MULTIDISCIPLINARY SCIENCE JOURNAL

RESEARCH ARTICLE
Published Online: March 13, 2024
https://doi.org/10.31893/multiscience.2024139

Determining the land valuation model for peri-urban areas in Central Vietnam

Le Huu Ngoc Thanh[a] | **Nguyen Huu Ngu**[a]

[a]Faculty of Land Resources and Agricultural Environment, University of Agriculture and Forestry, Hue University, Thua Thien Hue Province, Vietnam.

Abstract The research objective is to build a land valuation model for peri-urban areas in central Vietnam. This was achieved by conducting 200 surveys that examined other factors that influence land prices using a 5-level Likert scale. Then, the Hedonic regression provide novelty in research model was built using SPSS 26.0 software. The research results have given a land pricing model that explains 72.8% of land price fluctuations. This model identifies the main factor causing these fluctuations. These factors include distance to the main road (30.92%), ability to generate cash flow (23.13%), area of the land (16.14%), feng shui (8.14%), location of the land plot (8.00%), width of road attached to the land plot (7.25%), and education level in the area around the land plot (6.44%). This study will illuminate the suitability of the regression model for land valuation in peri-urban regions of Central Vietnam, providing valuable guidance for policymakers, real estate professionals, researchers and the local residents in this field.

Keywords: Hedonic model, land price, land valuation, peri-urban, Central Vietnam

1. Introduction

Land valuation plays an essential role in the economy as well as the State's management of land (Shatkin, 2016). Land valuation results form the foundation for transactions involving land use rights, thereby contributing to the stabilization of the land market and serving as a basis for compensation when the State reclaims land. They also contribute to enhancing the quality of land, promoting effective land use, and ensuring social justice, particularly in the resolution of land disputes and the Development and implementation of land laws (Thu, 2016). However, according to the 2013 Land Law in Vietnam, land valuation is not yet compelling, as the difference between market land prices and land prices prescribed by the State is enormous (Cuong, 2023). This discrepancy leads to inadequacies in compensation and site clearance as well as in the valuation of mortgaged assets by commercial banks. The exact land price needs to be determined based on the impact of factors, including the inside and outside of the land plot, on the land price (Ngu & Non, 2017).

In conjunction with the five designated land appraisal techniques outlined in Article 5 of Decree 44/2014/ND-CP entitled Regulations on land prices, alternative scientific methodologies exist to facilitate the establishment of land valuations (Government, 2014). In addition, there are many other scientific methods used around the world to construct land price models, such as GIS technology, analytical hierarchy (AHP), fuzzy hierarchy (FAHP), machine learning, and hedonic models (Zabel, 2022). By applying GIS technology, Shan and Nie utilized the geographically weighted regression (GWR) model in the urban area of Wuhan city, China. The results demonstrated that factors such as main streets, subways, and planning control significantly influence residential land prices in Wuhan (Shan & Nie, 2014). In Beijing, China, infrastructure and area are the main factors affecting land prices (Hui, 2010). Studies using expert factor interviewing methods, such as the analytic hierarchy process (AHP), have produced specific results in identifying the factors affecting land prices. Research results in Hanoi, Vietnam, showed that location factors significantly affect land prices (Cuong, 2023). However, research in Baybay city, Philippines, has shown that the limitation of the AHP method is that it lacks objectivity compared to the hedonic regression model method (Bencure et al., 2019). The effectiveness of the Hedonic model in building land valuation models has been confirmed by many studies worldwide (Gilbert & Stanley W, 2013). The model offers several benefits, including its capacity to effectively elucidate the factors causing price fluctuations and its stability irrespective of the size of the database. Conversely, the Hedonic model has five key drawbacks, namely, the challenges regarding the availability of information and knowledge, the verification of measurements, market limitations, multicollinearity, and price fluctuations (Chau & Chin, 2003). In Europe, a study on land prices in Luxembourg has shown the effectiveness of the Hedonic model when making land price forecasts (Glumac et al., 2019). For Asia, research in Bangkok city also showed effectiveness when 64.1% of the factors affecting land prices were found (Malaitham et al., 2020). Moreover, in Vietnam, research using the Hedonic model has focused on urban areas, including land prices in Hanoi city (Cuong, 2023; Phe et al., 2016) and Cua Lo town, Nghe An Province (Ha et al., 2022).

According to Phe, H. H. (2023), location plays a role in valuation, and Ha, P. T. (2022) found that land prices depend on factors such as proximity to business-friendly streets, proximity to the city center, and accessibility to public infrastructure. Thus, the Hedonic model is a tool for supporting the determination of appropriate land prices and contributes to identifying the factors affecting land prices.

The central region of Vietnam has large cities, such as Da Nang, Hue, and Hoi An, which are experiencing high urbanization rates due to newly built projects, such as housing projects, industrial parks, and the expansion of transportation infrastructure in peri-urban areas of cities (Pham et al., 2021). Due to the rapid Development of peri-urban areas, land prices have fluctuated due to many new factors, such as distance to main roads, ability to generate cash flow, transportation systems, the real estate market, and interest rates. Recently, few research projects have focused on constructing land price models for peri-urban areas (Nakamura, 2019). To the best of my knowledge, there have been no related research projects in Central Vietnam. Given the issues mentioned above, developing a land valuation model using the Hedonic regression model in peri-urban areas is crucial. Consequently, the authors selected the peri-urban areas of Hue city, which represent the typical Development of the central region of Vietnam, as their research location. This study was conducted to identify the factors affecting land prices and to develop an optimal land pricing model for peri-urban areas in central Vietnam.

For this paper, Cronbach's alpha and exploratory factor analysis were employed to determine the characteristic elements influencing residential land prices for the Hedonic Model. The specific objectives of this study are (1) to identify the factors affecting land prices, (2) to construct a land price model, and (3) to determine the ranking order of the independent variables.

2. Materials and methods

2.1. Study area

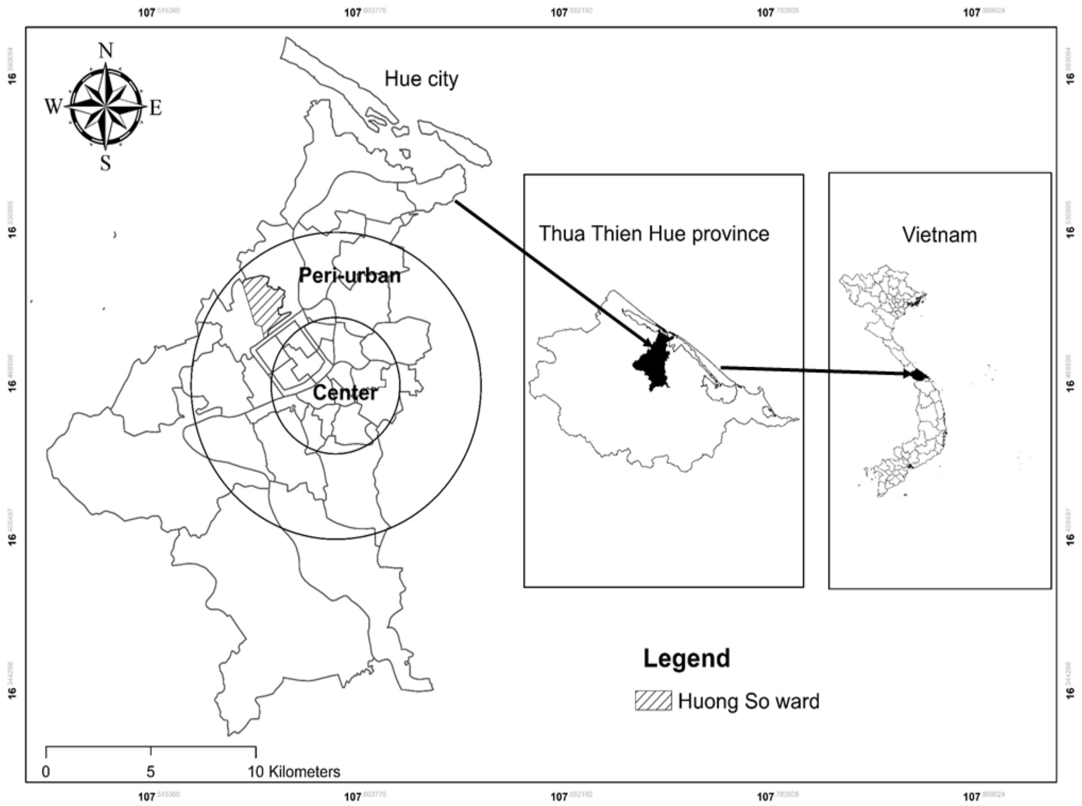

Figure 1 Location map of the study area.

In Vietnam, the central region exhibits a slower growth rate than the northern and southern regions. This area faces numerous challenges due to its expansive and elongated geographical layout coupled with a scarcity of natural resources and minerals. The infrastructure system remains underdeveloped, and the economy relies predominantly on agriculture and tourism. A major drawback is the prevalent weather conditions, characterized by frequent droughts in the dry season and floods and storms in the rainy season. Within the central region, Hue city is a significant city in terms of its economy, social Development, and natural environment. The decision to conduct research in Hue city, which is equipped with a comprehensive land price database system, serves as the foundation for extrapolating research findings to the remaining regions of central Vietnam. The Huong So ward is an administrative district within Hue city, the capital of Thua Thien Hue Province in Central Vietnam. It is situated to the North and is approximately 5 km from the center of Hue city, with a population of more than 20,000 residents (Committee, 2022). There is a typical economic, social and environmental region of the Hue city area in general and the whole central region of Vietnam. The Huong So ward of Hue city is a transitional zone between urban and rural environments. These areas experience rapid urbanization and expansion as cities grow, leading to a mix of urban and rural characteristics. In the context of Hue city, which is a large city in central Vietnam and is known for its historical significance and cultural heritage, Huong So Ward reflects a blend of traditional and modern elements. In addition, the coexistence of traditional rural lifestyles with urban influences may occur. This blend can create a unique cultural atmosphere where traditional practices and customs persist alongside modern trends.

2.2. Materials

The study used the following data, such as cadastral maps from the Information Technology Center and information about transferred land plots, including land prices and other information from the Huong So ward, Hue city, Vietnam, Department of Natural Resources and Environment of Thua Thien Hue Province. The study designed an available questionnaire with 37 factors affecting the price of residential land in the peri-urban region for 22 experts, including scientists, leaders of real estate companies, appraisal companies, and managers in the field of land evaluation in Hue city. All of these experts possess in-depth knowledge and expertise in the field of land prices. Some of them have also served as land price policy makers in Thua Thien Hue Province. After that, the study continued to use 200 questionnaires to interview individuals who participated in residential land use in the Huong So ward using a Likert scale ranging from 1-5 to determine the extent to which factors affect residential land prices. Moreover, information was collected on 200 randomly distributed residential land parcels located on all 12 routes/transaction areas in the suburbs to construct a hedonic valuation model. To ensure the representativeness of the study population for the process of performing Cronbach’s alpha analysis, the EFA exploratory factor analysis for the number of samples was calculated according to the formula (Hair, 2009) $n = 5 * m$ (5*37=185), and a Hedonic regression model was built with the number of pieces to ensure success according to the formula (Green, 1991) $n = 104 + m$ (104+37=141), which, as in n, is the sample size to be selected, as in m, is the number of independent variables. Thus, with 200 interview samples and 200 informational samples of residential land plots, the study met the sample size requirements according to the research methods.

2.3. Methods

2.3.1. Research steps

The study aimed to construct a Hedonic regression model to create a market land price map using Excel 2016 and SPSS 26.0 software to process the data. The test was carried out according to five steps as follows:

Step 1: Interview scientists and managers about the factors affecting residential land prices.

Step 2: Interview land transaction brokers and citizens in the area used a Likert scale ranging from 1-5 (Likert, 1932) to test Cronbach's alpha to remove variables unrelated to the price of residential land.

Step 3: Analyze exploratory factor analysis (EFA) factors to determine the factors affecting the price of residential land.

Step 4: Investigating land parcel information and applying the Hedonic model to build a residential land price regression model.

Step 5: Determine the ranking order of the independent variables affecting residential land prices by the absolute value of the coefficient in the Hedonic model.

2.3.2. Cronbach's Alpha and Exploratory Factor Analysis

Cronbach's alpha evaluates the dependability of an instrument by examining the level of common variance or covariance among the constituent items in relation to the total variance (Collins, 2007). According to Nunnally (1978), a good scale should have a Cronbach's alpha reliability coefficient of 0.7 or higher (Nunnally, 1978). Another important indicator is the corrected item–total correlation. This value represents the correlation between each observed variable and the remaining variables in the scale. If the observed variable exhibits a stronger positive correlation with other variables in the scale, a higher corrected item–total correlation value indicates better performance for that observed variable. According to Cristobal (2007), a reliable scale is characterized by observed variables having a corrected total correlation value of 0.3 or higher (Cristobal et al., 2007).

Exploratory factor analysis (EFA) involves the following steps: checking the appropriateness of the model, extracting factors, rotating factors, and making decisions regarding factor retention and naming. The suitability test for factor analysis is based on specific criteria. The Kaiser–Meiser–Olkin (KMO) criterion serves as an indicator of sample size and correlation between variables. If $0.5 < KMO < 1$ (Kaiser, 1974), factor analysis is deemed appropriate. The Bartlett test is a statistical measure used to test the hypothesis that variables do not correlate in the population. This analysis was only conducted when the hypothesis was rejected ($p < 0.05$) (Hair, 2009), indicating that there was a correlation between variables. Factor extraction is typically based on eigenvalues, and the study retains only those factors with eigenvalues more than 1 (Costello & Osborne, 2005).

2.3.3. Hedonic price model

A Hedonic Study makes some efforts to understand what characteristics contribute to the value of some goods. Most goods have a variety of factors that contribute to or detract from their value (Gilbert & Stanley W, 2013). This study uses the Hedonic model derived from Lancaster's (1966) consumer theory and Rosen's (1974) model, which has been used extensively in the scientific investigation of various aspects of housing markets. The Hedonic pricing model is used to model the relationship between one (or more) dependent or response variable and an independent predictor variable. The equation of the Hedonic pricing model can be written based on the classical linear regression specification as follows (Rosen, 1974):

$$Y = \beta0 + \beta1Xi1 + \beta2Xi2 + \beta3Xi3 + \ldots + \beta kXik + \varepsilon \quad (1)$$

where Y is the dependent variable; Xi1, Xi2, Xi3…Xik are the independent variables that affect land prices; β0 is the intercept; β1, β2,…βk are the coefficients of the variables showing the impacts of the factors affecting land prices; and ε is the residual error.

In this study, the dependent variable is the land price traded. The data include 200 residential land plots to be traded in 2022. The independent variables are specifically mentioned according to the data in Table 5.

3. Results

3.1. Determining the factors affecting the price of residential land

Through extensive research and surveys conducted on residential land prices within the peri-urban market, the findings indicate that numerous factors have a significant impact on transaction prices within this area, causing them to constantly fluctuate in comparison to the prices set by the State. These factors, although they vary in magnitude and scope, each have a distinct influence on different aspects of the market price of residential land. While the majority of these factors affect the level of residential land prices within the ward to varying degrees, they collectively contribute to the overall volatility of land prices. Drawing upon the factors that affect land prices within the ward and the outcomes of in-depth interviews conducted with 22 experts specializing in the field of land prices, a comprehensive study developed a model consisting of 35 observed variables, as illustrated in Table 1. Following the removal of 2 variables with a consent rate of less than 50%, it is worth noting that other studies may adopt a different agreement rate, as per the research findings of the author group led by Tran Trong Phuong. Consequently, variables with an agreement rate of less than 80% were deemed unsuitable and excluded from the study (Phuong et al., 2022).

3.1.1. Cronbach's alpha coefficient

The reliability of the scale was assessed through the Cronbach's alpha coefficient. The authors used the Cronbach's alpha reliability coefficient method before analyzing the exploratory factor (EFA) to eliminate unsuitable variables because these observed variables (garbage variables) can create pseudoelements. According to Hoang Trong, 2008, "Cronbach's alpha coefficient from 0.8 to nearly one is a good measurement scale; 0.7 to 0.8 is usable; 0.6 or more can also be used if the measurement concept is new or new to the respondents in the latest research context" (Trong & Ngoc, 2008)**.** In addition, when evaluating scales, the correlation coefficient (corrected item-total correlation) must equal 0.3 or greater to satisfy the requirement (Hair & Black, 2010).

The data in Tables 1 and 2 show that, after removing nine variables that did not meet the criteria (total correlation coefficient < 0.3), 26 factors that met the requirements remained. After removal, all groups of elements had Cronbach's alpha coefficient > 0.6, with the lowest being 0.742 for the Infrastructure group. This shows that the groups of elements ensure reliability, and most of the factors are correlated with each other and play a significant role in affecting land prices. Therefore, the results of the remaining factors are used after analyzing Cronbach's alpha coefficient to conduct exploratory factor analysis (EFA).

3.1.2. Exploratory Factor Analysis (EFA)

The Principal Component Analyzer method was used to conduct the EFA exploratory factor analysis with varimax rotation, and the results are shown in Tables 3 and 4.

The data from Table 3 show that all the factors that need to be evaluated for the independent variable have the following values. A KMO = 0.708 satisfies the 0.5 ≤ KMO ≤1 condition (Kaiser, 1974); thus, EFA exploratory factor analysis is suitable for accurate data. Bartlett's correlation test has a statistically significant significance (sig. = 0.000 < 0.05), which means that each factor group's observed variables are linearly correlated (Hair, 2009). The above results have 6 factors with eigenvalues >1; the minimum is 1.538 > 1 (Hair, 2009). These factors will remain in the model. Furthermore, the extracted variance (cumulative %) is 66.108% > 50% (Merenda, 1997), which means that the observed variables explain 66.108% of the change in factors, and the EFA model is adequate. Using a survey size of 200 samples, the factor loading coefficient needs to be > 0.5 (sample size from 100 to 350). The observed variables with sufficient reliability of the 6 independent variables were used to perform factor analysis (Hair, 2009). The above factors are all suitable and continue to be included in the rotated component matrix.

Table 1. Cronbach's alpha coefficient.

No.	Factor group	Symbol	Factor	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1		CB1	Area of the land	0.590	0.624
2		CB2	Width of the land	0.480	0.651
3		CB3	Depth of the land	0.631	0.612
4	Particular	CB4	Shape of the land	0.259	0.711
5	(CB)	CB5	Direction of the land	0.205	0.719
6		CB6	Type of road adjacent to the land plot	0.236	0.715
7		CB7	Width of road attached to the land plot	0.566	0.628
8		VT1	Location of the land plot	0.598	0.595
9		VT2	Distance the main road	0.630	0.577
10	Location (VT)	VT3	Distance to ward People's Committee	0.209	0.707
11		VT4	Distance to market	0.645	0.580
12		VT5	Distance to school	0.373	0.664
13		VT6	Distance to hospital	0.220	0.749
14		KT1	Demand for land in the market	0.231	0.893
15		KT2	Supply of land in the market	0.830	0.768
16		KT3	The average income of people	0.666	0.793
17	Economy (KT)	KT4	Profitability of the land plot	0.756	0.778
18		KT5	Ability to generate cash flow	0.656	0.792
19		KT6	Bank interest rates	0.597	0.800
20		KT7	Real estate market situation	0.601	0.800
21		XH1	Population density around the land plot	0.637	0.780
22		XH2	Education level in the area around the land plot	0.421	0.815
23	Society (XH)	XH3	Security of the area around the land plot	0.704	0.769
24		XH4	The environment around the land plot	0.280	0.850
25		XH5	Urbanization rate	0.660	0.776
26		XH6	Real estate speculation	0.641	0.780
27		XH7	The problem of feng shui	0.663	0.776
28		HT1	Electricity, water systems	0.154	0.742
29		HT2	Transportation system	0.631	0.396
30	Infrastructure	HT3	Education and health system	0.618	0.410
31	(HT)	HT4	Flood situation	0.348	0.622
32		PL1	Purpose of land use	0.221	0.787
33	Legal policy	PL2	Policy on taxes, fees	0.612	0.527
34	(PL)	PL3	Construction planning	0.554	0.549
35		PL4	Planning information	0.541	0.564

Table 2 Model adjusted by Cronbach's alpha.

No.	Element group name	Number of variables remaining	The number of variables eliminated	Cronbach's Alpha coefficient after correction
1	Particular (CB)	4	3	0.817
2	Location (VT)	4	2	0.814
3	Economy (KT)	6	1	0.893
4	Society (XH)	6	1	0.850
5	Infrastructure (HT)	3	1	0.742
6	Legal policy (PL)	3	1	0.787
	Total	26	9	

The data from Table 3 show that all the factors that need to be evaluated for the independent variable have the following values. A KMO = 0.708 satisfies the 0.5 ≤ KMO ≤1 condition (Kaiser, 1974); thus, EFA exploratory factor analysis is suitable for accurate data. Bartlett's correlation test has a statistically significant significance (sig. = 0.000 < 0.05), which means that each factor group's observed variables are linearly correlated (Hair, 2009). The above results have 6 factors with eigenvalues >1; the minimum is 1.538 > 1 (Hair, 2009). These factors will remain in the model. Furthermore, the extracted variance (cumulative %) is 66.108% > 50% (Merenda, 1997), which means that the observed variables explain 66.108% of the change in factors, and the EFA model is adequate. Using a survey size of 200 samples, the factor loading coefficient needs to be > 0.5 (sample size from 100 to 350). The observed variables with sufficient reliability of the 6 independent variables were used to perform factor analysis (Hair, 2009). The above factors are all suitable and continue to be included in the rotated component matrix.

Table 3 Results of the KMO test, Bartlett's test, eigenvalues and cumulative values.

Factors to evaluate	Value	Condition	Conclude
KMO	0.708	0.5< KMO <1	qualified
Sig. Bartlett's	0.000	< 0.05	qualified
Eigenvalues	1.538	> 1	qualified
Cumulative (%)	66.108%	> 50%	qualified

Table 4 Rotated component matrix.

Observed variables	Component 1	2	3	4	5	6
KT2	0.885					
KT4	0.864					
KT3	0.799					
KT7	0.768					
KT6	0.768					
KT5	0.758					
XH3		0.840				
XH7		0.799				
XH5		0.798				
XH6		0.781				
XH1		0.713				
XH2		0.563				
VT4			0.869			
VT1			0.832			
VT2			0.790			
VT5			0.666			
CB3				0.836		
CB7				0.799		
CB2				0.795		
CB1				0.768		
PL2					0.869	
PL3					0.813	
PL4					0.807	
HT2						0.791
HT3						0.775
HT4						0.769

The results from the rotation matrix determine that the load weights are divided into six groups of factors, with 26 factors with load factors > 0.5 (Hair & Black, 2010), which shows that each factor reaches high significance. Practices and factors are classified into the appropriate groups. The same parameters were maintained. All these factors are identified as factors affecting land price to determine value, including the Hedonic regression model.

3.2. Hedonic price model

The linear hedonic model was selected to determine the degree of influence of factors on the price of residential land in the peri-urban area through surveying the current situation and the above research analysis steps. They assessed groups of factors that affect land prices in urban areas of the suburbs. The authors divided the variables into 26 independent factors, including qualitative, quantitative and dummy variables. The study evaluated the influence of significant factors on the price of residential land and excluded nonsignificant variables. The study reformatted the variables shown in Table 5.

After removing and running the model many times, the variables that were not statistically significant were removed. The variables that appeared multicollinear in the model results are shown in Tables 6 and 7.

The results in Table 6 show that the adjusted coefficient of determination $\bar{R}^2$ is 0.728, which means that the independent variables explain 72.8% of the variation in the dependent variable LAND PRICE. The result Sig. (F) = 0.000 < 0.05 proves that the regression model is suitable with a statistical significance level of 5%. According to the results in Table

7, the variance inflation factor (VIF) is less than 2; hence, the above model does not exhibit multicollinearity. The Durbin–Watson coefficient d = 1.742 ranges from 1 to 3 (Savin & White, 1977), so the model also does not exhibit autocorrelation.

Table 5 Variable format for the land price regression model.

No.	Variable symbol	Description	Unit	Type
1	LAND PRICE	Land price (Dependent variable)	million vnd/m^2	Quantitative
2	CB1	Area of the land	m^2	Quantitative
3	CB2	Width of the land	m	Quantitative
4	CB3	Depth of the land	m	Quantitative
5	CB7	Width of road attached to the land plot	m	Quantitative
6	VT1	Location of the land plot	1= 2 fronts; 2=VT1; 3=VT2; 4: =VT3; 5=VT4	Qualitative
7	VT2	Distance to the main road	m	Quantitative
8	VT4	Distance to market	m	Quantitative
9	VT5	Distance to school	m	Quantitative
10	KT2	Supply of land in the market	1 = high; 0 = normal	Dummy variable
11	KT3	The average income of people	1 = high; 0 = normal	Dummy variable
12	KT4	Profitability of the land plot	1 = high; 0 = normal	Dummy variable
13	KT5	Ability to generate cash flow	1= yes; 0 = no	Dummy variable
14	KT6	Bank interest rates	1 = high; 0= normal	Dummy variable
15	KT7	Real estate market situation	2 = Exciting; 1 Normal; 0 = Quiet	Dummy variable
16	XH1	Population density around the land plot	2 = Populous; 1 Normal; 0 = Dear people	Dummy variable
17	XH2	Education level in the area around the land plot	2 = High; 1 = Normal; 0 = Low	Dummy variable
18	XH4	Security and order in the area around the plot of land	2= good; 1 = normal; 0 = not good	Dummy variable
19	XH5	Urbanization rate	1 = high 0= normal	Dummy variable
20	XH6	Real estate speculation	1= yes 0 = no	Dummy variable
21	XH7	Feng Shui	1 = yes 0 = no	Dummy variable
22	HT2	Transportation system	1 = good 0 = other	Dummy variable
23	HT3	Education and health system	1 = good 0 = other	Dummy variable
24	HT4	Flood situation	1= yes 0 = no	Dummy variable
25	PL2	Policy on taxes fees	1 = high 0= normal	Dummy variable
26	PL3	Construction planning	1= yes 0 = no	Dummy variable
27	PL4	Planning information	1= yes 0 = no	Dummy variable

Table 6 Results of the last Hedonic model.

Dependent variable	LAND PRICE
R^2	0.737
$\bar{R}^2$	0.728
F	76.903
Sig.	0.000
Durbin Watson	1.742

Table 7 Results of the Hedonic Model.

No.	Variable	Symbol	Coefficient	t- Statistic	Sig.	VIF
	Intercept		23.116	40.318	0.000	
1	Area of the land	CB1	-0.011	-5.548	0.000	1.348
2	Width of road attached to the land plot	CB7	0.085	2.656	0.008	1.182
3	Location of the land plot	VT1	-0.590	-2.962	0.004	1.165
4	Distance to the main road	VT2	-1.803	-8.858	0.000	1.935
5	Ability to generate cash flow	KT5	2.433	8.730	0.000	1.114
6	Education level in the area around the land plot	XH2	0.368	2.533	0.012	1.019
7	Feng shui	XH7	-1.090	-2.729	0.007	1.417

From Table 7, we built a regression equation that included variables affecting residential land prices in the Huong So ward; this equation was used to determine residential land prices as follows:

$$LAND\ PRICE_i = 23.116 - 0.011CB_{1i} + 0.085CB_{7i} - 0.590VT_{1i} - 1.803VT_{2i} + 2.433KT_{5i} + 0.368XH_2 - 1.090XH_7 + e$$

The results in Table 8 and the model above showed that the importance level of variables significantly affects land prices in the study area. The highest is the distance to the main road, at 30.92%. The reason is that most of the land in the area is situated within the planning zone, causing all land plots to be designated as position 1. Consequently, the disparity in the potential of land plots near main roads is substantial. In particular, land plots with a distance to main roads equal to 0, located on main roads such as Nguyen Van Linh and Tan Da Road, command significantly higher prices than those situated farther from these roads. This outcome underscores the preference for land plots that generate cash flow in land transactions within peri-urban areas. The ability to generate cash flow, constituting 23.12% of the influencing factors, is the next aspect affecting land prices. Land plots along main roads suitable for businesses and leases garner considerable interest from buyers willing to pay premium prices. The area factor accounts for 16.14% of the variance. The majority of the land plots fall within sizes of 60 m^2, 81 m^2, 100 m^2, 140 m^2 and 210 m^2. More significant land plots command lower selling prices per square meter due to their higher total value, creating incentives to attract buyers. Feng shui factors, comprising 8.14% of the influence rate, involve considerations such as the presence of graves on the land plot, proximity to intersections, and attachment to electric poles, maintenance holes, and electrical cabinets. These scientifically founded factors impact beliefs and convenience in daily life, leading land plots with Feng shui elements to have lower selling prices. The fifth most common factor was the land plot location factor, with planned areas having less impact on land prices in peri-urban regions, as most location 1 plots were within planning zones. The primary influence stems from land plots in existing residential areas, where higher prices correlate with higher prices due to enhanced convenience in travel and daily life. The sixth in the hierarchy is the road width associated with the land plot factor, which constitutes 7.25% of the influence. Wider roads, ranging from 3 m to 36 m, result in higher land prices due to increased travel demand, with narrower plots (<5 m) often commanding lower prices.

Table 8 Ranking of the factors affecting the land price according to the Hedonic model.

No.	Variable symbol	Description	The absolute value of the coefficient	Percentage(%)	Rank
1	CB1	Area of the land	0.238	16.14	3
2	CB7	Width of road attached to the land plot	0.107	7.25	6
3	VT1	Location of the land plot	0.118	8.00	5
4	VT2	Distance to the main road	0.456	30.92	1
5	KT5	Ability to generate cash flow	0.341	23.12	2
6	XH2	Education level in the area around the land plot	0.095	6.44	7
7	XH7	Feng shui	0.120	8.14	4
		Total	1.475	100	

Finally, the educational level of the surrounding area accounts for 6.44% of the influence. In peri-urban areas where households resettle from city centers, lower education levels negatively impact land prices, as residents fear the potential influence of the negative culture of less educated households on their children. The land price determination model comprises seven influencing factors specific to suburban areas, explaining 72.80% of the change in residential land prices. This model significantly contributes to a more efficient, transparent, and rapid land valuation process in peri-urban lands than traditional methods.

4. Discussion

Previous studies on building models to determine land prices worldwide and in Vietnam have primarily concentrated on central urban areas. However, the outcomes of these studies have only extended to the analysis of groups of factors influencing land prices. Research on the factors affecting land prices in Thai Nguyen city has shown that location factors account for 34.17% of the total land prices (Anh et al., 2016), and the percentage of infrastructure factor groups is 24.11% in Chi Linh city, Hai Duong Province (Tra et al., 2020). Compared to previous studies, this research has gone deeper into analyzing each factor in the group of factors to assess in detail the factors affecting residential land prices. The results indicate that land prices in the peri-urban area are influenced by 7 factors arranged in descending order of influence as follows: distance to the main road, ability to generate cash flow, area of the land, Feng shui, location of the land plot, width of road attached to the land plot and education level in the area around the land plot. This study provides new insight into the relationships between land prices and 7 factors. First, the role of distance to the main road is vital in determining land prices. This finding is similar to the findings of Sathita Malaitham's group in the Bangkok metropolitan area of Thailand (Malaitham et al., 2020) and of Abdulla in Sulaymaniyah city, Irag (Abdulla et al., 2023). Second, the influence of Feng Shui on the value of land is observed in both Eastern and Western cultures. Tam's study conducted in Tai Po New Town, Hong Kong, which represents Eastern cultures, demonstrated a significant relationship between Feng Shui and property prices, as indicated by a regression coefficient of 0.95 (Tam et al., 1999). Similarly, Bond's research in Florida, which represents Western cultures, focuses on the impact of Feng Shui on residential property prices. The findings of this study, which employ multiple regression analyses within a hedonic pricing framework, support the notion that Feng Shui indeed affects property prices in the West (Bond, 2008). This finding is entirely consistent with the results of previous studies in which Feng shui, which has spiritual and scientific elements, was found to have an impact on land prices. The third discovery of the authors is the education level in the area around the land plot, which is one of the most critical factors that affects the residential land price. Ingram & Kenyon noted that the relationship between residential location and education was influential in a 2014 US study (Ingram & Kenyon, 2014). Currently, amid socioeconomic Development, education has become a paramount consideration for individuals when deciding on a place to reside. Residents often opt for locales where the majority are government officials, fostering cultural tranquility for their children's future. Through the effectiveness and ease of implementation of the Hedonic model, future studies should consider building a land valuation model for rural areas in cities in the central region of Vietnam. Although specific results have been achieved, due to limitations in time and human resources, research on building a new land valuation model has used only the Hedonic model method. Future studies need to consider follow-up studies with other methods, such as the analytic hierarchy process (AHP) method (Chandio et al., 2011), (Binh & Cuong, 2020) and the fuzzy analytic hierarchy process (FAHP) method (Bencure et al., 2022), using GIS technology such as geographically weighted regression (GWR) (Hui, 2010) (Munshi, 2020) and multiscale geographically weighted regression (MGWR) (Dell'Anna et al., 2021), to find a suitable land valuation model for the peri-urban areas of central Vietnam.

5. Conclusions

In this paper, data on assessed prices and offering prices for sale in peri-urban areas of Hue city, Vietnam, are analyzed using a regression framework based on the Hedonic pricing model. Research results show that residential land prices are influenced by 7 main factors, including (i) distance to main road (30.92%), (ii) ability to generate cash flow (23.12%), (iii) area of the land (16.14%), (iv) Feng Shui (8.14%), (v) location of land plot (8.00%), (vi) width associated with the land plot (7.25%) and (vii) education level in the area surrounding the land plot (6.44%). In particular, the factor of distance to the main road has the most influence on the change in residential land prices according to the market. This research result has significant implications for both theoretical and practical applications. Theoretically, this approach can offer valuable insights into regression models and factors influencing residential land prices. On a practical level, this approach can help local governments develop more accurate land price lists and assist investors and individuals in the real estate industry in determining residential land value and pricing more precisely. Furthermore, these findings can be applied in research on residential land valuation and developing land price tables and contributing to the development of land price management policies in central, peri-urban and rural areas in central Vietnam in the future.

Acknowledgments

The authors would like to express their sincere appreciation to the People's Committee of Hue City and the various functional departments in Thua Thien Hue Province for their invaluable support in acquiring the study's data, which has been crucial. The authors also extend special thanks to the respondents who generously provided their survey responses; their contributions are deeply valued. We would also like to thank the outstanding research team led by Associate Professor Nguyen Huu Ngu, University of Agriculture and Forestry, Hue University, Vietnam for supporting this research (Code: NCTB.DHH.2024.05).

Ethical considerations

The study correctly followed the ethical policies for a study that included human subjects, in addition to confirming the consent of all the interviewers involved.

Conflict of interest

The authors declare no conflicts of interest.

Funding

This research received funds from the outstanding research team led by Associate Professor Nguyen Huu Ngu, University of Agriculture and Forestry, Hue University, Vietnam (Code: NCTB.DHH.2024.05).

References

Abdulla, H. M., Ibrahim, M. A., & Al-Hinkawi, W. S. (2023). The Impact of Urban Street Network on Land Value: Correlate Syntactical Premises to the Land Price. *Buildings, 13*(7), 1610. https://www.mdpi.com/2075-5309/13/7/1610

Anh, T. T., Hung, H., Van, Thi , N. Q., & Anh, N. N. (2016). Researching the major factors that effect to land price at Hoang Van Thu street, Thai Nguyen city, Thai nguyen province. *Journal of Science and Technology*, *17*(193), 111-117.

Bencure, J. C., Tripathi, N. K., Miyazaki, H., Ninsawat, S., & Kim, S. M. (2019). Development of an Innovative Land Valuation Model (iLVM) for Mass Appraisal Application in Sub-Urban Areas Using AHP: An Integration of Theoretical and Practical Approaches. *Sustainability*, *11*(13), 3731. https://www.mdpi.com/2071-1050/11/13/3731

Bencure, J. C., Tripathi, N. K., Miyazaki, H., Ninsawat, S., & Kim, S. M. (2022). Factors affecting decision-making in land valuation process using AHP: a case in the Philippines. *International Journal of Housing Markets and Analysis*, *15*(1), 188-202. https://doi.org/10.1108/IJHMA-11-2020-0136

Binh, T. Q., & Cuong, D. Q. (2020). Application of Exploratory Factor Analysis (EFA) and Analytic Hierarchy Process (AHP) in Valuation of Urban Residential Land in Quoc Oai Town, Quoc Oai District, Hanoi City. *VNU Journal of Science: Earth and Environmental Sciences*, *36*(2). https://doi.org/10.25073/2588-1094/vnuees.4521

Bond, S. (2008). The impact of Feng Shui on residential property prices in Western cultures. *International Journal of Housing Markets and Analysis*, *1*(1), 81-101. https://doi.org/10.1108/17538270810861175

Chandio, I. A., Matori, A.-N., Lawal, D. U., & Sabri, S. (2011). GIS-based land suitability analysis using AHP for public parks planning in Larkana City. *Modern applied science*, *5*(4), 177.

Chau, K. W., & Chin, T. L. (2003). A critical review of literature on the hedonic price model. *International Journal for Housing Science and its applications*, *27*(2), 145-165.

Collins, L. M. (2007). Research Design and Methods. In J. E. Birren (Ed.), *Encyclopedia of Gerontology (Second Edition)*. 433-442. Elsevier. https://doi.org/https://doi.org/10.1016/B0-12-370870-2/00162-1

Committee, H. C. P. s. (2022). *Hue city socio-economic report in 2022*.

Costello, A. B., & Osborne, J. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical assessment, research, and evaluation*, *10*(1), 7.

Cristobal, E., Flavian, C., & Guinaliu, M. (2007). Perceived e-service quality (PeSQ) measurement validation and effects on consumer satisfaction and web site loyalty. *Managing service quality: An international journal*, *17*(3), 317-340.

Cuong, D. Q. (2023). Determining the optimal land valuation model: A case study of Hanoi, Vietnam. *Land Use Policy*, *127*, 106578. https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106578

Dell'Anna, F., Bottero, M., & Bravi, M. (2021). Geographically Weighted Regression Models to Investigate Urban Infrastructures Impacts. 599-613. https://doi.org/10.1007/978-3-030-87007-2_43

Gilbert, & Stanley W. (2013). *Applying the Hedonic Method*. US Department of Commerce, National Institute of Standards and Technology.

Glumac, B., Herrera-Gomez, M., & Licheron, J. (2019). A hedonic urban land price index. *Land Use Policy*, *81*, 802-812. https://doi.org/https://doi.org/10.1016/j.landusepol.2018.11.032

Government. (2014). Regulations on land prices.

Green, S. B. (1991). How Many Subjects Does It Take To Do A Regression Analysis. *Multivariate Behavioral Research*, *26*(3), 499-510. https://doi.org/10.1207/s15327906mbr2603_7

Ha, P. T., Tuan, N. T., Van Quan, N., & Van Trung, N. (2022). Land Price Regression Model and Land Value Region Map to Support Residential Land Price Management: A Study in Nghe an Province, Vietnam. *Real Estate Management and Valuation*, *30*(1), 71-83. https://doi.org/doi:10.2478/remav-2022-0007

Hair, J. F. (2009). Multivariate data analysis.

Hair, J. F., & Black, W. (2010). B, J. Babin, and RE Anderson, Multivariate Data Analysis. In: Prentice Hall: New Jersey.

Hui, Z. (2010). Affecting factors research of Beijing residential land price based on GWR model. *Economic Geography*.

Ingram, G. K., & Kenyon, D. A. (2014). *Education, land, and location*. Lincoln Institute of Land Policy Cambridge, MA.

Kaiser, H. F. (1974). An index of factorial simplicity. *psychometrika*, *39*(1), 31-36.

Likert. (1932). A technique for the measurement of attitudes.

Malaitham, S., Fukuda, A., Vichiensan, V., & Wasuntarasook, V. (2020). Hedonic pricing model of assessed and market land values: A case study in Bangkok metropolitan area, Thailand. *Case Studies on Transport Policy*, *8*(1), 153-162. https://doi.org/https://doi.org/10.1016/j.cstp.2018.09.008

Merenda, P. F. (1997). Methods, plainly speaking: A guide to the proper use of factor analysis in the conduct and reporting of research: Pitfalls to avoid. *Measurement and Evaluation in counseling and Development*, *30*(3), 156.

Munshi, T. (2020). Accessibility, Infrastructure Provision and Residential Land Value: Modelling the Relation Using Geographic Weighted Regression in the City of Rajkot, *India, 12*(20), 8615. https://www.mdpi.com/2071-1050/12/20/8615

Nakamura, H. (2019). Relationship among land price, entrepreneurship, the environment, economics, and social factors in the value assessment of Japanese cities. *Journal of Cleaner Production*, *217*, 144-152. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.01.201

Ngu, N. H., & Non, D. Q. (2017). Land Valuation *Hue University Publishing House*.

Nunnally, J. C. (1978). An overview of psychological measurement. *Clinical diagnosis of mental disorders: A handbook*, 97-146.

Pham, V.-M., Van Nghiem, S., Van Pham, C., Luu, M. P. T., & Bui, Q.-T. (2021). Urbanization impact on landscape patterns in cultural heritage preservation sites: a case study of the complex of Huế Monuments, Vietnam. *Landscape Ecology*, *36*, 1235-1260.

Phe, H. H., Comber, A., Harris, P., Nguyen, Q., Chi, K., & Tran, H. (2016). Local variation in hedonic house pricing in Hanoi, Vietnam: a spatial analysis of status quality. Issue: International Conference on GIScience Short Paper Proceedings, 1 (1),

Phuong, T. T., Hien, N. T. T., Khue, P. V., Loc, N. D., Trung, N. D., & Son, N. A. (2022). Studying factors affecting land prices in Tu Son city, Bac Ninh province. *VNU Journal of Science: Earth and Environmental Sciences*, *06(139)*.

Rosen, S. (1974). Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of political economy*, *82*(1), 34-55.

Savin, N. E., & White, K. (1977). The Durbin-Watson test for serial correlation with extreme sample sizes or many regressors. *Journal of the Econometric Society*, 1989-1996.

Shan, Y., & Nie. (2014). Influencing factors of residential land price in wuhan based on gwr model. *Journal of Huazhong Agricultural University*, *113*(5), 111-118.

Shatkin, G. (2016). The real estate turn in policy and planning: Land monetization and the political economy of peri-urbanization in Asia. *Cities*, *53*, 141-149.

Tam, C. M., Tso Tony, Y. N., & Lam, K. C. (1999). Feng Shui and Its Impacts on Land and Property Developments. *Journal of Urban Planning and Development*, *125*(4), 152-163. https://doi.org/10.1061/(ASCE)0733-9488(1999)125:4(152)

Thu, N. T. M. (2016). Law on land valuation in Vietnam. *Ha Noi national university*.

Tra, H. T. L., Quan, N. V., Tuan, P. A., & Mai, T. T. (2020). Research on residential land prices and factors affecting residential land prices in Chi Linh city, Hai Duong province. *Vietnam Journal of Agricultural Sciences*, *18*(1), 40-51.

Trong, H., & Ngoc, C. N. M. (2008). Analyze research data with SPSS-volume 1. In: Hong Duc Publishing House.

Zabel, J. (2022). A matching method for land valuation. *Journal of Housing Economics*, *58*, 101878. https://doi.org/https://doi.org/10.1016/j.jhe.2022.101878