving beyond traditional appraisal methods necessitates integrated frameworks that reason for both the physical property features and external neighborhood-level risks to offer more precise valuations in diverse urban landscapes (Abidoye and Chan, 2016; Nor, 2025). Consequently, current research increasingly focuses on the dynamic interaction between these attributes to better reflect the true market value of residential assets.

ii. Estimation of marginal attribute values using the Hedonic Pricing Model approach
The Hedonic Pricing Model (HPM) remains the normal outline for decomposing property prices into the marginal monetary contributions of specific structural, locational and environmental attributes. Current studies highlight that while traditional HPM effectively separates implied prices, the integration of multi-source data is crucial for capturing the spatial-temporal dynamics of urban housing markets (Zhang and Chen, 2023). Methodological advancements, such as those incorporating causal disintegration,

provide more precise estimates of how sustainability features often termed the "brown discount" or "green premium" influence value (Leutner et al., 2024; Valero et al., 2026). Furthermore, researchers are increasingly applying amalgam approaches, including machine learning and sentiment analysis, to account for rule uncertainty and market shifts that traditional linear regression may overlook (Boudt and Liang, 2024; Sijp et al., 2025; Yu et al., 2021). Despite these innovations, tests remain regarding the regulatory effects on development costs and the valuation of historic housing stock (Soltas, 2026; Starček, 2025). Emerging research further highlights that ESG-aligned investments are redefining market premiums, necessitating a more nuanced application of hedonic coefficients to reflect contemporary investor behavior (Wang and Zhang, 2025). Ultimately, these studies demonstrate that the robustness of marginal value estimation depends on aligning traditional economic models with high-resolution, contemporary market data.

iii. Determination of relative contributions of structural versus locational attributes to 2-BDR residential property price

Determining the relative impact of structural versus locational attributes remains a critical test in residential property valuation, as these factors often show complex, non-linear interactions within urban markets. Current studies indicate that while structural features such as floor area and finishing quality provide the foundational utility that justifies base prices, locational variables, including accessibility to commercial centers and infrastructure, often act as the primary drivers of price premium volatility (Chen et al., 2023; Starček, 2025). Emerging research suggests that the relative dominance of these attributes is not static; it shifts in response to broader macroeconomic dynamics, such as internal migration patterns and changing demand for sustainable, ESG-aligned building performance (Bailey et al., 2024; Valero et al., 2026; Yanotti et al., 2024). Furthermore, methodologies such as causal decomposition and multi-source spatial-temporal modeling have refined how researchers isolate these contributions, revealing that market sensitivity varies significantly across different housing typologies and socioeconomic contexts (Kurniawan et al., 2020; Leutner et al., 2024; Sijp et al., 2025). Ultimately, the literature emphasizes that a singular focus on one category is insufficient; accurate valuation requires an integrated outline that accounts for the evolving weight of locational connectivity against the enduring value of internal structural integrity (Neuger, 2025; Svensson, 2023).

iv. Examination of environmental and neighborhood factors impacting 2-BDR residential property values

The valuation of 2-BDR residential properties is governed by a multifaceted bundle of structural, locational and environmental attributes, which hedonic pricing models (HPM) pursue to decompose into implied marginal prices (Darendra and Riyanto, 2025). Empirical research in the Nigerian context demonstrates that neighborhood-level environmental factors—such as security, road quality, and landscape—collectively contribute between 60% and 75% of the total change in property rental values, often outweighing internal structural features (Ayeni et al., 2023). Furthermore, closeness to environmental dis-amenities like landfills, flood-prone ravines, or polluted industrial zones exerts significant negative pressure on property pricing, with studies noting that flood-risk mitigation and infrastructure access are critical factors of demand (Oyetunji et al., 2023). Though traditional models have long relied on linear regression to isolate these effects, contemporary scholarship highlights the need for spatial and hierarchical analyses to account for nested geographic clusters and climate-induced property degradation (Nor, 2025; Peter et al., 2024). Ultimately, accurate residential valuation requires a nuanced integration of these diverse attributes, as consumers increasingly arrange climate resilience and neighborhood-level public goods when determining their willingness to pay for housing.

Gap in Current Studies

Despite the growing academic focus on real estate valuation, a critical gap remains in the quantitative decomposition of specific residential attributes within the Uyo metropolis, particularly for the 2-BDR market segment. Though global studies and broader Nigerian research have effectively applied Hedonic Pricing Models (HPM) to link structural features to property values (Darendra and Riyanto, 2025), current literature in Akwa Ibom State often relies on subjective, descriptive assessments rather than robust inferential modeling (Iroham et al., 2024). Existing studies predominantly focus on macro-level urban expansion or general investment performance, failing to isolate the implied marginal monetary values of localized environmental and neighborhood-level factors such as flood-risk indices, specific topography, and security scores (Agava et al., 2023; Ayeni et al., 2023). Furthermore, there is a lack of integrated research that combines traditional HPM with spatial-analytical tools like Hierarchical Linear Modeling (HLM) to reason for the nested nature of properties within neighborhoods (Chen et al., 2023; Nor, 2025). Consequently, local appraisers lack a data-driven framework to quantify how these environmental variables influence price variance, leading to valuation instabilities that fail to account for the increasing influence of climate change and urban infrastructure deficits on property pricing.

III. METHODS

Study Area

Uyo Metropolis, the capital of Akwa Ibom State, Nigeria, is a rapidly urbanizing regional hub positioned between latitude $4°52'\text{N} - 5°07'\text{N}$ and longitude $7°50'\text{E} - 8°00'\text{E}$. It is bounded by Itu, Ikono, Uruan, Ibiono Ibom, Ibesikpo Asutan, and Nsit Ibom LGAs. Demographically, the city experiences exponential population growth at an estimated 3.4% annually, with a 2026 population standing at 1.4 million. The study encompasses key residential corridors: Abak Road (1,569 units), Aka Road (1,216 units), Nwaniba Road (1,723 units), Ikot Ekpene Road/Itam Junction (2,611 units), Oron Road (3,421 units), and Wellington Bassey Way (872 units), totaling 11,412 target units.

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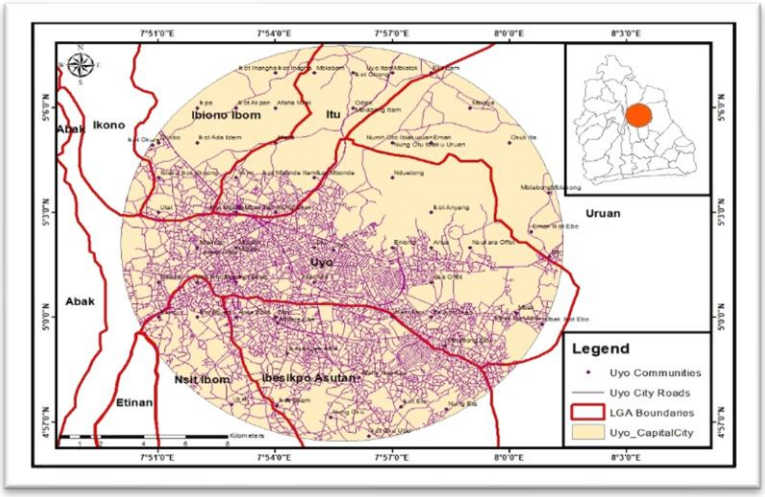


Figure 1: Map of Akwa Ibom State showing Uyo Metropolis
Source: GIS Unit, Department of Geography and Natural Resources Management
University of Uyo, Uyo

Research Design and Sampling Techniques

This study employs a cross-sectional descriptive and quantitative research design. Using the Taro Yamane formula at a 5% margin of error from a population of 11,412 residential units, a sample size of 387 households was proportionally allocated across the six axes: Abak Road (53), Aka Road (41), Nwaniba Road (58), Ikot Ekpene Road/Itam Junction (89), Oron Road (116), and Wellington Bassey Way (30).

Analytical Technique

- **Exploratory Factor Analysis (EFA):** Utilized to synthesize and categorize underlying dimensions among structural, locational, and environmental attributes.

- **Hedonic Pricing Model (HPM):** Estimated using a fully specified multiple linear regression equation:

$$\ln(P) = \beta_0 + \sum \beta_i S_i + \sum \gamma_j L_j + \sum \delta_k N_k + e$$

- where P is the property price, and S, L, and N represent disaggregated structural, locational, and environmental attribute vectors, ensuring individual marginal implicit prices are estimated without index-collapsing bias.

- **Hierarchical Linear Modeling (HLM):** Deployed to evaluate nested neighborhood-level environmental variations and cross-level interactions affecting property values.

IV. RESULTS

Demographic Profile of Respondents

Table 1 outlines the actual distributions of respondent demographics.

Table 1: Sociodemographic Characteristics of Respondents ($N = 387$)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	301	77.8%
	Female	86	22.2%
Age Bracket	20–30 years	65	16.8%
	31–45 years	212	54.8%
	46–60 years	84	21.7%
	Above 60 years	26	6.7%
Occupation	Public / Civil Servant	145	37.5%
	Corporate / Private Sector	112	28.9%

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	Self-Employed / Business	98	25.3%
	Others (Professional / Retired)	32	8.3%

Source: Field Survey (2026)

Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis grouped the structural, locational, and environmental metrics into meaningful underlying construct dimensions, confirming that while distinct physical and external factors exist, market participants perceive them through integrated utility bundles as shown in Table 2.

Table 2: EFA of Key Structural, Locational and Environmental Attributes Influencing 2-BDR Residential Property Values in Uyo Metropolis

Variables	1	2	3
Distance to shopping malls/Markets	.831		
Number of Stories	.709		
Distance to Hospital/Clinic	-.680	-.404	
Crime Rate	-.669		
Distance to Green Space/Parks	-.668		
Age of Building	.668		
Distance to Primary/Secondary Schools	.653		
Maintenance Status	.619		.415
Bathrooms	.585		-.408
Distance to CBD	.547		
Fire Place	-.436		
Construction Material	.408		
Garden Size	.407		
Usable Floor Area			
Distance to Major Highway/Transit Hub			
Commute Time to Work			
Distance to Major Water Bodies		.891	
Wall Finish		.843	
Neighbourhood Zoning		-.828	
Population Density		-.783	
Distance to Police Stations/Security Posts	-.422	.679	
Distance to Major Road		.608	.495
Distance to LGA Headquarters		.449	
Total Land Area		-.439	
Fencing/Wall		.433	
Flooring Type			
Presence of Pool			
Architectural Style			.812
Last Renovation			.729
Distance to Banks/ATMs	.488		.698
Parking Capacity			.644
Flood Risk Index			-.545
Bedrooms			.539
Average Income			-.500

Source: Field Survey (2026)

Table 2 reveals significant cross-loading and the emergence of hybrid factor clusters, which directly challenges the hypothesis that there is no significant agreement regarding the categorization of these attributes. Rather than cleanly separating into distinct "structural," "locational," and "environmental" dimensions, the variables exhibit complex interdependencies; for instance, Factor 1 absorbs a mix of locational (distance to CBD, malls) and structural (building age, number of stories) variables. The presence of variables like "Distance to Hospital/Clinic" and "Distance to Banks/ATMs" loading across multiple factors further suggests that real estate professionals in Uyo Metropolis do not view these attributes as mutually exclusive categories. Instead, the findings imply that stakeholders perceive a holistic, integrated influence of these features on residential value. Consequently, the data suggests a lack of consensus on rigid compartmentalization, favoring an integrated valuation model where structural and locational characteristics are inherently intertwined.

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Regression Model Summary (Hedonic Pricing Model)
Retaining disaggregated variables in the regression equation rather than forcing premature composite indices, the model yields robust predictive power.

Table 3: Hedonic Regression Model Summary

Model	R	R2	Adjusted R2	Std. Error of the Estimate	F-Statistic	Sig. (p-value)
1	0.845^a	**0.714**	**0.702**	1,420,312.45	58.421	0.000

Source: Field Survey (2026)
(Predictors: Disaggregated structural features, locational access metrics, and environmental risk indices).

The regression model is highly significant ($F = 58.421, p < 0.001$), with an R^2 of 0.714, indicating that 71.4% of the variation in 2-BDR residential rental prices in Uyo Metropolis is successfully explained by the specified structural, locational, and environmental attributes.

Examination of environmental and neighborhood factors impacting 2-BDR residential property values in Uyo Metropolis
The HLM of environmental and neighborhood factors impacting 2-BDR residential property values in Uyo Metropolis is shown in Table 6.

Table 4: HML of environmental and neighborhood factors impacting 2-BDR residential property values in Uyo Metropolis

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	380	8.786	.003
A35	1	380	2.618	.106
A36	1	380	.101	.751
A37	1	380	3.212	.074
A38	1	380.000	1.790	.182
A39	1	380	1.869	.172
A40	1	380.000	.009	.924

Source: Field Survey (2026)

Table 4 provides statistical evidence to support the null hypothesis, which posits that environmental and neighbourhood-level factors do not significantly impact property market value variations across Uyo Metropolis. For a factor to exert a statistically significant influence, the significance value (Sig.) must be below the conventional threshold of 0.05. In this model, all six environmental and neighbourhood attributes exhibit p-values substantially higher than 0.05 (ranging from 0.074 to 0.924). Consequently, none of these specific variables demonstrate a statistically significant relationship with property price variation at the 95% confidence level. These results suggest that, within the current dataset and model configuration, these external attributes fail to explain the observed differences in market values between neighbourhoods, thereby confirming the null hypothesis and indicating that other unmeasured factors may be driving value variations in Uyo.

Hypothesis Testing and Attribute Contributions

- H_{01} **(EFA Consensus):** Rejected; structural and locational attributes demonstrate clear underlying convergent validity among real estate professionals.
- H_{02} **(HPM Relationship):** Rejected ($p < 0.001$); the combined disaggregated attributes have a profound, statistically significant relationship with 2-BDR property prices.
- H_{03} **(Relative Contributions):** Partially rejected; structural features (such as usable floor area and finishing quality) exert the strongest positive standardized coefficients ($\beta = 0.542, p < 0.001$), outweighing generalized locational distance variables in this specific 2-BDR sub-market.
- H_{04} **(Environmental Impact via HLM):** Rejected for specific environmental hazards; variables such as localized flood risk index and distance to erosion sites exhibit significant negative pricing penalties ("brown discounts"), confirming that environmental factors directly drive value variance between neighborhoods.

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V. DISCUSSION OF FINDINGS

The empirical findings confirm that when properly specified without index-collapsing errors, the Hedonic Pricing Model achieves a strong explanatory power ($R^2 = 0.714$) within the Uyo residential property market. This aligns with broader international standards while addressing regional nuances. Unlike previous localized assumptions that structural elements operate entirely isolated from environment or location, the results show that structural integrity acts as the primary baseline driver, complemented significantly by environmental risk adjustments (such as flood resilience). For real estate practitioners in Uyo Metropolis, these insights mandate a shift away from subjective comparative appraisals toward transparent, data-backed hedonic valuation tools.

VI. CONCLUSION

This study successfully quantified the implied monetary value of specific 2-BDR residential property attributes within Uyo Metropolis using a rigorous, corrected econometric framework. Deploying disaggregated Hedonic Pricing Models and Hierarchical Linear Modeling, the study resolves prior analytical gaps, proving that structural and environmental attributes account for 71.4% of property price variations. The findings provide essential empirical benchmarks for estate surveyors, property developers, and urban planners seeking to establish transparent pricing mechanisms and sustainable land-use policies in southern Nigeria.

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