GIS IN BANKING INDUSTRY: THE DEVELOPMENT OF SPATIAL MODEL FOR LAND VALUATION IN SURABAYA - INDONESIA

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Abstract

Currently the banks in Indonesia uses Selling Value of Tax Object (SVTO) present in Property Tax (mass valuation) valuating land collateral in association with loans they would provide to the customers. The purpose of this research is to produce a land valuation method, namely individual valuation based on environmental situation in certain land location. The data employed in this research include spatial data which uses Geographical Information System (GIS), such as searching for the nearest distance, searching for object in certain radius among others. Those data are then processed using multiple regression analysis (MRA). There are three main factors used in this study encompassing structural factor, neighbourhood factor and location factor. The research produced three models namely structural model, location model and spatial model. The results showed that structural factor contributed to land value variation at 56.5% and location factor contributed to land value at 36.7%. On other hand, the spatial model which combines structural and location model introduced to land value variation at 73%. The remaining 27% was influenced by non-spatial factors such as legality, economic situation and other factors. Test of residual had "Null Plot" form, suggesting that all asumptions for residuals which are acceptable to regression equation such as predictable linearity, constant error variance, independent errors and normal error distribution are satisfied.

Keywords: Land Valuation, Structural Model, Location model, Spatial Model & Geographical Information System (GIS)

Introduction

The current system used in Indonesia for land collateral valuation in banking is land value that is officially stamped on Property Tax. The property tax uses Land Value Zone (LVZ) for land valuation. LVZ is an area with certain border in which the land value is the same, and the area border of LVZ is of dynamic in nature, suggesting that it can change following the development of the surrounding environment. Thus, the determination of LVZ border can result in problems in the field. The problems emerge because of the unique natures of the land, i.e. immobility, indestructibility, and heterogeneity. Therefore the value of each land should be unique.

The current study tries to design a land estimation system for banking based on Hedonic model. Its long-term objective is that hopefully one day the banking world would agree on one land estimation system standard thus making economic transactions easier. Hedonic Model represents the relation between land value and its spatial attributes. The land value used here is a transaction value that shows the market value while the spatial attributes in general consist of 3 key factors. The first is structural factor that refers to physical situations such as the shape and direction of the land lot. The second is environmental factor accounting for social situation such as the number of hospitals, sport facilities, and other public facilities in certain radius. The last factor is location factor that describes economic situations such as the distance to the nearest main road and to the center of the city.

The fair value of land collateral will increase consistently, so the banks opportunity to distribute its funds and the customers' opportunity to expand their business increase as well. This can be achieved by visualizing the location of the land. Real world visualization into digital map layers which depict the spatial attribute value used to estimate the value of every land lot will improve the sense of objectivity in valuing land for both the banks and the customers.

Statement of the Problem

From the introduction above the problem raised in the research is how to design the **Spatial Model for Land Valuation** based on Hedonic Model that fits to the study area for the purpose of estimating land value as collateral in banking.

Literature Review

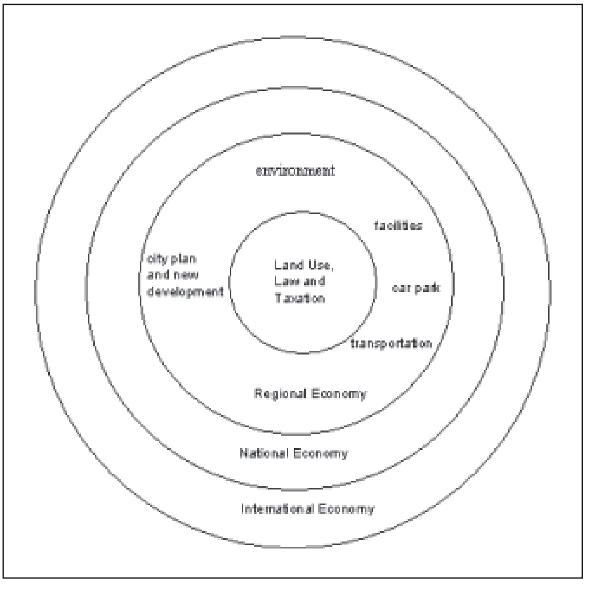
Land Value

A value refers to a quality of goods or service, which can be exchanged for other goods, while price is defined as value of commodity, or service which can be measured using a standard money unit.[1] The term "value" may be interpreted as "meaning" of the goods. In order to have a value, the goods must have certain characteristics, such as utility, scarcity and demand and can be transferred.[2] Those characteristics must co-exist simultaneously in the goods prior to value determination. In this case, there are three related terms, namely value, price and cost. The value denotes what buyer should pay or what seller should receive in trading transaction. In addition, the price stands for an agreement between the buyer and seller. Therefore, there is a condition where the value is not proportional to price. The use of terms value and price in the economy is the same. Cost is amount of money spent to secure goods or services. However, in certain situation, the value, price and cost may be the same. Therefore, in case of the goods, such as land, there are three approaches commonly used in the land valuation process[3,4] namely *sales comparison*, *cost*, and *income capitalization* approaches.

Some factors influencing land value

Land value is highly sensitive to any changes around it. Anything possibly bringing about a change in the land value is also called as a factor, which influences the value. This may result in an increase or decrease in the land interests. The international economic condition is one of the factors that are likely to affect the land value. For example, the increased loan cost worldwide in 1973 has reduced the land value. In addition, a high demand for the land will create a high price for land. This shows that the land can be rented or sold quickly.[5] Figure 1 indicates factors affecting the land value.

Figure 1: Factors influencing the land value



Source: Omar I 1992, 84

Several factors as indicated in Figure 1 are classified theoretically. But in practice, those factors should be translated properly by taking into consideration of the specific researches and locations taken. One model commonly used in the practice is Hedonic model, which explains the effects of the structural, neighbourhood and location factors on the land value. In the Hedonic model, the measurement can be carried out using *Geographical Information System*.[6] This can be done by describing the real world in the form of the map layers representing earth surface objects. For example, a river can be represented as a line, public phone as dot and sea as polygon. Next, those layers are processed to obtain necessary data using spatial analysis.

Previous Researches

In geographical perspective, factors influencing the land value can be grouped into two categories, namely spatial and non-spatial factors. Some previous researches have identified factors affecting the land value in relation to spatial factors in various areas.

The research of the effect of crime on the land tax revenue in Boston uses modified Muth Model with five indispensable assumptions. First, the employment opportunities only exist in Central Business District (CBD). Second, the travel cost is dependent on a distance. Third, numbers of travels for entire family members are known for certain period. Fourth, housing is a homogenous commodity. And fifth, people considered here are only those who have valid and legal identity. The original equation represents income variables as function of transport cost, housing price per unit and number of the goods bought. The Muth model is modified and developed further using a certain method.[7] This modified model regards housing price as a function of crime/population ratio, crime/land ratio, crime number, people's incomes and distance to CBD. Regression method is used to perform statistical analysis. The results suggest that the crime has significantly reduced land value. A reduction in crimes at 5% will increase the land tax revenue of US$ 2.5 – 12 million. However, the model has limitations relating to its assumptions used. Some new plants in many countries are established in areas/zones far from CBD. Thus, the employment opportunities do not merely exist in CBD.

An empirical research carried out to investigate effect of governmental zoning on the land value in Champaign-Urbana, Illinois[8] uses a distance to University of Illinois, lot size and selling time as independent variables. Data used for testing comprise data on land sales in Champaign and Urbana in 1977 until 1978. The results show that the land value decreases appreciably in association with the increased distance to the University of Illinois. The selected areas are zones for single-family housings. The analytical results suggest that such zoning is not appropriate where zones for use with "high" criteria have too large area, while zones for use with "low" criteria are too narrow.

Furthermore, the research of the housing land price in Jakarta[9] uses Hedonic model. The equation takes the form of logarithm namely $V_x = e^c\, e^{d1}\, e^{d2}\, e^{d3}\, e^{hx}$,
where

V_x : land price budget
C : continuous variable
d1 : dummy variable to show high infrastructure condition
d2 : dummy variable to indicate ownership type
d3 : dummy variable to show land tax
h : slope coefficient
x : distance to CBD.

Cluster and regression methods are put into use to undertake statistical analysis. The results show that a distance to CBD becomes the most prominent variable, and individually it can explain dependent variables at 62%. Other results suggest that the price of any land with low infrastructures in suburb increases quickly than that of the land present in the heart of city with high infrastructures. This may be caused by the fact that the low price of the land in suburb brings about the increased demand.

The research of the effect of inadequate facilities on land value in Washington County city[10] uses land price as a function of selling time, percentage of flood probability, land slope, land area, land quality, distance to city center, distance to suburb and distance to city border. Regression method is employed to undertake statistical analysis. The results are well fitted to the existing theory, stating that the land price will decline when its distance to the heart of city is increasingly far. However, this model also has limitations related to its assumptions where the suburb is unfriendly zone and has less employment opportunities.

The research of the integration of *Artificial Neural Network* (ANN) and GIS for valuating land in Brazil[11] is mainly intended to compare error rates in forecasting done by the GIS and ANN integration and regression method. Variable used here is the land value as a function of the lot and infrastructures dimensions. The lot dimension consists of area, width, distance to CBD, area and distance interaction, width and distance interaction. Infrastructures comprise position, fence, sidewalk, water supply system, electrical pole, water and land slope. The results show that the error rate of the forecasting conducted using GIS and ANN integration is smaller compared to regression method. The lot dimension has significant effect on land value through an interaction between the area and distance to CBD and between area and width. However, the efforts to build infrastructures have no strong impact on the land value. This is understandable since such service already exists in throughout city areas. One of the strengths of this research is the integration of two variables as one new variable.

The research on the spatial characteristics of the land in Jakarta[12] tries to describe very striking difference in land values, ranging from IDR 48 thousand to IDR 10 million for each square meter in the spatial characteristics map. The difference between the lowest and highest values is 208 times. In addition, the model of the relationship between land value and infrastructures consisting of distance to city center, distance to botanical garden, distance to commercial areas, land zone and flood risk is also developed. The model is established using *stepwise multivariate regression analysis* technique. There are six models developed through division of zones and values. The zones are divided into two parts, namely central and non-central zones. Furthermore, the values are also divided into three parts, namely high, moderate and low. In the research there are three dummy variables, including distance to commercial area (1 for 1 km radius and 0 for radius more than 1 km), zone (1 for commercial zone and 0 for housing zone) and flood risk (0 = low risk and 1 = high risk). It appears that the use of the dummy variables, such as distance to commercial zone and flood risk will cause a difficulty in performing analysis since an exact value between 0 and 1 cannot be described properly. The research's finding indicates that of the six variables arranged, the distance to city center becomes the most prominent factor in elucidating a difference in land value, namely within the range of 30-45%. However, the distance's role diminish significantly compared to the same role in the other research carried out at 62%.

Objective

From the above problem and review of recent Hedonic models, the objective of this study is to design **Spatial Model for Land Valuation** consisting of the structural, environmental, and location factors. Geographic Information System (GIS) will be used for collecting data about the factors because it is the only way to access the data.

The Research Model
This model will be represented by structural, neighbourhood and location factors. Structural factor represents physical value, while neighbourhood factor refers to infrastructure value and location factor is the distance from economic facilities. Spatial model will be developed based on Hedonic Model. This is a general model for property valuation.[13] The general model can be represented as,

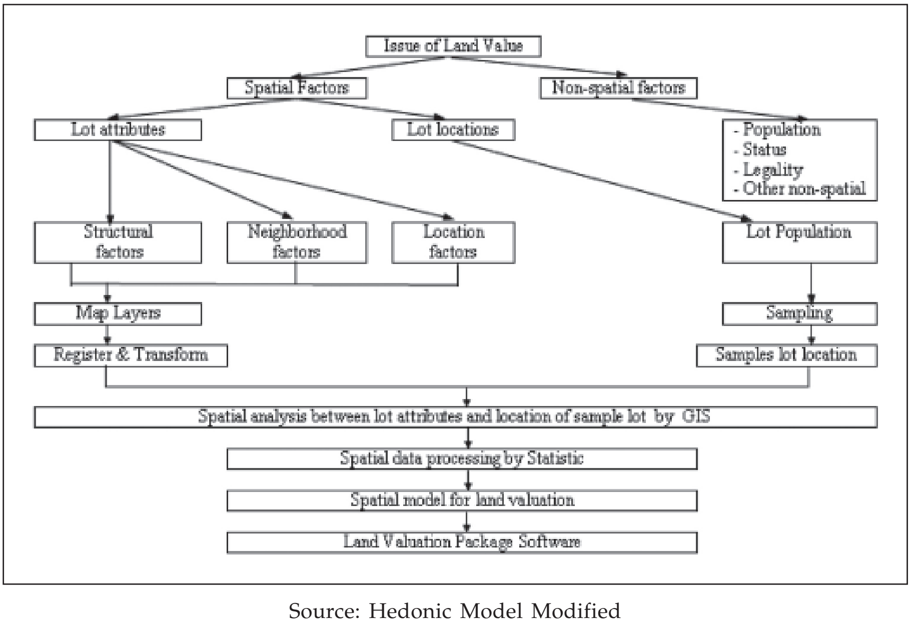
$$P = f(S,N,L)$$

where,

P = Land Value
S = Structure Factors
N = Neighbourhood Factors
L = Location Factors

Based on the general model, the conceptual framework will be used to develop the spatial model as showed in Figure 2.

Figure 2: Conceptual Framework



Source: Hedonic Model Modified

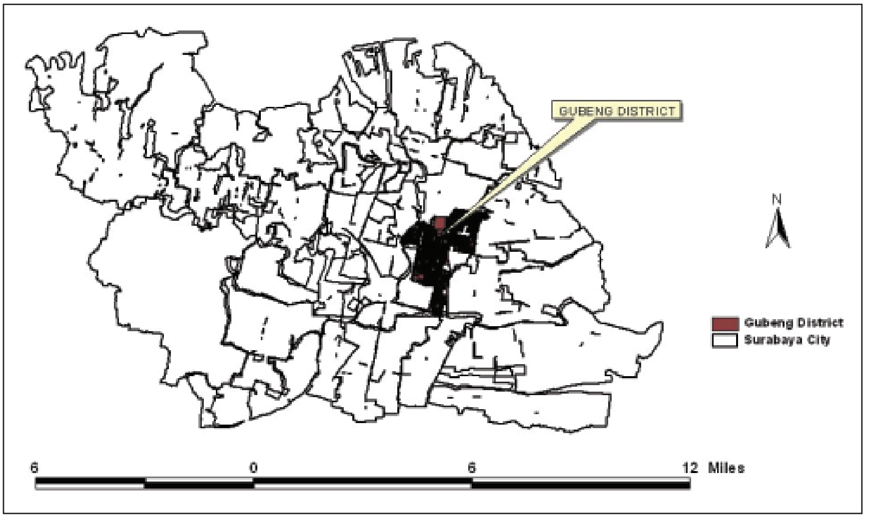
The selection of spatial factor
In relation to the conceptual framework, the spatial factors are divided into three classes. They are structure, neighbourhood and location. The selection of variables depend on the area. The importance of the variables for each area is different. The variables are developed based on the previous studies consistent with study area. The structural factors consist of 4 variables. They are direction lot[14] front width, area and shape index. The neighbourhood factors consist of 7 variables. The first

is number of Primary schools in 400 meter radius; second, number of secondary schools in 1 km radius; third, number of prayer houses in 1 km radius; fourth, flood class; fifth, the road class; sixth, nearest distance to primary and seventh, nearest distance to secondary schools. The location factors consist of 5 variables. They are distance to Central Business District;[15] distance to market, distance to primary road, distance to electricity pole and distance to pipeline.

Study Area

The setting of the study is at Gubeng district in Surabaya city. The position of Gubeng district in Surabaya City is shown in Figure 3.

Figure 3: Gubeng district position in Surabaya city



Source: Department of Surabaya City Planning

The lot number in every sub-district in Gubeng area is shown in Table 1 as follows.

Table 1: Lot number of each sub-district in Gubeng district

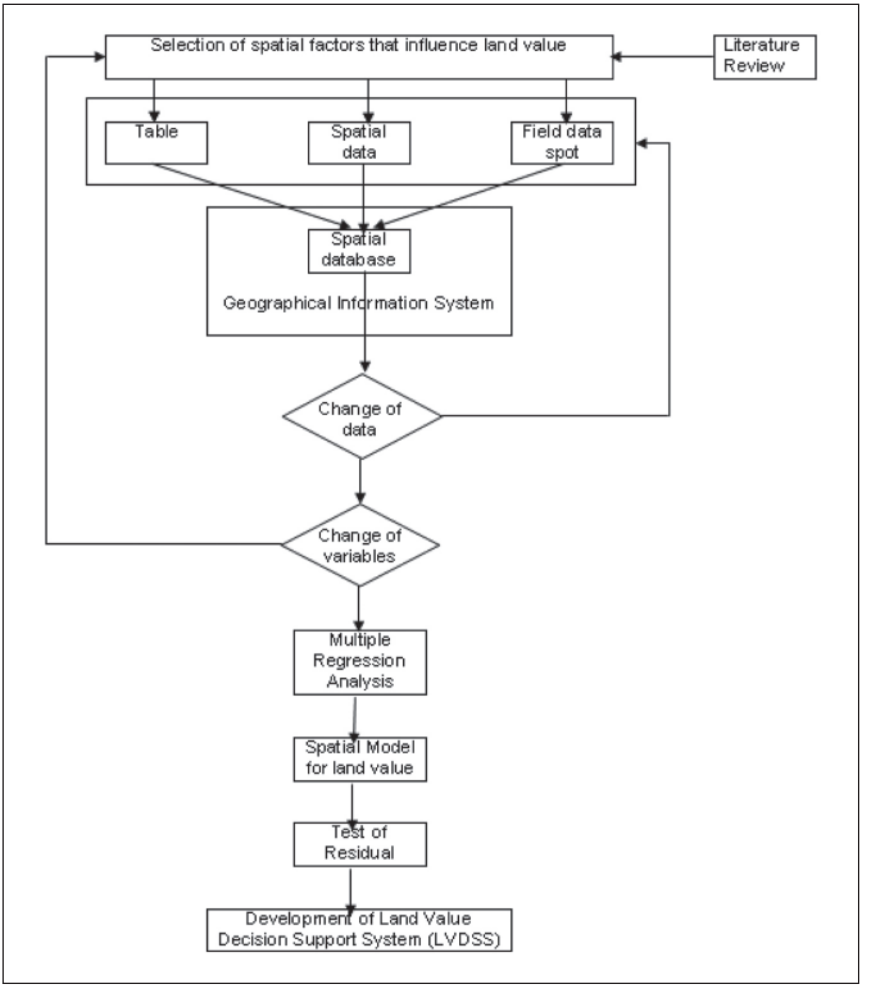
No	Sub-district	Number of lot
1	Baratajaya	4,018
2	Pucangsewu	3,034
3	Kertajaya	4,127
4	Gubeng	2,008
5	Airlangga	3,856
6	Mojo	7,969
	Total lots	25,012

Source: Department of Surabaya City Planning

Research Methodology

The flow chart of research methodology is showed in the Figure 4 below.

Figure 4: The flow chart of research methodology



Source: Field Study

The research methodology involves four essential steps; first, the selection of factors that influence land value, second, the development of spatial database, third, the development of spatial model and fourth, the development of application system.

Step 1: The selection of factors influencing land value

Regarding the conceptual framework, the spatial factors are divided into three classes. They are structure, neighbourhood and location. The selection of variables depend on the area. The importance of the variables for each area varies considerably. The variable is developed based on the previous research consistent with study area. The structural factors consist of four variables. They are lot direction,[13] front width, area,[11] and shape index. The neighbourhood factors consist of seven variables. First, number of elementary schools in 400 meter radius; second, number of secondary schools in 800 meter radius; third, number of worship houses houses in 1 km radius; fourth, flooded class;[10] fifth, the road class;[13] sixth, nearest distance to elementary schools and seventh, nearest distance to secondary schools. The location factors consist of five variables, including nearest distance to Central Business District,[15] nearest distance to market, nearest distance to primary road, nearest distance to electric pole and nearest distance to pipeline.

Step 2: The development of spatial database

The spatial data are represented in map and attribute. There are 11-map layers related to the selected variables. The map layers are,

1. Lot layer.
2. Flooded area layer.
3. Elementary school layer.
4. Secondary school layer.
5. Worship houses layer.
6. Road layer.
7. CBD layer.
8. Public market layer.
9. Electric pole layer.
10. Pipeline layer.
11. Primary road layer.

The source of data on lots is derived from the Directorate General of Taxation. They use MapInfo software to build the lot data. The projection is WGS 84. Furthermore, all of the layers would be converted to WGS 84 projection.

Other layers are converted to WGS 84 projection as shown in Table 2.

Table 2: Source of data

No	Data	Source
1	Flooded area	Bapeko Surabaya
2	Primary & Secondary School	Dikbud Surabaya
3	Worship houses	Depag Surabaya
4	Arterial & primary road	D.P.U Surabaya
5	C.B.D	Dinas Tata Ruang Surabaya
6	Public Market	Dinas Pasar Surabaya
7	Electric Pole	PLN Surabaya
8	Pipe line	PDAM Surabaya

Source: Field Study

Step 3: The development of models

The development of model is performed using Multiple Regression Analysis (MRA). This analytical technique is employed here because the dependent variable which is the land value takes the form of quantitative data (metrics), while the independent variables take the form of quantitative data and qualitative data or non-metrics.[16]

There are 3 models in the research namely:

1. Structural Model
2. Location Model
3. Spatial Model

Structural model represents Land value as function of the structural factor. It consists of 5 variables of the Land Value (LV), Area (S1), Front width (S2), Lot Direction (S3) and Shape Index (S4). The model is:

$$LV = a_0 + a_1 S_1 + a_2 S_2 + a_3 S_3 + a_4 S_4$$

Location model is Land value as function of neighbourhood and location factors. Neighbourhood and location factors have the same treatment called characteristics of the location. It comprise of 13 variables, encompassing Land Value (LV), Nearest distance to primary schools (N_1), Nearest distance to secondary schools (N_2), Number of primary schools in radius 400 meter (N_3), Number of secondary schools in 1 km radius (N_4), Number of worship houses in 1 km radius (N_5), Flooded class (N_6), Road class (N_5), Nearest distance to CBD (L_1), Nearest distance to public market (L_2), Nearest distance to main road (L_3), Nearest distance to electric pole (L_4), Nearest distance to pipeline(L_5). The model is:

$$\begin{aligned} LV = {} & a_0 + a_1 N_1 + a_2 N_2 + a_3 N_3 + a_4 N_4 + a_5 N_5 + a_6 N_6 + a_7 N_7 + \\ & a_8 L_1 + a_9 L_2 + a_{10} L_3 + a_{11} L_4 + a_{12} L_5 \end{aligned}$$

Spatial model is Land Value as function of the structural, neighbourhood and location factors. It comprise of 17 variables accounting for a combination of the structural and location models. The model is:

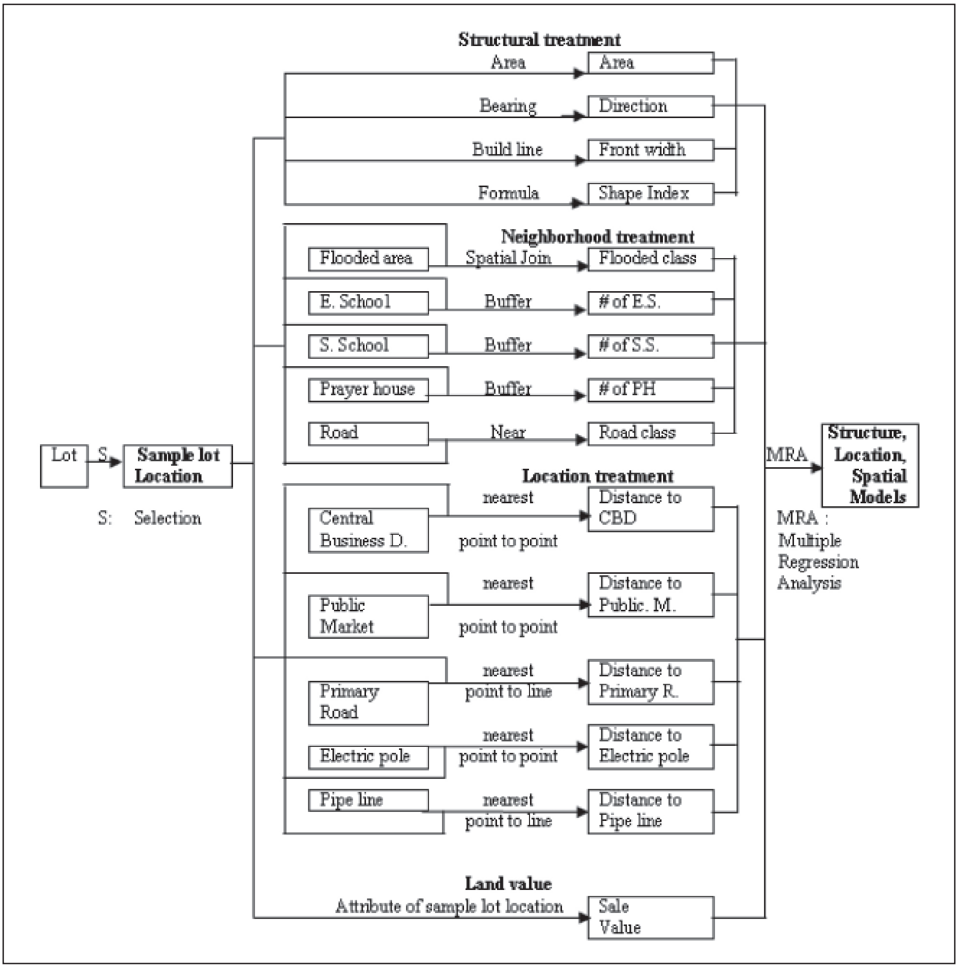
$$\begin{aligned} LV = {} & a_0 + a_1 S_1 + a_2 S_2 + a_3 S_3 + a_4 S_4 + a_5 N_1 + a_6 N_2 + a_7 N_3 + a_8 N_4 + a_9 N_5 + \\ & a_{10} N_6 + a_{11} N_7 + a_{12} L_1 + a_{13} L_2 + a_{14} L_3 + a_{15} L_4 + a_{16} L_5 \end{aligned}$$

Contribution of the structural and location models to the land value will be measured partially, while contribution of the spatial model, represents a combination of the structural and location models, to the land value, will be evaluated simultaneously.

Integration of GIS and Statistical Analyses

To produce spatial model, the spatial data are measured using geographical information technology. The data are then processed by statistical analysis to generate the model. This process is an integration of spatial analysis by GIS and statistical analysis by Multiple Regression Analysis as shown in Figure 5.

Figure 5: Integrated Spatial Analysis by GIS and Statistic Analysis by MRA



Source: Field Study

Several spatial analyses used here include measurements of area, bearing, buffering, distance point to point, distance point to line and etc. Statistical analysis is conducted by Multiple Regression Analysis (MRA).

Results

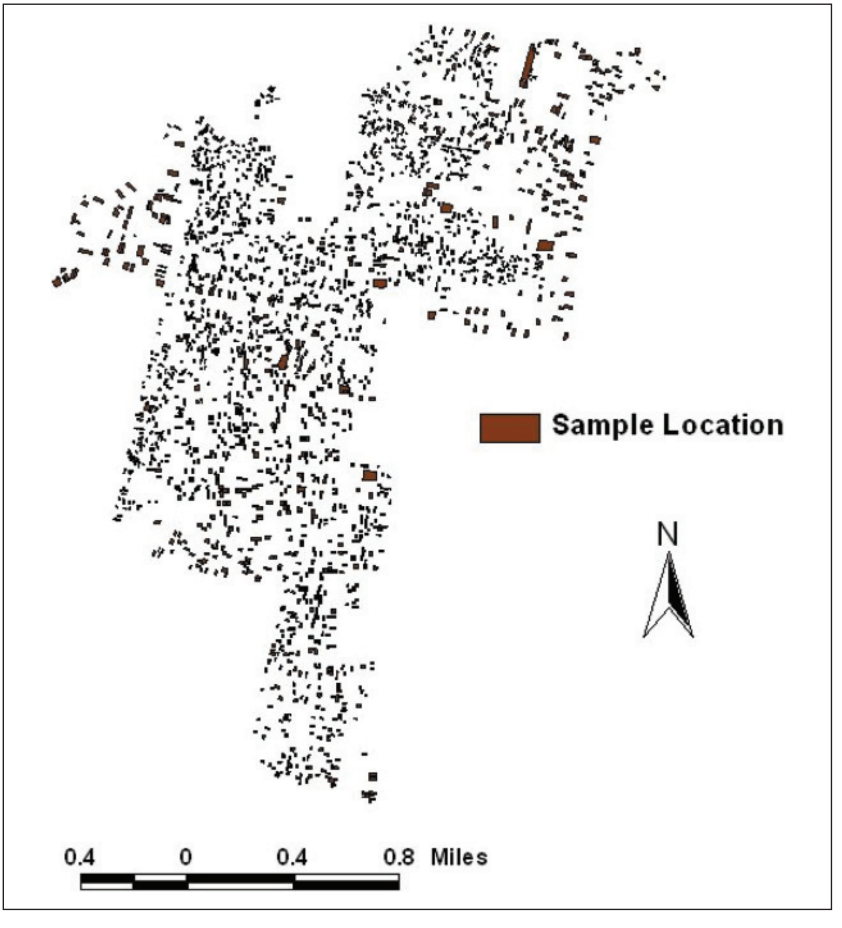
Population in the study area (Gubeng district) includes 25,012 land lots. Gubeng district is composed of six sub-district, including Baratajaya, Pucangsewu, Kertajaya, Gubeng, Airlangga and Mojo. The size of the sample employed to establish model was about 2,549 lots (10.19%) displayed in Table 3.

Table 3: Number of the sample lots making up the spatial model

No.	Sub-district	Population	Sample	(%)
1	Baratajaya	4,018	383	9.53
2	Pucangsewu	3,034	328	10.85
3	Kertajaya	4,127	442	10.71
4	Gubeng	2,008	239	11.90
5	Airlangga	3,856	396	10.27
6	Mojo	7,969	761	9.55
	Total	25,012	2549	Samples average: 10.19

Location of the sample is indicated in Figure 6.

Figure 6 : Location of 2549 samples lots



Source: Department of Surabaya City Planning

Structural Model

Structural model stands for land value as a function of Area (S1), Direction (S2), Front Width (S3) and Shape Index (S4). Results of the measurement for each variable are displayed in Table 4.

Table 4: Data summary for structural factor

	N	Minimum	Maximum	Mean	Std. Deviation
Land Value (Y)	2549	1536.00	1858380.80	39924.906	96004.5930
Area (S_1)	2549	30	6900	191.76	277.79
Direction (S_2)	2549	0	1		
Front Width (S_3)	2549	3.4772	81.1662	10.978806	5.745748
Shape Index (S_4)	2549	.2071	.9997	.699526	.149626
Valid N (listwise)	2549				

Subsequently those data were processed using statistical method of Multiple Regression Analysis (MRA). Results of the regression analysis are indicated in Table 5.

Table 5: Regression Analysis for Structural Model

Variables	Unstandardized Coefficients (B)	Standardized Coefficients (beta)	Sig.
Constant	65896.769		0.000 *
Area (S_1)	248.901	0.720	0.000 *
Direction (S_2)	4400.627	0.019	0.154
Front Width (S_3)	-33.307	-0.002	0.879
Shape Index (S_4)	-105358.0	-0.164	0.000 *
Adjusted R square	0.565		

* : Significance at level α = 0.05

As can be seen in Table 5, the variables producing significant and constant effect on land value (at level α = 0.05) are Area (S1) and Shape Index (S2). Thus, the resulting structural model is shown in equation 1.

$$Y = 65896.769 + 248.901\ S_1 - 105358.0\ S_4 \quad \text{.................. (Equation 1)}$$

Location Model

Location model represents land value as function of the Nearest distance to primary schools (N_1), Nearest distance to secondary schools (N_2), Number of primary schools in radius 400 meter (N_3), Number of secondary schools in 1 km radius (N_4), Number of worship houses houses in 1 km radius (N_5), Flood class (N_6), Road class (N_5), Nearest distance to CBD (L_1), Nearest distance to public market (L_2), Nearest distance to main road (L_3), Nearest distance to electric pole (L_4) and Nearest distance to pipeline (L_5). The results of the measurement for every variable can be seen in Table 6.

Table 6: Data summary for location factor

	N	Minimum	Maximum	Mean	Std. Dev.
Land Value (Y)	2549	1536.00	1858380.80	39924.905	96004.593
Nearest distance to primary schools (N_1)	2549	9.48	617.70	198.4153	113.5959
Nearest distance to secondary schools (N_2)	2549	8.63	897.10	297.2264	156.1775
Number of primary schools in radius 400 meter (N_3)	2549	0	14	4.76	3.53
Number of secondary schools in 1 km radius (N_4)	2549	4	21	13.76	4.40
Number of worship houses in 1 km radius(N_5)	2549	68	178	147.57	23.03
Flood class (N_6)	2549	1	19		
Road class (N_7)	2549	1	5		
Nearest distance to CBD (L_1)	2549	153.8100	2372.0900	1210.61799	419.099370
Nearest distance to public market (L_2)	2549	26.7200	1985.8000	771.105861	486.389980
Nearest distance to main road (L_3)	2549	15.0540	591.9200	206.100429	128.605029
Nearest distance to electric pole (L_4)	2549	10.0231	438.8610	64.530303	62.023625
Nearest distance to pipeline (L_5)	2549	7.0500	84.2930	14.641211	11.012395
Valid N (listwise)	2549				

Those data were then processed using statistical method of Multiple Regression analysis. The results of the regression analysis can be seen in Table 7.

As can be seen in Table 7, the variables generating significant and constant influence on land value ($\alpha = 0.05$) include Nearest distance to primary schools (N_1), Number of secondary schools in 1 km radius (N_4), Flood class (N_6), Road class (N_7), Nearest distance to CBD (L_1), Nearest distance to main road (L_3) and Nearest distance to pipeline (L_5). The resulting location model is shown in equation 2.

$$Y = 120130.2 + 35.883\, N_1 - 1812.247\, N_4 - 650.355\, N_5 - 2097.018\, N_6 + 97365.856\, N_7 - 26.347\, L_1 - 48.235\, L_3 - 349.070\, L_5 \quad \text{(Equation 2)}$$

Spatial Model

Spatial model corresponds to land value as function of the Area (S1), Direction (S2), Front Width (S3), Shape Index (S4), Nearest distance to primary schools (N_1), Nearest distance to secondary schools (N_2), Number of primary schools in radius 400 meter

Table 7: Regression Analysis for Location Model

Variables	Unstandardized Coefficients (B)	Standardized Coefficients (Beta)	Sig.
Constant	120130.2		0.000 *
Nearest distance to primary schools (N_1)	35.883	0.042	0.013 *
Nearest distance to secondary schools (N_2)	6.734	0.011	0.578
Number of primary schools in radius 400 meter (N_3)	811.080	0.030	0.204
Number of secondary schools in 1 km radius (N_4)	-1812.247	-0.083	0.000 *
Number of worship houses in 1 km radius(N_5)	-650.355	-0.156	0.000 *
Flood class (N_6)	-2097.018	-0.126	0.000 *
Road class (N_7)	97365.856	0.467	0.000 *
Nearest distance to CBD (L_1)	-26.347	-0.115	0.000 *
Nearest distance to public market (L_2)	-9.351	-0.047	0.146
Nearest distance to main road (L_3)	-48.235	-0.065	0.000 *
Nearest distance to electric pole (L_4)	61.518	0.039	0.058
Nearest distance to pipeline (L_5)	-349.070	-0.040	0.013 *
Adjusted R square	0.367		

* : Significance at level $\alpha = 0.05$

(N_3), Number of secondary schools in 1 km radius (N_4), Number of worship houses in 1 km radius (N_5), Flood class (N_6), Road class (N_5), Nearest distance to CBD (L_1), Nearest distance to public market (L_2), Nearest distance to main road (L_3), Nearest distance to electric pole (L_4), and Nearest distance to pipeline(L_5). Result of the measurement for each variable is shown in Table 8.

Those data were then processed using statistical method of Multiple Regression analysis, and the result of regression analysis is incorporated in Table 9.

As can be observed in Table 9, the variables bringing about significant and constant influence on land value (at level $\alpha = 0.05$) include Area (S1), Number of secondary schools in 1 km radius (N_4), Number of worship houses houses in 1 km radius(N_5), Flood class (N_6), Road class (N_7), Nearest distance to CBD (L_1), Nearest distance to public market (L_2), Nearest distance to main road (L_3) and Nearest distance to pipeline (L_5), and the resulting spatial model is shown in equation 3.

$$Y = 82909.355 + 215.679\ S_1 - 1497.522\ N_4 - 551.683\ N_5 - 1138.726\ N_6 + 75068.046\ N_7 - 26.011\ L_1 - 23.261\ L_2 - 20.728\ L_3 - 409.706\ L_5 \quad \text{..... (Equation 3)}$$

Table 8: Data summary for spatial factor

	N	Minimum	Maximum	Mean	Std. Dev.
Land Value (Y)	2549	1536.00	1858380.8	39924.905	96004.593
Area (S_1)	2549	30	6900	191.76	277.79
Direction (S_2)	2549	0	1		
Front Width (S_3)	2549	3.4772	81.1662	10.978806	5.745748
Shape Index (S_4)	2549	.2071	.9997	.699526	.149626
Nearest distance to primary schools (L_1)	2549	9.48	617.70	198.4153	113.5959
Nearest distance to secondary schools (L_2)	2549	8.63	897.10	297.2264	156.1775
Number of primary schools in radius 400 meter (L_3)	2549	0	14	4.76	3.53
Number of secondary schools in 1 km radius (L_4)	2549	4	21	13.76	4.40
Number of worship houses in 1 km radius(L_5)	2549	68	178	147.57	23.03
Flood class (L_6)	2549	0	19		
Road class (L_7)	2549	1	5		
Nearest distance to CBD (L_1)	2549	153.8100	2372.0900	1210.617995	419.099370
Nearest distance to public market (L_2)	2549	26.7200	1985.8000	771.105861	486.389980
Nearest distance to main road (L_3)	2549	15.0540	591.9200	206.100429	128.605029
Nearest distance to electric pole (L_4)	2549	10.0231	438.8610	64.530303	62.023625
Nearest distance to pipeline (L_5)	2549	7.0500	84.2930	14.641211	11.012395
Valid N (listwise)	2549				

Structural model contributed to land value variation at 56.5% and location model contributed to land value at 36.7% when they are considered separately. However, once they are combined, their contributions to the land value changed to 73%. Increased contribution of the spatial model to land value from structural model is 16.5%, or 36.3% from location model.

In mathematical terms, the contribution of spatial model is 93.2% which is the summation of structural model's contribution at 56.5% and location model's contribution at 36.7%. However, the increased contribution from spatial model is in

Table 9: Regression Analysis for Structural Model

Variables	Unstandardized Coefficients (B)	Standardized Coefficients (beta)	Sig.
Constant	82909.355		0.000 *
Area (S_1)	215.679	0.624	0.000 *
Direction (S_2)	-1122.411	-0.005	0.649
Front Width (S_3)	-21.837	-0.001	0.902
Shape Index (S_4)	4458.241	0.007	0.542
Nearest distance to primary schools (N_1)	20.776	0.025	0.078
Nearest distance to secondary schools (N_2)	-3.457	-0.006	0.669
Number of primary schools in radius 400 meter (N_3)	661.201	0.024	0.114
Number of secondary schools in 1 km radius (N_4)	-1497.522	-0.069	0.000 *
Number of worship houses in 1 km radius(N_5)	-551.683	-0.132	0.000 *
Flood class (N_6)	-1138.726	-0.068	0.000 *
Road class (N_7)	75068.046	0.360	0.000 *
Nearest distance to CBD (L_1)	-26.011	-0.114	0.000 *
Nearest distance to public market (L_2)	-23.261	-0.118	0.000 *
Nearest distance to main road (L_3)	-20.728	-0.028	0.014 *
Nearest distance to electric pole (L_4)	-0.286	0.000	0.989
Nearest distance to pipeline (L_5)	-409.706	-0.047	0.000 *
Adjusted R square	0.730		

* : Significance at level $\alpha = 0.05$

statistical sense in which its processing might contain *probability* and *error*. This suggests that spatial model is superior compare to structural model or location model.

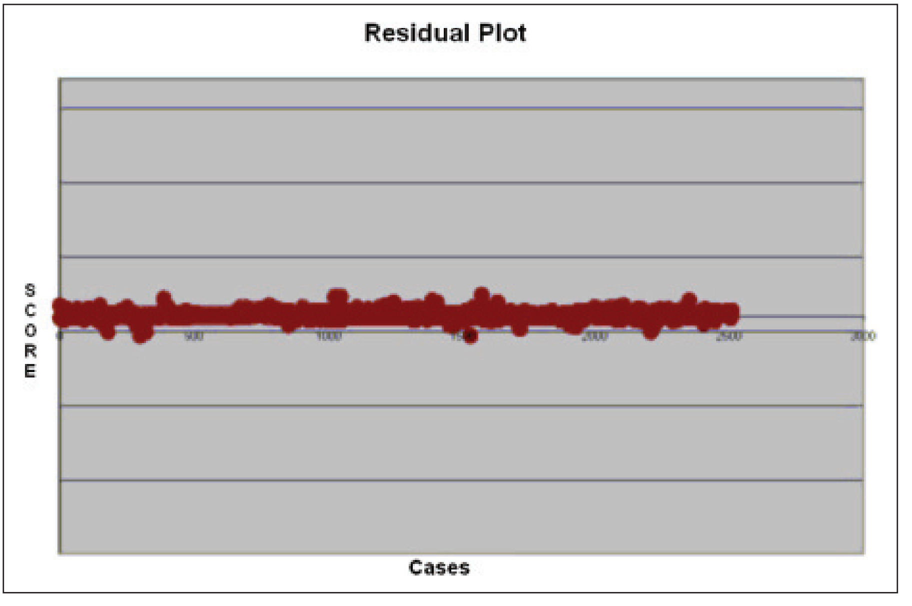
Non-spatial factors such as legality, economic situation and the like contribute to land value at 27% while the remaining 73% was contributed by spatial factor.

Test of Residual

Residual analysis enables us to see residual error by describing a difference between residual value and true value and demonstrating residual errors in the form of axis and ordinate in which principally the residual errors were analysed graphically.

There are 2549 errors necessary for forming the spatial model. Axis of the map was number of errors and ordinate of the map was residual errors. This is represented in Figure 7.

Figure 7: Residual plot of the spatial model



As can be seen in Figure 7, we can say that residual errors had "Null Plot" form. The null plot occurs when all assumptions are fulfilled.[16] Assumptions in residual errors are predictable linearity, constant error variance; independent errors and normal error distribution.

Automation of Spatial Model

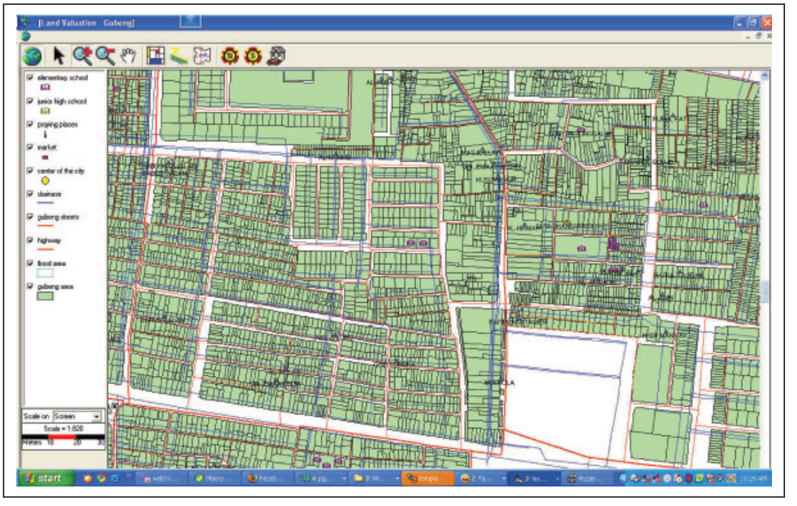
Automation of Spatial Model is developed using Visual Basic, Map Object and Arc View software. Arc View is put into use to build map layers required by system while Visual Basic and Map Object are used for model automation with user friendly design.

Automation of Spatial Model is carried out with 4 steps as follows:

1. Building necessary map layers
2. Entering equation parameters into setting menu
3. Searching for lot location based on address
4. Calculating land value based on parameter and variable value

The first step in model automation is building 10 map layers, including lot layer, flooded area layer, elementary school layer, secondary school layer, worship houses layer, road layer, CBD layer, public market layer, electric pole layer, pipeline layer and primary road layer as shown in Figure 8.

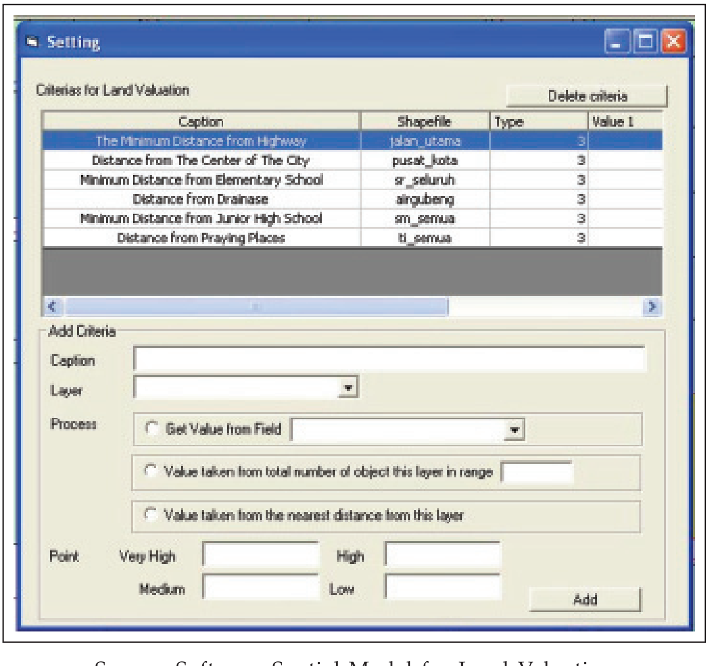
Figure 8: Map layers in Gubeng district



Source: Software Spatial Model for Land Valuation

The second step in model automation is entering regression equation parameter values using icon **"Ti"** as can be seen in Figure 9.

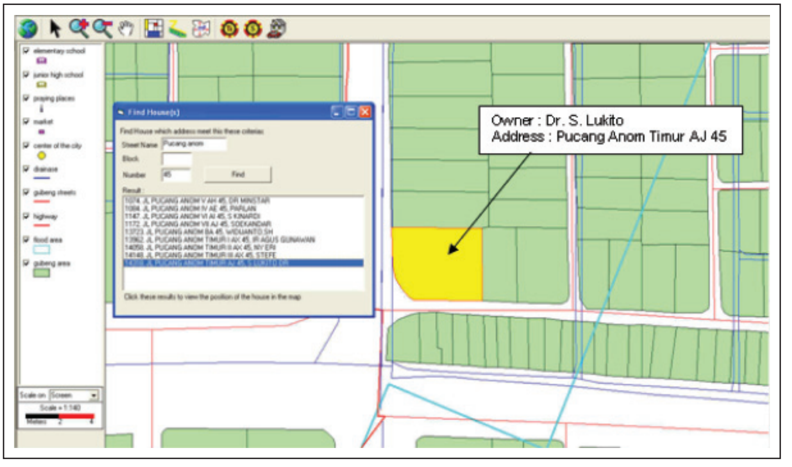
Figure 9: Setting for entering regression parameter values



Source: Software Spatial Model for Land Valuation

The third step in model automation is searching for lot location based on address with icon **"Home"** as shown in Figure 10.

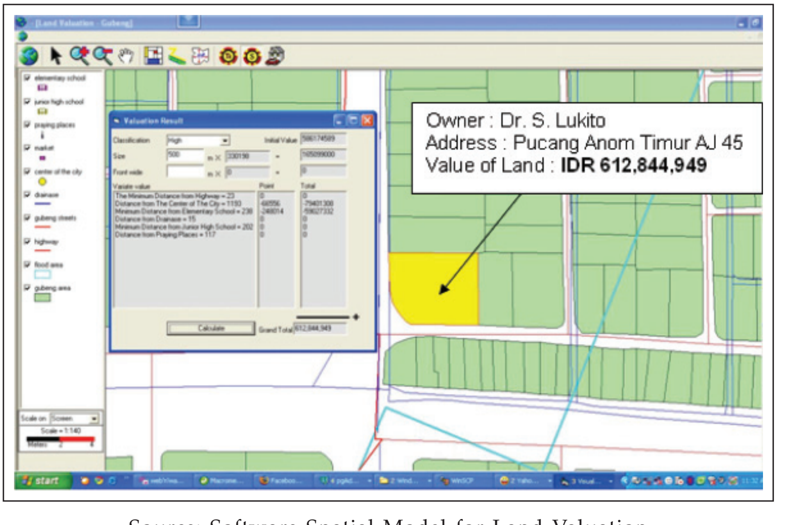
Figure 10: Searching for lot location based on address



Source: Software Spatial Model for Land Valuation

And in fourth step, the model automation was carried out by calculating variable values of regression equation with measurement of GIS, such as distance to CBD, distance to public market, distance to worship houses houses using icon **"$"**. After all variables values have appeared, we proceed with icon **"Calculate"** as shown in Figure 11.

Figure 11: Land value generated by Automation of Spatial Model



Source: Software Spatial Model for Land Valuation

As suggested in Example, we can see that land value of Dr. S. Lukito residing in Pucang Anom Timur AJ 45 amounts to IDR 612,844,949. The land value resulting from Automation of Spatial Model calculation can be used as supporting information for valuating land collateral by which the bank can determine amount of loans for certain customers in association with their land collateral.

Contribution and Limitation of the research

Spatial Model for Land Valuation is done based on individual valuation for each lot. This is a new perspective for land valuation in Indonesia because the current system is based on mass valuation for certain area, it is about 15 ha. In mass valuation, each lot in those areas possesses the same value.

A significant contribution of this research is creating individual valuation system. This individual valuation system is greatly consistent with unique nature of the land.[17] Therefore the value of each land should be unique.

However as many other studies, this study also has its limitations. The main limitation lies in the fact that the model is generated based on selling value of land in certain time. The selling value of each land will change in relation to each development that takes place in our environment. When the selling value has changed, the model would change too. Therefore, further studies are required to develop new model, which is always consistent with the environmental development.

Endnotes

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