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# Sustainable Urban Regeneration: GIS and Hedonic Pricing Method in determining the value of green space in housing area

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**Abstract**

This paper explores a framework that combines Geographic information System (GIS) with Hedonic pricing method in improving the analysis and determining the value of green spaces with housing prices in Subang Jaya, Malaysia. The previous study found that proposed combination between GIS and Hedonic pricing method for the same purpose has not been fully explored particularly in Malaysia. Findings show the proposed combined method leads to an improved understanding and representation of urban dynamics and regeneration process, furthermore will encourage a sustainable setting of the environmental amenities in improving the geospatial technologies respectively.


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*Keywords: GIS, Hedonic Pricing Method, green Spaces and urban regeneration*

## 1. Introduction

In urban areas, green spaces consist of parks and open spaces not only provide a pleasant and natural environment but also the quality of life and undertake essential environmental functions. An importance of urban green spaces in contributing fundamentally the quality of urban life has been stated by many researchers (Chiesura, 2004 and Biao et al, 2012). In Malaysia, development guidelines required 10% of an area to be green spaces which is will be rank according to total populations in each development proposed particularly surrounding residential areas (TCPD, 2013). Recently, residential property market in Malaysia has experienced significant price expansion over the past fifteen years with prices at several states experienced at higher rate. The Malaysia Valuation and Properties Services Department (JPPH)

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reported that the Malaysian house price Index increased by 8.0% in Q12014 relative to Q12013 and prices index changes over 12 months shows that increased from 1.5% (Q1-Q42009) to 11.6% (Q1- Q42013) (JPPH, 2014). At the same time, there is growing evidence showing that a factor of house prices was influences by green spaces as well the amenities and its infrastructure (Anderson and Cordell, 1988; Tyrvainen, 1997; Morancho, 2003). Since the green space is a part of natural resources and environmental amenities, it is a big challenge to measure the value of on willingness to pay (WTP) because they are non-market goods. The value of green space has been the subject of a good deal of research using hedonic method and GIS and stated preference method as surveyed in various scholars. The hedonic pricing method was revealed preference method to quantify a value from non-market goods purchased with a housing properties. Meanwhile GIS can easily provide an overall profile of land uses and open space surrounding the environmental amenity of interest in terms of their spatial distributions.

Therefore objective of this paper is to analyze the approach of integration GIS-HPM in determining values of green spaces in housing prices. This paper firstly conducts a survey on the property attributes of 200 units of semi-detached in Klang Valley which represent by Subang Jaya, then uses GIS-HPM to analyze the relationship between property values and parks. This study not only provides a better understanding on urban regeneration process (Robert and Sykes, 2000), it also assessing planning and economic valuation on urban green space in Malaysia which is still comparatively limited. In consequences, it is hoped that the result in this study will provide a reference for the valuation of green space in Malaysian cities.

### 1.1 Theoretical on Green spaces value using hedonic Pricing Methods and GIS

The study on this topic study was began with Morales et al (1976) concluded that residential properties with good tree cover could raise total sale price by as much as 6%-9%, Anderson and Cordel, (1988) found that landscaping with trees was associated with 3.5%-4.5% increase sales prices. Meanwhile, Luttik, (2000) was studied on 3000 houses transaction 8 towns in Netherlands found that a pleasant view could bring a considerable increase in house price based on lakes (8%-10%) and open space (6%-12%). A few years later, Crompton (2005) suggested that a positive impact of 20% on property values abutting or fronting a passive park was a reasonable staring point guideline. Sanders and Polasky, (2009) estimated a spatial error model with monthly and school district dummy variables on 9992 homes sold in 2005 in two Minnesota (USA) counties. According to result, a 10% was increase in tree canopy cover within 100 meters increases the average home price $1371. Conway et al, (2010) considered instead a spatial lag model to examine 260 homes sold in 1999/2000 in Los Angeles, California (USA) with a result consider that 1 percent increase in green space 200-300 meters from single family properties raises their value by 0.07 %.

The study conducted by Zhang et al, (2012) found that urban green had positive and statistically significant influences on neighboring property values; on average was a 5%-20% premium. City parks are more highly more valued with an average premium of 10.9% with parks inside 2$^{nd}$ ring road can increase property value by about 14.1% while the parks beyond 5$^{th}$ ring road only add 0.5% in house prices. They also found a property located on the edge of a park could potentially attract a premium of between 0.5% and 14.1% in Beijing. The most recent on this study can be refer to Veie and Panduro, (2013) mentioned that proximity to parks and size of the park is associated with higher prices, the effect of size is small with approximately 0.01% increase in the price with a one percent increase in size. The size of common area is associated with statistically significance higher property prices. 1% increase in the size of common area coincides with a 0.01% increase in property price. They also suggested that proximity is measured in Euclidian distance in steps of 100 meters from property to all types of green except green common area and lakes. It's included a house with view of lake will gained into 7% of higher prices. Housing which having a view of a park is associated with price premium of almost 6 %.

The nature of green spaces which are non-commodity goods, it very challenging measure the monetary on willingness to pay (More et al, 1998) because they are non-market goods. Therefore, different methods have been employed to estimate the value of urban green spaces. Several methods such as travel cost, contingent valuation method including hedonic pricing models have been developed and were improved in recent decades (Kong and Nakagoshi, 2007). Hedonic pricing method (HPM) is regression analysis of house sale transaction prices as a dependent variable with an array of explanatory variables, range of GIS-HPM context is expansive which, the utilization of Geographic information system (GIS) technique and software in estimating the green spaces as a factor for house prices have a potential to provide a reliable sets of results. A basic requirement to utilize GIS is the availability of information on existing land use, urban pattern identification and computation of landscape metrics. All these required information need to be compiled and converted into digital forms which can readily use in Digital Image Processing System. The HPM is well established method based on consumer theory (Lancaster,1966), relying on the premise that the amount of money an individual is willing to pay for a particular good is dependent upon the individual attributes of that goods (Rosen, 1974 and Freeman, 1979). In the case of housing, method explains the variations in the house prices through difference in preferences for structural attributes (bedrooms, bathrooms and land area), house prices may reflect a premium for proximity to other neighborhood (e.g., distance to city center, distance to road ways) and environmental (e.g., tree cover in an around the house, distance to urban parks, distance to forest) attributes. Using HPM we can model the house price as a function of different attributes to derive marginal implicit price of the attribute, which reflects a value that homeowners place on the attribute.

Urban green spaces have important amenity values that include provision of leisure opportunities and aesthetic enjoyment. However, most of these values lack a market price. Consequently, they are usually ignored or underestimated by urban planning policy-makers, with the result that remnant urban green spaces are being gradually encroached upon by urban sprawl. As a result, quantitative information regarding the implicit, non-market price benefits from urban green space is urgently required. Properties bought and sold on the market are compound commodities that embody amenity values and people are willing to pay to live in the proximity of local amenity environment. In recent decades, the development of GIS has gradually made hedonic pricing model a powerful tool, but at present, it is still underutilized in urban and environmental economics (Brasington and Hite, 2005). The common dictum that location is the most important parameter for real estate valuation can only be fully taken into account by using the descriptive framework of a GIS. One of the most basic advantages of a GIS is to position properties on local map in term their geographic coordinates (Din et al., 2001, Saphores and Li, 2012), which these can then be used to measure the environmental characteristic of properties better, increasing the understanding of house pricing variations as compared to previous study (Wyatt 1996).

## 2. Material and Methods

### *2.1. Material*

We gathered property data, along with associated structural, neighborhood, and environmental attributes from variety of sources. We acquired property sales data till year 2014 from Malaysian Valuation and Property Services Department, the agency that collects and distributes property particularly on house prices index database for this study area. Data contained average house sale price for Subang Jaya area. We select semi-detached houses and cadastral map retrieved from Town and Country Planning Department (TCPD) allowed delineation of property boundaries and to spatially reference the sample properties. Data on the extent and location of business, housing and recreational areas (parks and reserves) were obtained from GIS layer from (TCPD). A gravity index of industrial and recreational areas

within 400m (which is consider as within walking distance) for each property was constructed, adopted from Powe et al, (1997) to capture combined influence of their size and proximity on property value.

Table 1 : Hierarchy of open space in study area

| No | Hierarchy of open space | Acreages (ha)-requirement | Population catchment | Levels |
|---|---|---|---|---|
| 1 | Neighborhood Park | 2.0 | 3000-12000 | Local community |
| 2 | Playground | 0.6 | 1000-3000 | 3 sub-neighborhood area |
| 3. | Play lot | 0.2 | 300-1000 | neighborhood area |

## *2.2. Methodology*

### *2.2.1. Study area*

The study area was conducted in Subang Jaya which is suburban city in the Klang Valley, Selangor Malaysia, its located at 3°3'52"N 101°35'37"E. It is located about 20 km from the Kuala Lumpur city Centre. It comprises the southern third district of Petaling, making it the 5th most populous city in Malaysia. Specific study area is located at USJ and Putra Heights with an area is approximate 17473ha. This site was covered for semi-detached family housing which is identified from 5 selected areas (figure 1). As we refer to the annual price index for semi-detached housing in study area which shows a tremendously increase in 14 years from 85.6 (year 1999) to 244.8 in year 2013 which brings the approximate gap of 159.2 due to rapid development and increasing of urban settlement, industrialization and commercialization in study area.

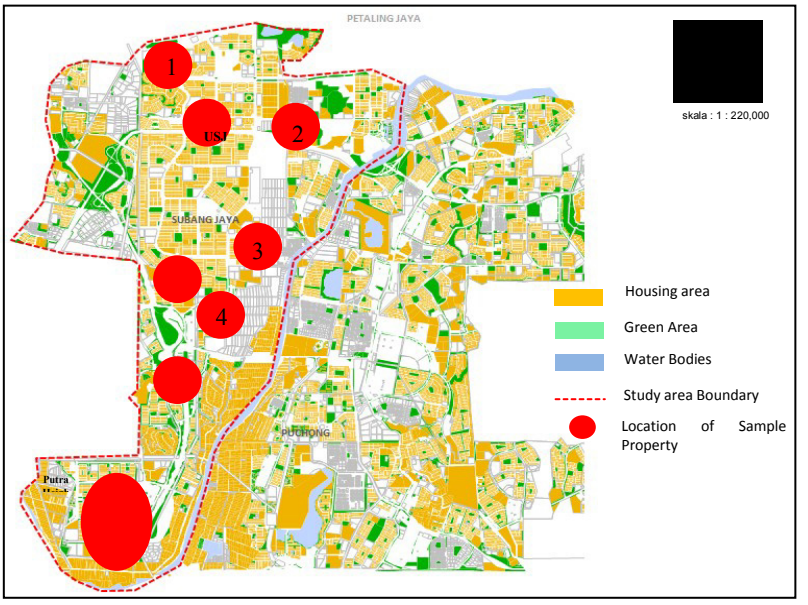


Fig 1. The study area and geographic distribution of sample properties

### 2.2.2 Main Processing

We firstly investigate the property characteristic of 50 samples of residential units with approximate 1100 ha of green area, and apply hedonic price method to analyse the relationship between semi-detached value and its nearby park. Then we adopt GIS technology to map urban green spaces and estimate the overall benefit to property value. In order to obtain a representative sample of each neighbourhood, the respondent includes real estate agents, household and planned property buyers. We create a survey form to record the neighbourhood characteristic of each sample property and its surrounding areas. The characteristic or variables to be included in the estimates must be determined before obtaining such estimate using hedonic pricing method. This decision maybe involves recognition of relevant variables that are omitted from the analysis and determination of how to capture the chosen variables. The implicit prices of spillover benefits from the neighborhood or environmental characteristic can be inferred based on the hedonic hypothesis (Rosen, 1974). Consequently, the traditional hedonic pricing model takes the following form:

$$P = f(x_1, x_2, \ldots\ldots\ldots x_n) \quad (1)$$

Where $P$ is the market price of the housing and $x_1, x_2, \ldots\ldots\ldots x_n$ are the characteristic contained in the property. We choose average house price of per residential district as the housing price (P); proximity (PWRD), location (LST), size (SAD), hierarchy (HCAN), facilities (FSSU), maintenance (MROS) and cleanliness (CWOS). This study was used linear model (Kong and Nakagoshi, 2007). Another analysis will be performed using an extreme value regression technique in SPSS software to reveal the effect radius of different parks. Four radiuses with range of 100m for each ring have been applied in this study, it significant to have 400 meters in compliment a standard walking distance.

## 3. Result and Discussion

Housing is a multi-attribute commodity, accessibility to work, transport and amenities, and its neighboring properties are routinely considered by housing buyers. The previous study consistently demonstrated that, a value of urban green space had a 5%-20% premium on neighboring property values. An overall questionnaire area interviewed about the profile of housing ownership including length of stayed and prices during they purchased that property. The results of the housing profile in Subang Jaya are presented in figure 3.

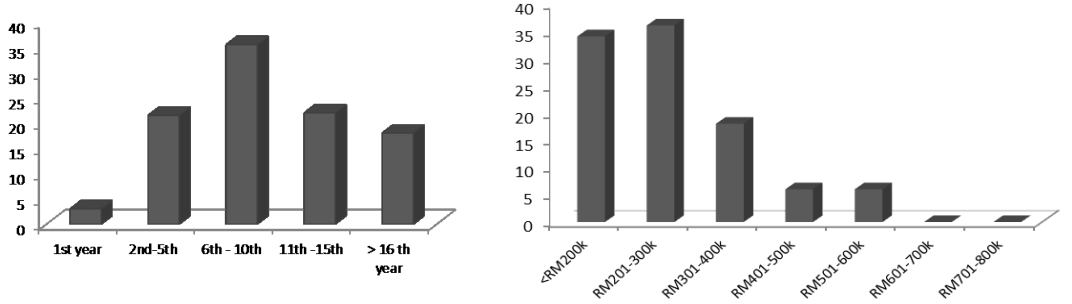


Fig 2. (a) Year of house ownership, b) Transacted price of house (when purchased)

Result show that, the average year of ownership of semi-detached house in Subang Jaya mostly stayed for 6-10$^{th}$ years (36%) and 11$^{th}$-15$^{th}$ years (22%) and its concurrent with length of this area developed. Meanwhile a transacted price of house shows that the price when they purchased in a range of RM200-300k and <RM200k. Likewise, housing prices in study area are one of the highest countrywide, more specifically they are increasing rapid after 2009.

Using relative importance index to assess the element of open space which is might influences the proximate house prices shows that most of the respondent agreed to have cleanliness (CWOS) is very important in determining a value of each green spaces. Followed with a regularity of maintenance (MROS), seizes (SAD) and locations (LST). The result show that, to have good prices, proximity is not a vital so as a facilities provided in each green spaces nearby their houses. This result a little bit different between a previous studies might be due to local culture and attitudes (Table 2).

Table 2. Elements of open space influences a house prices in the study area

| No | Elements of Open Space | Elements of Open Space | N | Mean RII | Additive RII | Simple Percent RII | Priority Rank |
|---|---|---|---|---|---|---|---|
| 1 | PWRD | The proximity is within reasonable walking distance (400 meters) | 200 | 4.0 | 0.81 | 404 | 7 |
| 2 | LST | The location is strategic | 200 | 75.7 | 15.14 | 7571.5 | 4 |
| 3 | SAD | The size is adequate | 200 | 78.8 | 15.77 | 7884.5 | 3 |
| 4 | HCAN | The hierarchy fulfils the catchment area of users | 200 | 68.4 | 13.68 | 6841.5 | 5 |
| 5 | FSSU | The facilities provided are sufficient and suitable with the users | 200 | 67.8 | 13.56 | 6781.5 | 6 |
| 6 | MROS | It has regular maintenance | 200 | 84.7 | 16.94 | 8469 | 2 |
| 7 | CWOS | Cleanliness is well kept | 200 | 86.7 | 17.34 | 8670 | 1 |

These ranking are the evidence that respondents are emphasizing the quality of life through nominating the functional quality of green spaces, which is in this study it was represented by cleanliness and regularities of maintenance. These variables are in line with the concept that people can relate to their everyday lives and within a form of practicality. Based on result from priority rank, the variables of sizes has been selected and tested using the GIS spatial analysis. Four rings with range of 100 meters and estimate that the house price will be increase between 3-12% (JPPH, 2014) are used to determine the value of green spaces. The neighborhood park with above 2 hectare was used to be nodes and result found that in each range of 100m to green space, the prices will be increased 3%.

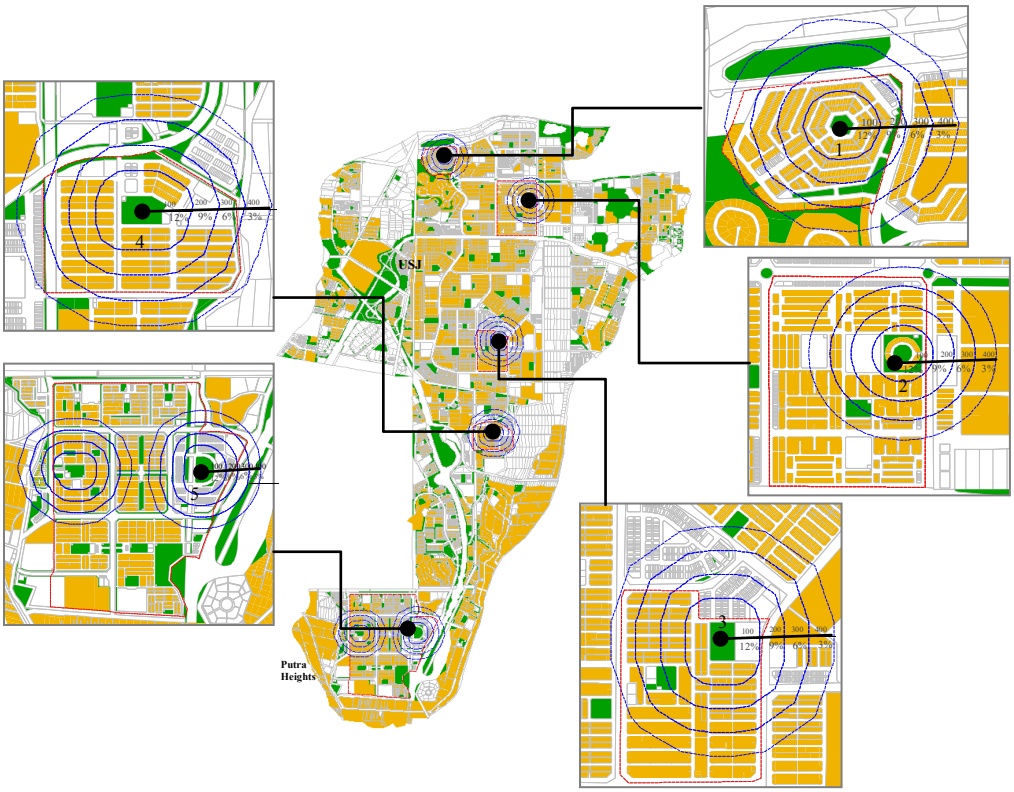


Fig.3. Spatial Distribution of green spaces values within 400 meter radius

This result shows that based on green spaces size (neighbourhood parks), the possibilities of increasing in house prices is between 3-12%. The justification of this percentage has been based on the annual increment on house price in Malaysia particularly in Selangor, which study area is located. The rapid development and infrastructure provided in this study area catalyst the prospect buyer. The economic benefits are varying from different regions. From a regional perspective, green spaces in in Subang Jaya contribute a higher total benefit of property increment.

As expected, the results proved that the GIS-HPM performed well using this approach, and accordingly it was further improved. Results also confirmed the positive amenity impact of urban green spaces on house prices, and highlighted the preferences of homeowners in Subang Jaya. Green space amenity

variables that were statistically significant at the 5% level included the housing price (P); proximity (PWRD), location (LST), size (SAD), hierarchy (HCAN), facilities (FSSU), maintenance (MROS) and cleanliness (CWOS). By the large, the study presented evidence that green spaces statistically significant and positive impact on the prices of neighboring properties and distribute of these benefits across regions. It shows that the environmental dimension, as expressed through green spaces characteristics, has a significant impact on house prices. Whereas several raw land use variables enter significantly in the models, it appears that even more interactive variables are significant. These results show the importance of considering the impact of an amenity – here, the environmental dimension – in conjunction with other dimensions. As stated before, the influence of an attribute varies through space, relating to the spatial variation of accessibility and socioeconomic profiles.

These research findings could provide useful insights and hints for both real-estate developers and the government. GIS-HPM studies could help to refine the art and science of property valuation. It adds a new dimension to the study of related issues in Malaysia, including property purchase and sale, transfer, tax assessment, investment and financing. Decision makers could apply the method to make an informed weighing of alternatives in land acquisition for residential development. The analysis could help judgment on marketability and potential profit margin. It could enlighten decision on whether to purchase a piece of expensive land situated in a densely urbanized area with limited room for green spaces, or a piece of cheaper rural land with similar green space rooms plus good external environment. The determination of sale prices of individual units could more accurately take into account people's preference and desire to have view or access to green spaces and other environmental amenities. Urban planner could be molded to improve and apply the strict policies to strengthen enforcement in providing 10% green spaces in development proposal; it should tally with supplies to meet consumer demands and to raise the value of the development.

TCPD could use the method to inform land use zoning, especially to find appropriate location for green spaces. It could provide objective data to develop a nature conservation plan and green space plan for the city to preserve natural areas of high ecological value to upgrade existing, and to provide new ones based on landscape ecology principles. The 10% of green spaces comply with planning permission nowadays are no longer adopted when the urbanization process happened. Government should think to plan a sustainable development whereby most of green area have been preserved and provided to the residence. However, a constraint in local governments was the budget to preserve green spaces in urban areas is often insufficient. Land rent is collected by local governments when developers use land for buildings, and often land price determination is inordinately affected by political and administrative factors. Local government revenue from land rent could be properly estimated especially when a piece of land is attached close to green spaces and areas of high ecological or scenic quality. The future outlook for this study could aim at expanding studies in different categories of housing with varied variables of factors that influence a house price in Malaysia. Since last five years back, the housing prices in Malaysia are rigorously increased, therefore to advocate quality of life through urban greening, the GIS-HPM could yield research finding that lend support the people in attributing an environmental value in home purchase decision.

## 4. Conclusion

Since urban green spaces have a positive impact on proximate property values, this represent a " capitalization" of park land into increased property values of proximate land owners. Urban regeneration process which happened in all cities in Malaysia was aims for better and positive results but, it is not simple to carry out this process without understanding its impact on an area more importantly to the people who live there. It comprehensive and integrated vision and action which leads the resolution of urban problems and which seeks to bring about a lasting improvement in the economic, physical, social and environmental condition of an area that has been subject to change (Robert and Sykes, 2000). The

role and value of green spaces in urban regeneration process should be established through the enforcement and implementation compliance by decision makers. In this paper we analyzed the approach of integration GIS-HPM in determining values of green spaces in housing prices.

The hedonic pricing model is a useful aid or guide to understanding the amenity value of urban green space. The modeling results could be used to inform policy decisions concerning urban green space preservation and allocation. Inserting urban green spaces in undeveloped areas before they are subject to development pressures will reduce leapfrogging development in or around the preserved scenery forest or other green spaces areas. In addition to assessing green space value, analysis regarding the amenity impact of spatial land-use patterns could also contribute to policy analysis and design, particularly in assisting in the targeting of detailed district planning. Using a GIS-supported spatially explicit approach in the hedonic model could also help in targeting specific locations for construction of urban green space.

This study also applied GIS techniques of Klang Valley green spaces to measure the impact our residential on property value. This study not only provide a better understanding of the relationship between house prices and green spaces in Klang valley, but also offer a new perspective of investment strategy on urban green spaces for the city policy makers. This study shows that the environmental dimension plays an important role in the spatial structure of residential house prices. Moreover, the significance of interactive variables shows that the consideration of combined influences is useful for a better understanding of the residential market. Although only parts of the environmental amenities are integrated, the effect of the residual on spatial autocorrelation is very significant.

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