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An Economic Valuation of Urban Green Spaces in Kuala Lumpur City

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ABSTRACT

An economic value of urban green space (UGS) in Kuala Lumpur (KL) city is estimated in this study. A global model and a local model are formulated based on hedonic price method. The global and local models were analysed with an Ordinary Least Squares (OLS) regression and a Geographically Weighted Regression (GWR) respectively. Both the models were compares to see which model offered a better result. The results of OLS regression illustrated that Titiwangsa and Forest Research Institute Malaysia (FRIM) offer the highest economic value for model 2 and 3 respectively. The results of GWR determined that the economic value of an UGS can be analysed by the region. The GWR result revealed that FRIM provides high economic value to all the residential areas in KL city. However, the economic value of Titiwangsa is not valuable for the residential areas in KL city including Mont Kiara Pines, Jinjang Selatan, Segambut Garden, Bandar Menjalara and Taman Bukit Maluri. As a conclusion, even though Titiwangsa generates the highest economic value, it is only significant at certain residential areas as proved by the local model. In terms of model application, the local model performed better than the global model.

Keywords: Economic valuation, geographically weighted regression model, hedonic pricing model, urban green space

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INTRODUCTION

The urban green space (UGS) can be defined as the range of urban vegetation, including open spaces, parks, residential gardens, street trees and any other vegetation located around the urban environment (Pietsch, 2012). According to Saphores and Li (2012), the position of the UGS in cities is increasing worldwide as a result of the expansion of urban land fueled by urbanisation. City areas with a lot of greenery are aesthetically pleasing and attractive to residents and investors.

Based on the Kuala Lumpur (KL) City Plan 2020 in The Star Online (2008), the city expressed a vision of a network of high quality, accessible parks and economic generation to assist KL in becoming a more attractive city to live in and work at. The implementation of the greening city may create a more comfortable living environment and provide space for healthy recreational activities. Moreover, the beautification of KL has been one of the factors that attracted significant foreign investments to Malaysia and boosted the country's rapid economic growth. Overall, urban green spaces have provided indispensable elements of aesthetic, ecological, recreational and economic values. The economic values include property prices (Sadeghian & Vardanyan, 2013). Due to the demand and benefits of UGS, the UGS in KL should be preserved.

In Malaysia, Yusof (2012) stated that the urban area of KL has almost tripled in area since the 1950s; it is currently 243 km^2. Unfortunately, Yaakup (2005) predicted that KL has lost nearly 50% of its green spaces, mainly to residential development to cater for the population increase and some industrial development. Tyrvainen (2001) also beleived that industrial development activities could diminish the values of UGS.

As reported in KL Structure Plan 2020, currently, the total areas of UGS in KL city only represents 6.5% of total land use and the amount that is available as public UGS is even less when private green spaces such as field golf are excluded. This issue has caused general concern among local authorities. Various efforts have been taken by them to protect and maintain the existence of UGS. However, it is noticed that existing statutes and policies over a recent decade were not sufficiently strong with regard to the protection they afforded to green spaces in KL. Luttik (2000), and Zhuo and Parves Rana (2012) claimed that it is not easy to come to a clear conclusion about the effectiveness of existing arrangement for protecting UGS without much more information, especially in terms of monetary value.

In the case of Malaysia, Mohd Noor, Asmawi and Abdullah (2015) is one of the earliest ones that have a concern about this issue. They conducted a study about the economic valuation of UGS in Subang Jaya, Selangor. However, KL city which is the highest percentage of diminished green area was not included in their study. It would be much useful if an analysis of economic valuation of UGS is conducted in KL city. At least it will offer valuable information especially in terms of monetary value of urban green space to the real estate developers. Other than that, it will help the government authorities to improve their future policy specifically about land use and development part by developing a comprehensive improvement of monitoring the provision, extent, and condition of green space more thoroughly based on the monetary information.

Therefore, the economic value of the UGS, specifically in KL city, will be estimated in this study. By using the hedonic pricing method (HPM), the economic value obtained in this study will prove the value of UGS in monetary value. The HPM based on the ordinary least square (OLS) regression and geographically weighted regression (GWR), together with geographic information systems (GIS) are employed. This study reveals the specific residential areas in KL city which are able to generate economic value of UGSs. At the same time, this study also helps the local authorities to develop a comprehensive improvement of monitoring the provision, extent, and condition of green space more thoroughly based on monetary information. Lastly, this study will contribute to the literature since there are limited studies conducted in Malaysia regarding the economic valuation of UGSs using GWR.

LITERATURE REVIEW

HPM is widely used to measure the economic value of UGS (Zhuo & Parves Rana, 2012). Its value can be predicted from the prices of related actual market house transaction (Kong, Yin, & Nakagoshi, 2007). House prices are regressed against sets of control variables. It includes structural attributes of a house, neighborhood variables, and environmental attributes.

Chin and Chau (2003) believed that the property prices are associated with their structural attributes. It includes size of building lot, number of rooms and building age (Saphore & Li, 2012; Kong et al., 2007; Morancho, 2003). However, Morancho (2003) mentioned that size of ancillary in the building is also relatively important to the house price. Forrest, Glen, and Ward (1996) stated that lot size also has a significant effect on house price. All of them concluded that any functional space is considered to have a significant relationship with the house price. Other than structural attributes of the house, Geoghegan (2002) mentioned that the shortest distance between town and the house which is considered to be neighborhood variable also has a significant relationship with the house price.

Additionally, most of the previous studies proved that environmental attributes work well towards the house price. They believed that there is an inverse relationship between distance and property price (Boyer & Polasky, 2004; Cho, Bowker, & Park, 2006; Cho, Poudyal, & Roberts, 2008; Gibbon et al., 2013; Morancho, 2003; Tajima, 2003;). Most of them also proved that there is a positive relationship between the size of UGS and property price (Boyer & Polasky, 2004; Cho et al., 2008; Morancho, 2003). It shows that UGS has an important economic value.

Based on previous studies, all the reviewed variables seem to have a significant effect on the house price. Previous studies outside Malaysia have proven that the urban green space attributes including the size of urban green space and its distance to the residential area are important factors for house price. Therefore, all these variables are used to estimate the economic value of UGS in KL city.

METHODS

The house price is used in order to measure the implicit value of UGS based on UGS attributes (that is, the distance between the residential area and the UGS and the size of the UGS).

Based on Valuation and Property Service Department, the total number of residential units in Kuala Lumpur in 2013 was 424,324. Although it would be useful to utilise all the 424, 324 units of house, the data collection cost would be prohibitive and take very long. Hence, a random sampling scheme was employed. The sample size was calculated based on a 95% confidence level within a ± 5% range of accuracy of the total housing units. Based on Krejcie and Morgan's (1970) specification, the minimum number of sample size was 384. However, due to data availability, the final sample size in this study was 372 units of houses.

Cross sectional data for 372 sample housing units in 2013 was used in this study. This includes data from 10 residential areas and 14 urban green spaces (two forest reserves and 12 recreational parks). The residential areas included Mont Kiara Pines, Mont Kiara the Residents, Bandar Manjalara, Kepong Baru, Taman Bukit Maluri, Jinjang Selatan, Jinjang Utara, Kepong Garden, Segambut Garden, and Desa Park City. The urban green spaces included Bukit Nanas, Batu Caves, Bukit Lagong, Dataran Merdeka, Desa Park City, Forest Research Institute Malaysia (FRIM), KL City Centre (KLCC), Taman Tasik Permaisuri, Pudu Ulu, Rimba Bukit Kiara, Taman Tasik Perdana, Taman Tasik Titiwangsa, Taman Sains Rimba and Universiti Malaya Forest (UMF).

There are six strategic zones in KL. However, the residential areas of this study focused on Sentul-Menjalara zone for several reasons, one of which is that it has the largest population (445,000 persons), land size (4657 hectares) and highest residential units (137,097 units of houses). However, due to data availability, there are only ten residential areas involved in this study, while the list of UGSs in this study focused on public green space with four subcategories known as district parks, city parks, local parks and neighborhood parks. These parks are classified as well known parks, have good physical structure of facilities, level of naturalness, safety and are easily accessible by the public.

The data for independent variables were divided into three parts, namely, housing structures, neighborhood attributes, and UGS attributes. The data about housing structures and UGS attributes were gathered from the Valuation and Property Service Department while the neighborhood attributes and UGS attributes data were gathered from GIS

Software. GIS software was used in this study because the availability of GIS data on environmental attributes has increased the detail and flexibility with which these attributes can be associated with house locations. The data about the number of rooms, size of the ancillary (m^2), size of the building lot (m^2), size of the lot (m^2), age of house (year) and shortest distance to town (km) are categorised as housing structures. The shortest distance to town (km) is categorised as neighborhood attribute. The distance between the residential area and the UGS (km), as well as the size of the UGS per house (m^2) is categorised as the UGS attributes. The coordinates of the center of each UGS and 372 housing unit are captured to measure the distance between UGS and residential areas. The size of UGS per house is measured as follows:

$$size\ of\ UGS\ per\ house = \frac{size\ of\ UGS}{size\ of\ the\ lot\ for\ each\ houses} \quad [1]$$

The house price represents dependent variable. Any type of apartment, semi-detached house, and terraced house is considered as house in this study.

An economic valuation of the UGS is estimated using the HPM. The traditional HPM model takes on the following form:

$$P = f(x_1, x_2, \ldots, x_n, E_i) \quad [2]$$

where P is the house price, x_i, x_2, x_n are the housing structures and E_i is the environmental attribute variables. In this study, environmental attributes are reflected as UGS attributes.

Based on equation [2], the appropriate equation can be formulated as:

$$P = \alpha + a_1 x_1 + a_2 x_2 + \ldots + a_n x_n + b_i E_i + \varepsilon_i \quad [3]$$

However, the logarithmic specification is formulated in this study since there are no reasons to expect the relationship between the price and the environmental variable or attribute to be linear (Kong et al., 2007). In addition, it is able to normalise the data and reduce the numbers; this makes the interpretation easier. Thus, equation [3] can be expressed as:

$$\ln P = \alpha + a_1 \ln x_1 + a_2 \ln x_2 + \ldots + a_n \ln x_n + b_i \ln E_i + \varepsilon_i \quad [4]$$

In this study, the HPM is formulated in two types of models: the global model and the local model. Global models are statements about processes which are assumed to be stationary and location independent. Local models are the spatial disaggregation of global models, the results of which are location-specific. The purpose of using two types of HPM model is to examine whether the local model offers an improvement over the global model. In this study, six models are formulated based on the global model and local model.

Three global models based on the HPM are formulated in this study. Model 1 represents the relationship between the housing structure and the housing price. Model 2 represents the relationship between the housing structure together with the distance between the residential area and the UGS and the housing price. Model 3 represents the relationship between the housing structure together with the size of the UGS and the housing price. All these three models can be written based on equation [4]. The global model is regressed by using OLS regression.

The implicit economic value (EC) of the UGS is measured by using the house price. The EC of UGS are evaluated based on the following calculation:

$$EC = \frac{\underline{coefficient\ of\ each\ variables}}{100} \times \begin{matrix} mean\ of\ house\ price\ for\ the\ shortest \\ distance\ between\ UGS\ and\ house\ unit \end{matrix} \quad [5]$$

The GWR technique is a statistical methodology useful in exploring and describing spatial data, especially when spatial non-stationary relationships prevail (Brunsdon, Fotheringham, & Charlton, 1998; Jaimes, Sendra, Delgado, & Plata, 2010; Yu, 2007). This regression is conducted using localised points within the geographic space. Thus, it is assumed that the relationship may present variations that are dependent on the location, which is well-defined by a pair of prototype coordinates (u,v) (Fotheringham et al., 2003).

Fundaentally, the GWR specification is similar, except that the coefficients are estimated at each observation point (Bitter, Mulligan, & Dall'erba, 2006):

$$y_i = \alpha_0 + \sum_k \beta_k (u_i, v_i) x_{k.i} + \varepsilon_i \quad [6]$$

where

Y_i = dependent variables at location i

$x_{k,i}$ = kth independent variables at location i

ε_i = Gaussian error at location i

(u_i, v_i) = x-y coordinate of the ith location

$\beta_k(u_i, v_i)$ = coefficient of kth independent variables at location i

The coefficients $\beta_k(u_i, v_i)$ varyied conditionally at the location.The first variable is usually constant by setting x_{0i}=1, after which $\beta_0(u_i, v_i)$ becomes a geographically varying 'intercept' term.

As adopted and modified by Jaimes et al. (2010), the GWR involved in this study can be formulated as:

$$\ln P = \alpha_0 (u_i, v_i) + \beta_1 (u_i, v_i) \ln x_1 + \ldots + \beta_n (u_i, v_i) \ln E_n + \varepsilon_i \quad [7]$$

Based on equation [7], Model 4,5 and 6 were developed. Model 4 represent the relationship between house structure and house price. Model 5 represents the relationship between the housing structure together with the distance between the residential area and the UGS and the housing price. Model 6 represents the relationship between the housing structure together with the size of the UGS and the housing price. All these three local models are regressed by using GWR.

The expected sign and detailed explanation for each variable involved in all the models are illustrated in Table 1.

Table 1
Expected sign and explanations for each variable

Variables	Definition of the variables	Expected sign
Size of ancillary	self-contained living accommodation on the same lot as a single house that may be attached or detached from the single house occupied by members of the same family as the occupants of the main dwelling (Residential Design Codes, April 2008)	+/-
Size of building lot	Size of house itself	+
Size of lot	Size of total land for each house area	+
Number of rooms	Number of rooms per house	+
Age of house	Age of house counting from completed build until year 2013	-
Shortest distance to town	The shortest distance between the residential area and central town	-
Distance between UGS and residential areas	The distance between central of UGS and each of house location at all residential areas in KL city	-
Size of UGS per house	Size of UGS for each 372 houses	+

RESULTS AND DISCUSSION

The adjusted R^2 and t-statistics values for all the global models were examined. Table 2 presents the summary of the variables' statistics.

Table 2
Model variables and basic statistics

Variables	Mean	Standard deviation	Minimum	Maximum
Dependent Variable				
Housing Price (RM)	682864	784512.9	32000	7700000
Housing Structure Variables				
Size of ancillary (Sa)	26.53	27.74	0	252
Size of building lot (Sbl)	139.80	69.32	9	595

Table 2 *(continue)*

Variables	Mean	Standard deviation	Minimum	Maximum
Size of lot (Sl)	178.70	112.64	80	894
Age of house (A)	26.13	13.02	3	62
Number of room (Nr)	3.42	0.69	1	8
Shortest distance to town (Sdt)	14.38	3.33	8	18.32
Environmental Attribute Variables				
Distance between UGSs and residential areas (km)				
1. Bukit Lagong (Dbl)	10.72	2.67	7.2	16.2
2. Bukit Nanas (Dbn)	12.97	2.04	5.9	16.04
3. FRIM (Dfrim)	9.55	2.63	5	15
4. Desa Park City (Ddpc)	4.90	2.85	0.2	11.23
5. Taman Tasik Perdana (Dttp)	12.89	2.28	6.6	15.84
6. Taman Tasik Titiwangsa (Dttt)	12.67	2.20	4.9	16.04
7. KLCC (Dklcc)	15.20	2.05	7.5	19.2
8. Dataran Merdeka (Ddm)	12.28	2.03	5	15.44
9. Batu Caves (Dbc)	11.28	1.64	5.9	13.34
10. Taman Tasik Permaisuri(Dtp)	21.23	2.18	14.9	24.43
11. Pudu Ulu (Dpu)	19.99	2.43	12.7	24.3
12. Rimba Bukit Kiara (Drbk)	10.11	2.16	7.5	14.9
13. Taman Sains Rimba (Dtsr)	5.88	2.76	1.5	12.2
14. UM Forest (Dumf)	14.96	2.68	9.4	19.23
Size of UGS per house (m^2)				
1. Bukit Lagong (Sbl)	116963	159145	9868.5	755550.2
2. Bukit Nanas (Sbn)	375.06	504.98	98	2403.15
3. FRIM (Sfrim)	18535.8	24956.43	4843.28	118766.1
4. Desa Park City (Sdpc)	1594.43	2146.72	416.61	10216.1
5. Taman Tasik Perdana (Sttp)	1910.51	2572.30	499.2	12241.39
6. Taman Tasik Titiwangsa (Sttt)	97.32	131.35	25.07	614.76
7. KLCC (sklcc)	617.86	831.88	161.44	3958.87
8. Dataran Merdeka (Sdm)	1265.30	1703.58	330.61	8107.24
9. Batu Caves (Sbc)	60927.81	90717.9	13598.1	1026784
10. Taman Tasik Permaisuri (Stp)	1805567	12309979	4851.18	1.03E+08
11. Pudu Ulu (Spu)	15064.76	22430.54	3362.21	253878.5
12. Rimba Bukit Kiara (Srbk)	107546	160129.6	24002.52	1812416
13. Taman Sains Rimba (Stsr)	6752.69	10054.35	1507.09	113799.5
14. UM Forest (Sumf)	11313.2	16844.7	2524.92	190655.6

Note: These statistics are for 372 observations of housing units in the city of KL

The results of the three global models are illustrated in Table 3. Based on model 1, half of the house structures were found to be statistically significant with expected sign. These are size of lot, size of building lot and age of house. The results also show that the housing price grows by 0.5%, 0.06%, and 2.2% for every unit increase in size of lot, size of building lot, and decrease in the age of house respectively.

Based on model 2, the house structures were only statistically significant for the size of ancillary, size of lot and size of building lot with the expected sign. For environmental attributes, only two UGS were statistically significant with negative sign. They were Pudu Ulu and Titiwangsa. From model 2, the results show that a reduction of 50 meters of distance from residential area to the nearest UGS (Titiwangsa) increases the price of house by RM6600. The reduction of 130 meters of distance from residential area to the nearest UGS (Pudu Ulu) increases the price of house by RM1000. The distance between the residential area and Taman Sains Rimba was also statistically significant, but with a positive sign. Donovon and Butry (2011) state this may occur for two possible reasons. First, although parks are generally viewed as a positive amenity, Troy and Grove (2008) found that neighborhood proximity to a park reduced the sales price of a house in high-crime locations. Second, the distance to a park may correlate with an omitted, positive neighborhood amenity. For example, houses that are further away from parks may tend to be closer to shops or restaurants, which could increase the house price. In addition, Saphores and Li (2012) found that the opposite effect is reflected in the landscaping taste.

Residential areas close to Batu Caves, Rimba Bukit Kiara, UM Forest, KLCC, Desa Park City, FRIM and Bukit Lagong would increase the value of the housing price. However, these coefficients were statistically insignificant. The distance between the residential area and Permaisuri, Dataran Merdeka, Tasik Perdana and Bukit Nanas were also statistically insignificant.

For model 3, all housing structures were statistically significant with expected sign. For environmental attributes, only four UGSs were statistically significant with positive sign. They were FRIM, Permaisuri, Pudu Ulu, and UM Forest. From model 3, the results show that an increase in the size of the FRIM by 60,000 m^2 led to RM 323,000 increase in the house price. An increase in the size of the Pudu Ulu by 3500 m^2 led to RM 69,000 increase in the house price. An increase in the size of the UM Forest by 2600 m^2 led to RM 100,000 increase in the house price. An increase in the size of the Permaisuri by 5100 m^2 led to RM340 increase in the house price. This expected result was supported by Ishikawa and Fukushige (2012). The size of UGS (Bukit Lagong, KLCC, and Dataran Merdeka) was also statistically significant but with negative sign. The size of UGS (Desa Park City and Tasik Perdana) would increase the house price but these variables were statistically insignificant. The size of

UGS (Taman Sains Rimba, Rimba Bukit Kiara, Batu Caves, Titiwangsa, and Bukit Nanas) was also statistically insignificant.

The rationale of regressing three models for OLS Regression is to do a robustness test. Based on the estimated coefficients for model 2 and model 3, the house structure attributes are robust. It can be seen through the coefficient of house structure attribute for model 2 and 3 is not much different with house structure attribute for model 1. Then, this study intends to compare which variable offers the highest house price. In other words, the environmental attributes that have high economic value are probed. Based on these three models, it proved that the house prices are more influenced by the size of UGS (model 3) that is, the size of FRIM compared to the distance between UGS and residential area (model 2). It is determined based on the largest value of increasing house price. Model 3 also attained the highest significance level. Overall, the performance of all the global models were satisfactory, as reflected by adjusted R^2 and AIC in the analysis.

The results of the global models exposed a significant relationship between the house prices and some of the housing attributes, together with the UGS attributes. However, the relationship was constructed upon the theory of a stationary housing price, which is likely untenable. Hence, a GWR model was conducted to examine and explore such non-stationarity. The ANOVA Test of local model against the global model and the results of the GWR model are presented in Tables 4 and 5, respectively.

The AIC and adjusted R^2 values in Table 4 clearly illustrate that each local model exhibited a significant improvement over the global model. The AIC for all local models was smaller than the global models. This finding suggests that the local model performed better than the global model, even after the complexity of the GWR is taken into account. These findings are consistent with the empirical work by Yu (2007). In addition, the increase in the adjusted R^2 clearly confirms that the local model explains the variance considerably better than the global model. The level of the variance explanation increased considerably, obtaining an adjusted value of 76%, 74%, and 73% which were 13%, 3%, and 3% more than the global model respectively.

Table 5 exhibits the results of the local model. The local parameter estimates vary at each of the 372 observation points. They are described by their median, minimum (min) and maximum (max) values, as well as their interquartile range. For model 4, the geographical variability was only significant for certain house structures. There were size of ancillary, size of building, size of lot, and age of house. For model 5, the geographical variability was significant for the distance between UGS and residential areas except the distance between UGS (Bukit Nanas, Pudu Ulu, and FRIM) and the residential areas there.

Table 3
Global OLS regression result

Statistic Intercept	Model 1			Model 2			Model 3		
	Estimate	Std error	t-value	Estimate	Std error	t-value	Estimate	Std error	t-value
Sa	12.91	0.0010	-0.2849	-0.0021	0.0012	-1.7716*	-0.0024	0.0012	-2.0417**
Sbl	0.15	0.0006	8.0922***	0.0033	0.0006	5.5847***	0.0039	0.0006	6.8930***
Sl	84.27***	0.0003	2.0384**	0.0016	0.0003	5.5310***	0.0010	0.0006	1.8122**
A	20.43	0.0022	-10.1321***	-0.0026	0.0035	-0.7364	-0.0177	0.0028	-6.2241***
Nr	4.85	0.0391	0.2135	-0.0307	0.0392	-0.7816	-0.0512	0.0405	-1.2627
Sdt	4.21***	0.0068	0.5446	-0.0017	0.0112	-0.1501	-0.0117	0.0087	-1.3527*
Dbl	-133.57			-0.5092	0.7287	-0.6987			
Dbn	44.79			0.0066	0.3462	0.0191			
Dfrim	-2.98***			-0.1851	0.7073	-0.2617			
Ddpc	-0.0003			-0.0672	0.1166	-0.576			
Dttp	0.0046			0.5985	0.7724	0.7748			
Dttt	0.0006			-1.5372	0.6809	-2.2575**			
Dklcc	-0.0219			-0.0687	0.4874	-0.1410			
Ddm	0.0083			1.1591	1.1591	1.0389			
Dbc	0.0037			-0.2687	0.4021	-0.6680			
Dtp				0.4861	0.5988	0.8117			
Dpu				-0.2252	0.1032	-2.1834**			
Drbk				-0.5770	0.5127	-1.1254			
Dtsr				0.8162	0.3406	2.3960***			
Dumf				-0.2327	0.4599	-0.5060			
Sbl							-0.2935	0.1509	-1.9457**
Sbn							-4.2522	8.1268	-0.5232
Sfrim							47.2509	8.002	5.9049***
Sdpc							19.0545	15.9890	1.1917
Sttp							20.3375	15.9335	1.2764
Sttt							-0.0358	0.1508	-0.2371
Sklcc							-29.6269	11.6713	-2.5384***
Sdm							-52.1317	10.169	-5.1265***
Sbc							-13.2153	14.5025	-0.9112
Stp							0.0535	0.021	2.5434**
Spu							10.1484	7.0325	1.4431*
Srbk							-2.1820	6.1972	-0.3521
Stsr							-9.518	14.4195	-0.6600
Sum f							14.6387	6.0631	2.4144***
Adjusted R^2	0.6279			0.7078			0.6870		
AIC	389.1325			312.5860			338.1722		

Note: ***, ** and * denote significance at the 1%, 5% and 10% significance levels, respectively The value in parentheses ( ) contain the t-values. A critical value for t-test is assigned on 372 degrees of freedom = 1.282 (10%), = 1.645 (5%), and = 2.326(1%).

Table 4
ANOVA test of GWR against global model

Source	SS	DF	MS	F
Model 1				
Global Residuals	59.386	365.000		
GWR Improvement	25.389	46.099	0.551	
GWR Residuals	33.997	318.901	0.107	5.166
GWR Akaike Information Criterion (AIC) = 266.221649 (OLS = 389.132530); GWR adjusted R^2 = 0.756110 (OLS =0.627926)				
Model 2				
Global Residuals	44.836	351.000		
GWR Improvement	6.255	13.008	0.481	
GWR Residuals	38.582	337.992	0.114	4.212
GWR Akaike Information Criterion (AIC) = 275.355 (OLS = 312.586); GWR adjusted R^2 =0.739 (OLS =0.708)				
Model 3				
Global Residuals	48.029	351.000		
GWR Improvement	7.470	14.243	0.524	
GWR Residuals	40.559	336.757	0.120	4.354
GWR Akaike Information Criterion (AIC) = 294.103 (OLS = 338.172); GWR adjusted R^2 =0.725 (0.687)				

SS = Sum of Squares; DF = Degree of Freedoms; MS = Residual Mean Square

Table 5
Test for non-stationarity and GWR result

Independent variable	Min	Lower quantile	Median	Up Quantile	Max	DIFF of criterion	F-value
Model 1							
Intercept	11.6375	11.7518	12.1799	12.4386	13.7666	-679.031	-27623.6673
Sa	-0.0148	-0.0017	-0.0013	0.0022	0.0102	-31.0068	6.8236***
Sbl	0.0015	0.0025	0.0027	0.0063	0.0110	-13.7546	4.428***
Sl	-0.0057	0.0010	0.0019	0.002	0.0021	-20.992	5.5809***
A	-0.0490	-0.0289	-0.0098	-0.006	0.0761	-7.1581	3.4766
Nr	-0.2723	-0.0071	0.0509	0.1446	0.1989	4.4442	1.6952
Sdt	-0.0001	0.0091	0.0246	0.027	0.0518	3.8525	1.5593
Model 2							
Intercept	10.9657	13.9874	21.0262	24.1640	54.110	-99.1152	111.739***
Sa	-0.0097	-0.005	-0.0033	0.001	0.0022	-25.1992	17.7596***
Sbl	0.0025	0.0027	0.0033	0.004	0.0022	-2.3433	4.1063**
Sl	0.0007	0.0014	0.0017	0.0021	0.0021	-3.578	5.6717***
A	-0.0060	-0.0049	-0.0013	0.0008	0.0154	-1.6627	3.9901**
Nr	-0.0682	-0.0140	0.0145	0.0430	0.0566	-0.2878	2.4793*

Table 5 *(continue)*

Independent variable	Min	Lower quantile	Median	Up Quantile	Max	DIFF of criterion	F-value
Sdt	-0.0078	-0.0013	0.0008	0.0013	0.0041	0.5564	1.1656
Dbl	-4.129	-2.1120	-1.1463	-1.0218	-0.200	-9.1192	31.7538***
Dfrim	0.0657	0.7299	0.8717	2.0481	3.5974	-604.110	-582.6205
Ddp	-1.0225	-0.8646	-0.2671	-0.0095	0.0721	-5.3178	10.4874***
Dbn	-0.0988	0.0065	0.0184	0.0501	0.1646	-150.151	-6761.983
Dttp	-2.7482	-1.3898	0.6734	1.1508	1.8029	-14.4125	290.8893***
Dttt	-5.3459	-1.4665	-1.1492	5.1116	9.428	-1.0083	5.3178**
Dklcc	-0.594	-0.2099	0.2009	0.2279	0.574	-11.7649	83.0954***
Ddm	-8.1182	-4.0478	0.2813	0.569199	8.1693	-2.4090	8.6606***
Dbc	-7.4072	-4.0478	0.2813	0.5692	0.0331	-3.6660	18.0748***
Dtp	-0.3436	-0.0691	-0.0393	0.0372	0.5957	-721.872	2706.575***
Dpu	-0.5785	-0.303	-0.0802	-0.0596	0.1944	-16.1198	-126.2818
Drbk	-2.4675	-1.6797	-0.9878	-0.8692	-0.394	-25.768	82.878***
Dtsr	-1.6824	-0.6603	0.5408	0.6143	6.8997	-1.7978	9.3244***
Dumf	-0.2439	0.1797	0.27	1.8712	2.4611	-26.7893	41.7936***
Model 3							
Intercept	-207.501	-190.8124	-152.572	-115.4952	-87.524	-413.925	773.8182***
Sa	0.0031	-0.0040	-0.0029	0.001	0.0042	-15.9717	17.083***
Sbl	0.0031	0.0033	0.0036	0.0039	0.0042	-5.7907	9.8140***
Sl	-0.0002	0.0001	0.0014	0.0020	0.0027	-15.3969	20.3295***
A	-0.0277	-0.019	-0.0144	-0.0099	-0.006	-10.9431	17.5488***
Nr	-0.0678	-0.0252	-0.0144	0.0058	0.0150	-12.522	19.4233 ***
Sdt	-0.0178	-0.0006	0.0021	0.0043	0.0084	-7.912	14.122***
Sbl	-0.5556	-0.4119	-0.2817	-0.0540	0.0047	-175.719	654.1582***
Sbn	-17.5303	-13.1024	-7.8798	-3.987	7.2103	-323.021	-905.1021
Sfrim	28.8429	36.7713	47.468	61.6104	65.766	-48.0939	108.2666***
Sdpc	-2.6411	8.1367	11.368	14.0194	18.381	-178.109	544.8212***
Sttp	12.3921	18.3222	28.0636	33.8624	42.648	-238.689	735.1984***
Sttt	-0.0443	-0.0416	0.0380	0.0981	0.1906	-160.979	8292.6535
Sklcc	-45.6123	-40.1537	-34.051	-27.9376	-18.04	-252.99	1642.355***
Sdm	-50.4571	-45.3933	-43.204	-40.5432	-38.40	-20.1147	48.0169***
Sbc	-29.4896	-22.2096	-15.530	-9.9963	-6.659	-531.785	1039.391***
Stp	0.033	0.03726	0.0457	0.0477	0.0618	-19.1422	315.6145***
Spu	0.079	5.2236	7.6526	9.2014	13.732	-575.722	842.7798***
Srbk	-7.8332	-4.7726	3.7241	9.6962	15.109	-630.795	4730.081***
Stsr	-13.2033	-10.1062	-8.5584	-5.7247	2.2695	-1710.41	576642.0631***
Sumf	5.3269	12.1906	12.5049	15.2889	20.264	-1352.88	50541.27***

Note: Positive value of diff-Criterion (AICc, AIC, BIC/MDL or CV) suggests no spatial variability in terms of model selection criteria
F test: in case of no spatial variability, the F statistics follows the F distribution of DOF for F test.

For model 6, geographical variability was significant for most sizes of UGS except Bukit Nanas and Titiwangsa. The result justifies that the significant non-stationarity relationships between the house price and house attributes, together with the UGS attributes, exists in certain locations in KL city. This indicates strong evidence that house prices are not constant and can vary over space and locations within KL city.

For model 4, the interquartile ranges of the local GWR estimates were the possible magnitudes. However, the min and max values were counterintuitive in some of the cases. They were the size of ancillary, number of rooms and shortest distance to town. It is estimated that the size of ancillary, number of rooms, and shortest distance to town ranged from -0.015 to 0.01, -0.272 to 0.2, and -0.001 to 0.05 respectively. The negative values for size of ancillary and number of room reflects that reduction in the size of ancillary and number of rooms increase the house price at certain locations. Meanwhile, the positive values for the shortest distance to town depicts that increase in the distance to town will increase the house price at certain locations. For model 5, the min and max values for the UGS attributes (distance between UGS and residential areas) were also found to be counterintuitive at most of the distances between them (UGS and residential areas). They were the distance between residential areas and UGS (FRIM, Desa Park City, Bukit Nanas, Tasik Perdana, Titiwangsa, KLCC, Dataran Merdeka, Batu Caves, Permaisuri, Taman Sains Rimba, and UM Forest). The positive values for the distance between them depicts that the raising of the distance between UGS mentioned above and residential areas will increase the house price at certain locations. For model 6, the min and max values for environmental attributes (size of UGS) were also counterintuitive. It consists of the size of Bukit Lagong, Bukit Nanas, Desa Park City, Taman Tasik Titiwangsa, KLCC, Dataran Merdeka, Batu Caves, Rimba Bukit Kiara, and Taman Sains Rimba. The negative values for environmental attributes show that reduction in the size of UGS will increase the price of house at certain locations.

One advantage of the GWR is that spatial distribution is inherent in the parameter estimates and can easily be visualised. Figure 1, Figure 2 andd Figure 3 illustrate the parameter estimate surfaces of each individual attribute's coefficient that were significant at different significance levels (1%, 5%, and 10%). These results were determined by the F-value. The local R^2 surfaces for each local model are presented in Figure 4.

The map in Figure 1, Figure 2 and Figure 3 reveal that the relationship between the house structures and the house prices is not necessarily significant with the expected sign at each of the residential areas (house locations) in KL city. The same goes for the relationship between the UGS attributes and the house price.

For model 4 as illustrated in Figure 1, the size of ancillary and size of building lot were statistically significant with expected sign at each of the residential areas. For the size of lot and age of house, statistical significance with expected sign was also found at each residential area in KL city except in the south west. For model 5 as illustrated in Figure 2, the distance between the residential area and Bukit Lagong, Desa Park City, Batu Caves and Rimba Bukit Kiara were negatively significance in each of residential area in KL city.

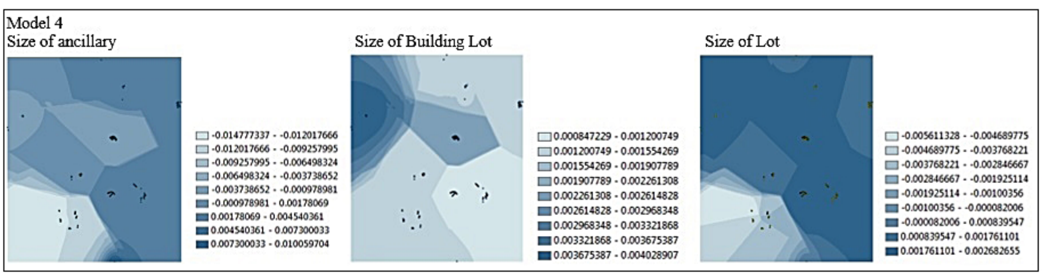

Figure 1. Spatial distribution of the parameter estimates of each variable that is statistically significant on geographical variability for Model 4

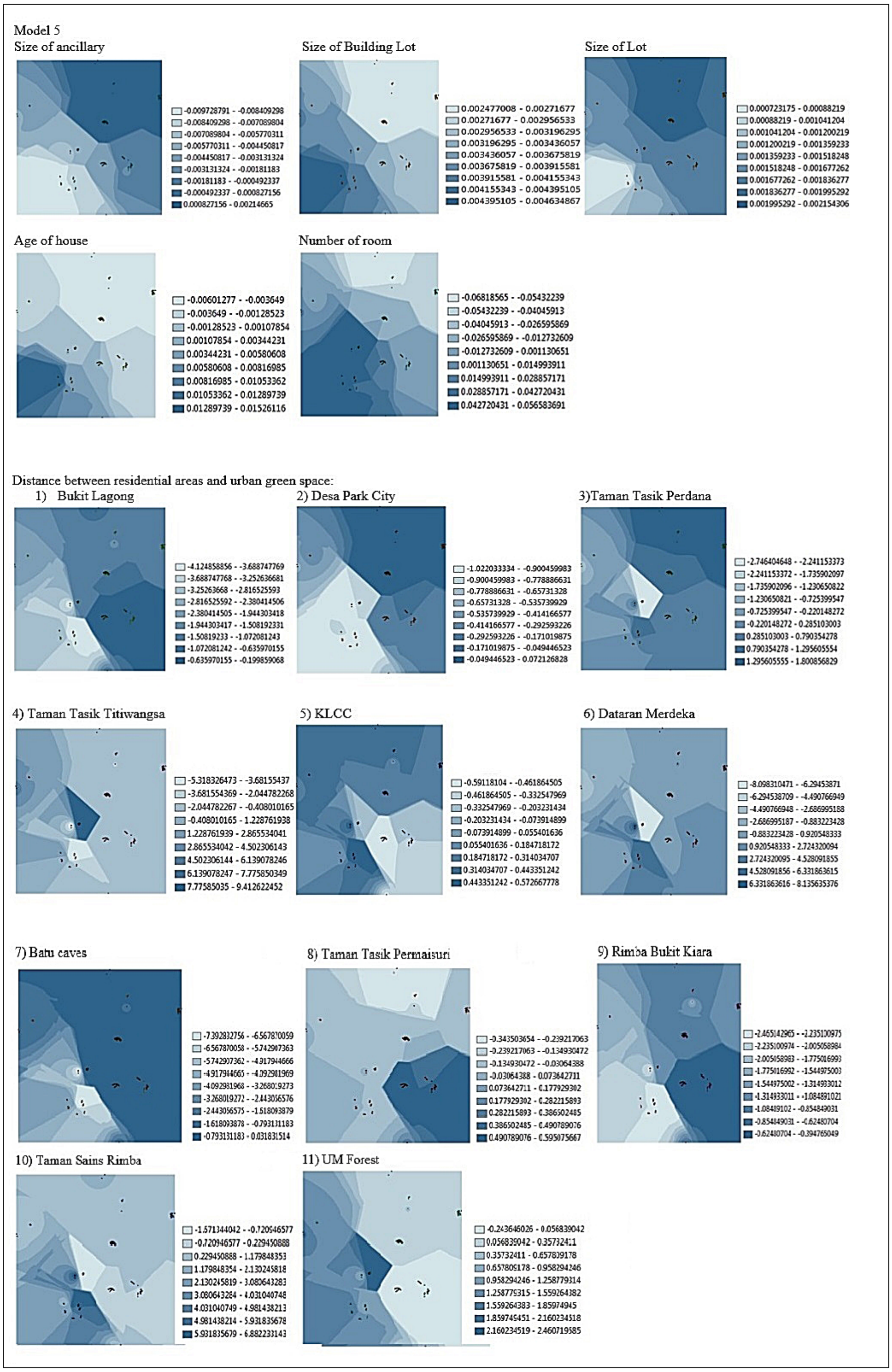

Figure 2. Spatial distribution of the parameter estimates of each variable that is statistically significant on geographical variability for Model 5

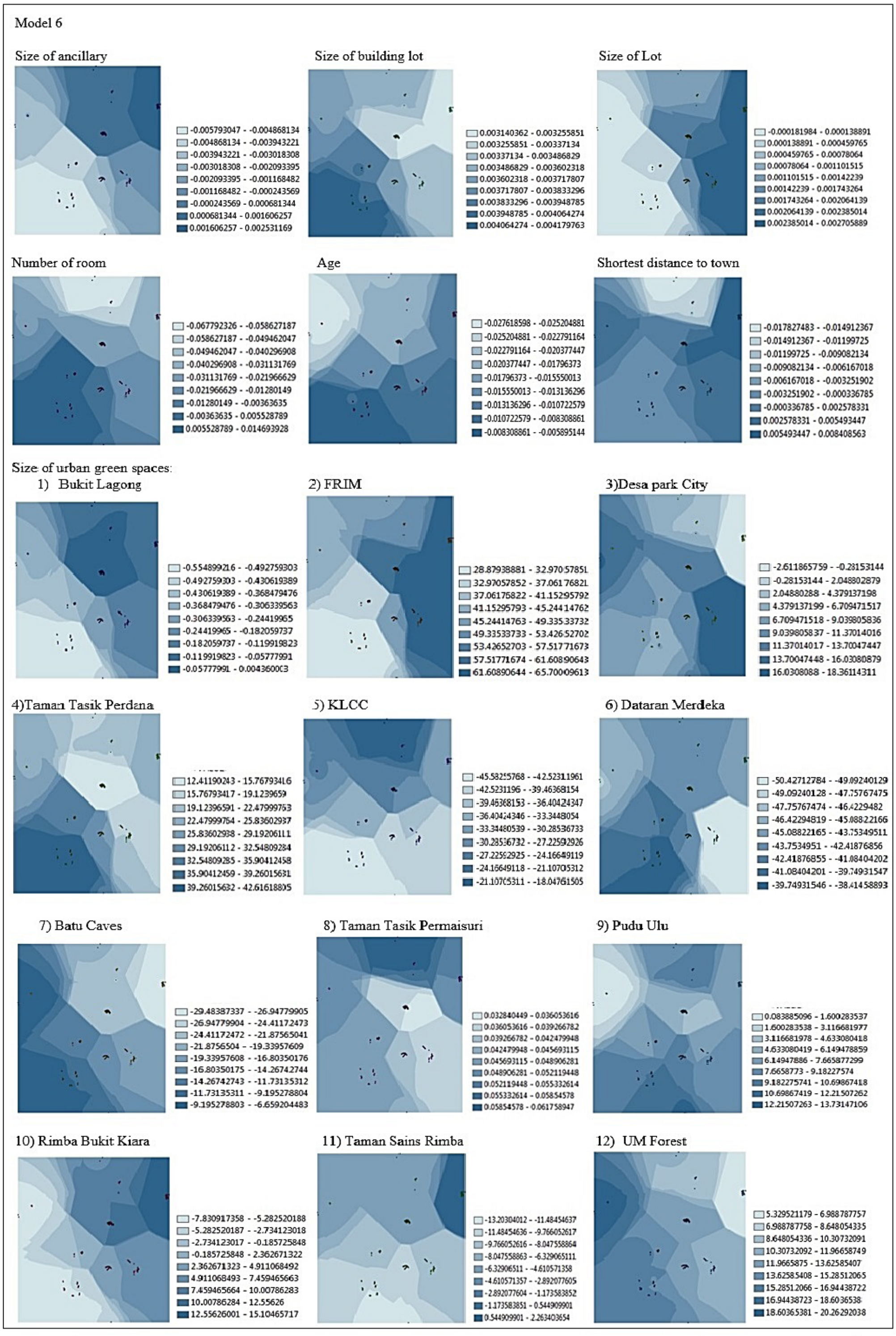

Figure 3. Spatial distribution of the parameter estimates of each variable that is statistically significant on geographical variability for Model 6

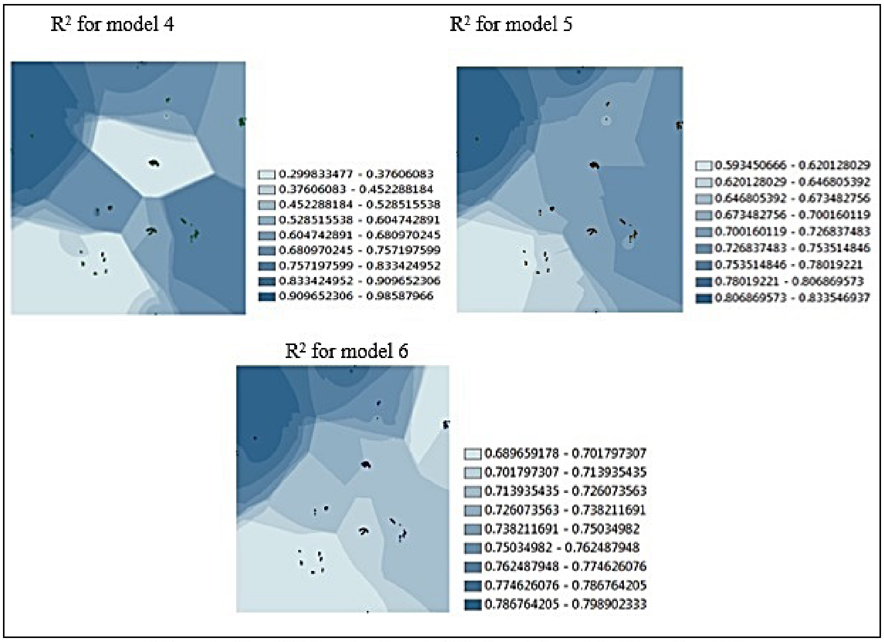

Figure 4. Spatial distribution of R^2 values for each local Model

It shows that the house price at each of residential areas in KL city was influenced by the distance of UGS (Bukit Lagong, Desa Park City, Batu Caves and Rimba Bukit Kiara). This result illustrated that these UGS have high economic value for all residential areas in KL city. Tasik Perdana and Dataran Merdeka were negatively significant in the west, north west, and south west. Taman Tasik Titiwangsa was negatively significant in most of the residential areas in KL city except in the west of KL city. Permaisuri was also negatively significant in most of the residential areas in KL city except in the east and south. KLCC was only negatively significant at the residential areas located in the east and west of KL city. Taman Sains Rimba and UM forest were only negatively significant at residential areas located in the south east of KL city. For model 6 as illustrated in Figure 3, the size of UGS (FRIM, Tasik Perdana, Permaisuri, Pudu Ulu, and UM Forest) were positively significant at all of the residential areas in KL City. Size of Bukit Lagong and Taman Sains Rimba were positively significant at residential areas located in the north east of KL city. Size of Desa Park City was positively significant at all the residential areas in KL city except in the south east. Size of Rimba Bukit Kiara was positively significant at residential areas located in the north, east, and south of KL city. Meanwhile, the size of KLCC, Dataran Merdeka, and Batu Caves was negatively significant at all the residential areas in KL city.

For model 4, the local R^2 values shown in Figure 4 present a variation of 0.3 to 0.98, which means that the fit explained 30% to 98% of the data variance. For model 5, the local R^2 values showed a variation of 0.59 to 0.83, indicating the fit explained 59% to 83% of the data variance. For model 6, the local R^2 values presented a variation of 0.69 to 0.8, that is, the fit explained 69% to 80% of the data variance. The highest R^2 values for all local models were obtained in the north west of KL city, which suggests that the conclusion between the variables was better with GWR in this region.

CONCLUSION

This study economically valued UGS in relation to housing price. In general, it shows the economic benefits associated with environmental amenities such as proximity to recreational parks and size of parks. The house price is valued based on two types of models. For global model, model 2 was found to be the best, as it indicated the highest adjusted R^2 value and the lowest AIC value. For local model, model 4 offerrd the best model. However, by comparing the global and local model, it was found that local model is better than global model as indicated by the adjusted R^2 and AIC values. Hence, it is proven that geographic coordinates play an important role in valuing the economic benefits of UGS.

The global model proved that Taman Tasik Titiwangsa and FRIM are the UGS that offer the highest economic value for model 2 and model 3 respectively. This finding is based on the highest increase in house price due to environmental attributes. However, there is a little difference with the results obtained of the local model. Overall, the result of the local model illustrated that most UGS attributes are statistically significant and have positive impact on house prices.

On average, global model proved that Taman Tasik Titiwangsa offers the highest economic value due to the distance between UGS and residential area. However, local model shows that the economic value of Taman Tasik Titiwangsa is only valuable for certain residential areas in KL city, that is Mont Kiara The Residence, Kepong Baru, Jinjang Utara, Kepong Garden and Desa Park City. This situation is due to the existing spatial non-stationarity. For the size of UGS variables, local model shows that the economic value of FRIM is significant and has positive impact for the whole residential area in KL city.

By using GWR, this study offers information about where real estate developers would gain benefits by targeting the best locations to build houses or residential areas. Besides that, the results recommend that policy makers should protect UGS in the urban environment and design zoning and land-use regulation policies accordingly.

However, this study has its limitation in regard to the variables and quantity of data. This study only included one neighborhood variable, that is the distance to town. It would be useful if other neighborhood variables such as information about school, hospital, crime rate, airport and place of worship could be included. In addition, instead of regressing individually the environmental variables, the house structure variables, neighborhood variables and all of the environmental variables also need to be regressed in one model. As for the quantity of data, hedonic pricing analysis will be more accurate with a large number of sample size (more than 1000 samples). By considering all of these limitations, a future study will be valued.

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