Automatic land and parcel valuation to support the land and buildings tax information system by developing the open source software

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Key words : Land Value, Spatial Analysis, Regression Method , Artificial Neural Network Method

Summary

The land valuation is to provide a credible, reliable, and cost-effective estimate of market value as of given point in time. Land valuation is one of most important activity for Service point of land & buildings taxation in Indonesia. Where the location became the strongest factor to land value. Geographical Information Systems Technology with spatial analysis capability can measure distance between some location of land to the certain references. The GIS information can be increasingly more valuable for decision making.
The Artificial Neural Network (ANN) has an excellence tool in finalizing problems to the land value data which have a characteristic of non linear and will represent the truth in valuation, and also to solve the unknown algorithm problems.
Based on multikolinear analysis test showed that there is strongly relationship between land value and their independent variables. Result of calculation land value with Artificial Neural Network method shows existence of improvement of accuration than regression.

Ringkasan

Penilaian tanah adalah salah satu kegiatan yang paling utama di Kantor Pelayanan Pajak Bumi dan Bangunan (PBB). Metode penilaian yang tepat untuk menghasilkan nilai tanah yang akurat dapat meningkatkan objektifitas data dan selanjutnya dapat mengoptimalkan penerimaan PBB serta dapat menekan jumlah pengajuan keberatan oleh wajib pajak. Metode penilaian tanah yang telah banyak digunakan adalah analisis statistik regresi berganda. Dalam penelitian ini dilakukan pengembangan metode penilaian tanah menggunakan analisis spasial dan jaringan syaraf tiruan. Karakteristik jaringan syaraf tiruan yang bersifat tidak linear dan struktur informasi terdistribusi diharapkan dapat memperbaiki metode regresi yang bersifat linear dan memperhitungkan multikolinearitas data. Hal ini mengingat karakteristik nilai tanah terhadap variabel-variabelnya yang memiliki kecenderungan tidak linear dan terdapat multikolinearitas. Berdasarkan analisa uji multikolinear diketahui bahwa terdapat hubungan yang erat antar variabel bebas. Hasil perhitungan nilai tanah dengan metode jaringan syaraf tiruan (JST) menunjukkan adanya peningkatan akurasi daripada metode regresi. Kesalahan standar deviasi nilai tanah menurun dari 346.493,00 menjadi Rp 149.320,00, sedangkan koefisien korelasi (R^2) meningkat dari 83.88% menjadi 92%. Nilai *Price-Related Differential* (PRD) metode JST sebesar 0,996 berarti nilai tersebut berada di dalam batas toleransi (0,98 sampai dengan 1,03) sehingga dapat disimpulkan bahwa prediksi nilai tanah model mendekati nilai tanah sebenarnya. Nilai *Coefficient of Dispersion* (COD) metode JST diperoleh angka sebesar 12.8 % dan berada dalam batas toleransi COD, yaitu 15%. Hal ini menunjukkan bahwa tingkat seragram nilai tanah model sama.

1. Introduction

The purpose of land valuation is to provide a credible, reliable, and cost-effective estimate of market value as of given point in time. One of most widely used method for land valuation models is Multiple Regression Analysis (MRA). MRA Weakness is consider multicollinearity problem, can be influenced by outlier, and calculates linear correlation of variable. These weakness can cause level of accuration of regression to become decreasing.

Land valuation is one of most important activity for Kantor Pelayanan Pajak Bumi and Bangunan (PBB). This activity influences success of other activitys, like decision-making of potential PBB, acceptance PBB and service to taxpayer. High Accuration Valuation causes existence of amenity in doing prediction of acceptance of PBB and lessens proffering is objecting by taxpayer.

Location is "strongest" factor to land value (Hidayati, 2003). Location variable can be interpreted as relative situation a land area to certain reference and it can be defined as distance between a land area to the reference. Geographical Information Systems Technology with spatial analysis can measure land area to reference.

GIS information can become increasingly more valuable for decision making when couple to artificial intelligence. GIS and artificial intelligence can be useful for evaluating, monitoring and decision making. One of method in artificial intelligence is artificial neural network.

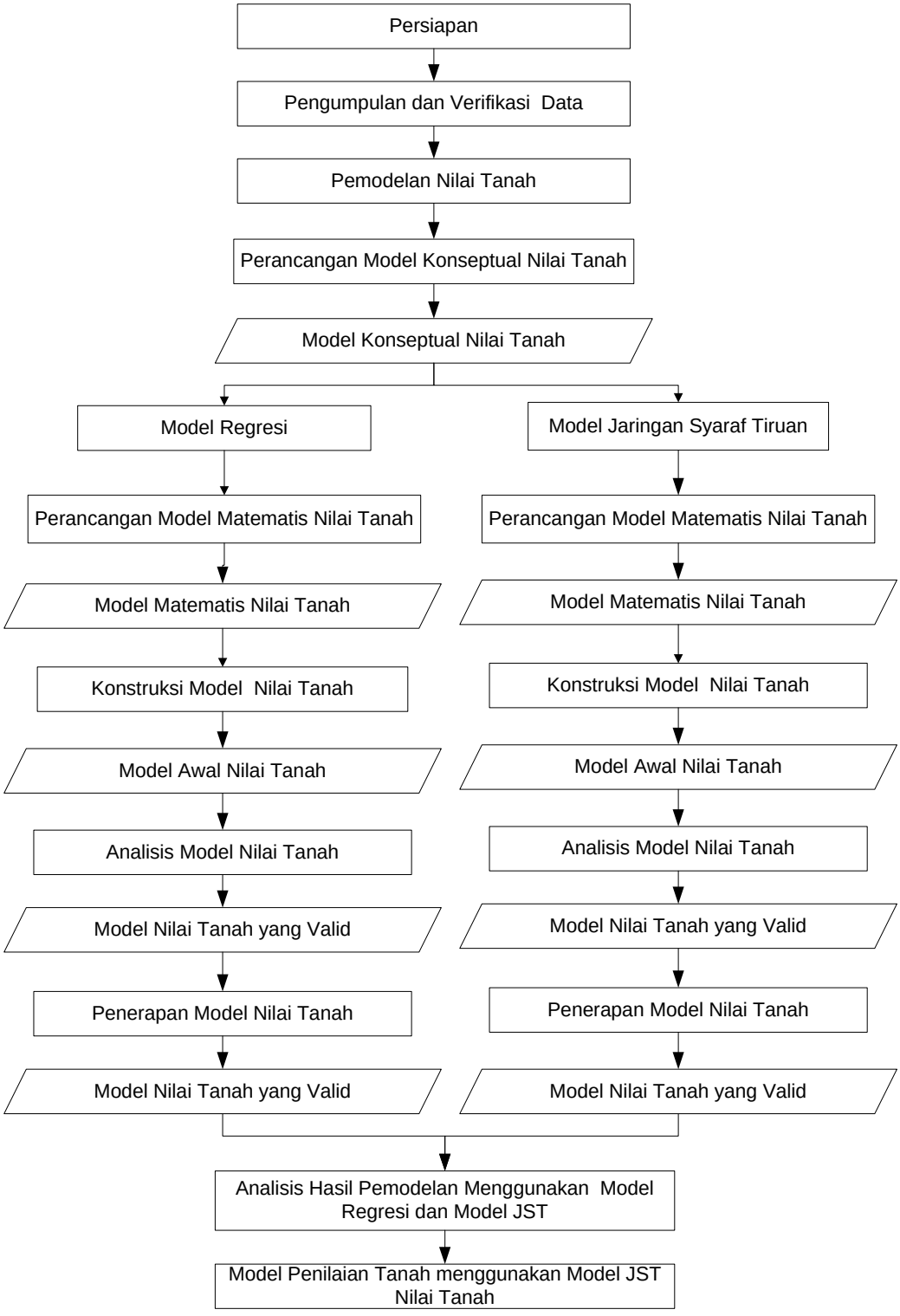
Artificial neural network has excellence in solving problems which contains uncertainty, inaccurate and partial truth (Kusumadewi, 2006). ANN Computation applies approach of pattern recognition to solve problem. ANN learn patterns in data during training process by propagating it to some associative neurons at the same time. One of characteristic ANN is not linear and can solve unknown algorithm problems.

The purpose of this research is to develop land valuation method using spatial analysis and artificial neural network. **Problems which can be solved is :**

- How land Value Characteristic?
- What Variable is having a significant effect to land value?
- How Multiple regression land value model and Artificial Neural Network Model?
- How much accuration of Multiple regression land value model and Artificial Neural Network Model?

2. Research Method

Research method used is shown in Figure.1.


Persiapan
Pengumpulan dan Verifikasi Data
Pemodelan Nilai Tanah
Perancangan Model Konseptual Nilai Tanah
Model Konseptual Nilai Tanah
Model Regresi
Model Jaringan Syaraf Tiruan
Perancangan Model Matematis Nilai Tanah
Perancangan Model Matematis Nilai Tanah
Model Matematis Nilai Tanah
Model Matematis Nilai Tanah
Konstruksi Model Nilai Tanah
Konstruksi Model Nilai Tanah
Model Awal Nilai Tanah
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Analisis Model Nilai Tanah
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Model Nilai Tanah yang Valid
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Penerapan Model Nilai Tanah
Penerapan Model Nilai Tanah
Model Nilai Tanah yang Valid
Model Nilai Tanah yang Valid
Analisis Hasil Pemodelan Menggunakan Model Regresi dan Model JST
Model Penilaian Tanah menggunakan Model JST Nilai Tanah

Figure 1. Research Method

Research is done at District of Lengkong on Bandung City. District Map of Lengkong shown. The Data reqirurements are PBB data spatial, List Result of PBB Tax Object Record, Road Network Map, and Land Data Transaction.

Factors influencing land value can be grouped to four categories, that is Physics, Economy, Social and Politics (Figure 2) (Eckert et al., 1990; Hidayati, 2003).

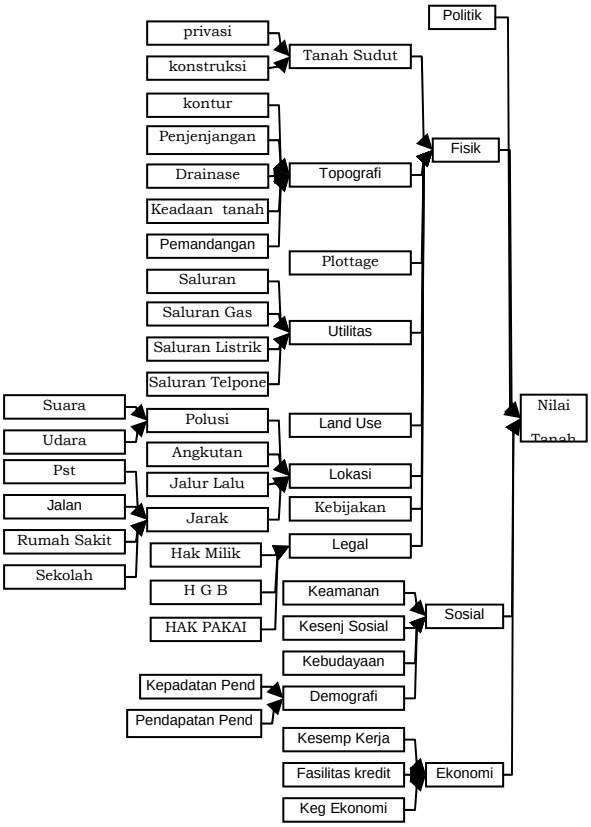

Figure 2 Conceptual Models of Land Value

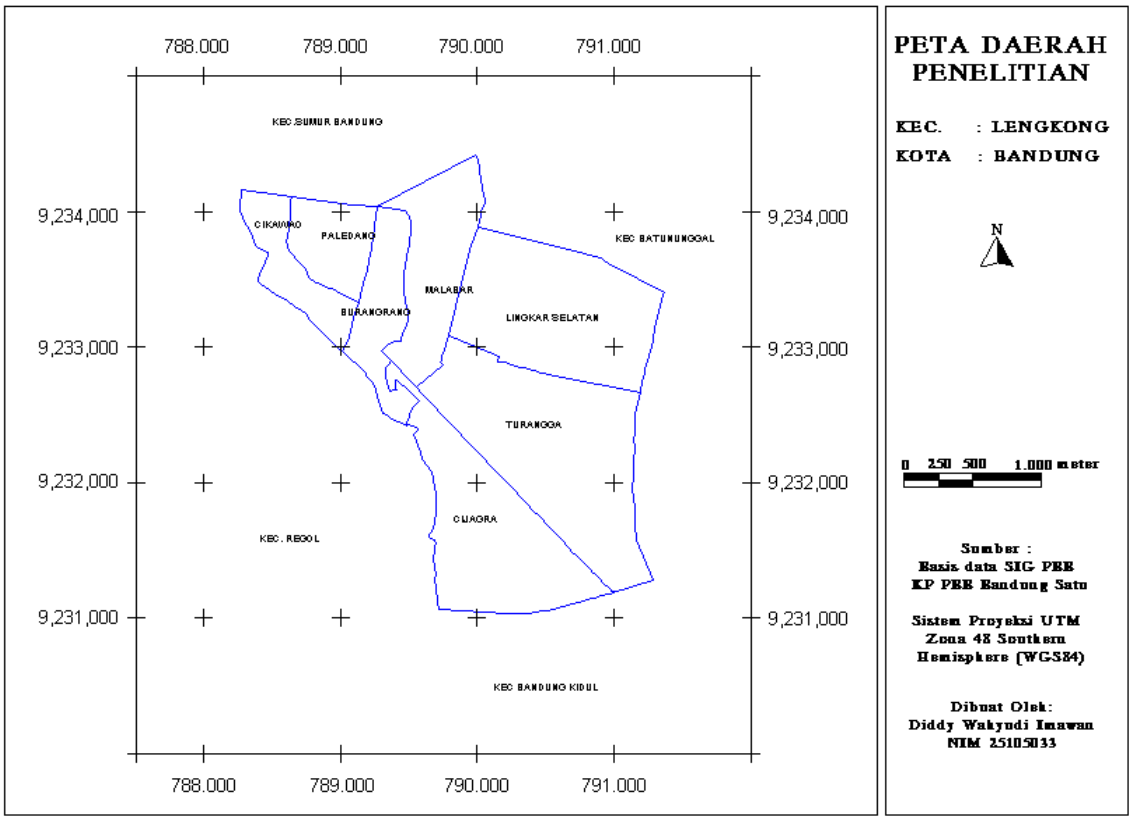

Figure 3 Research Location

3. RESULT AND ANALYSIS

3.1 Result of Data Verification of Land Value Data

Relation between data transaction (PPAT) with Selling Value (NJOP) PBB in the year 2006 having the character of linear. Correlation coeficient, R^2, the relation of PPAT and NJOP is the equal to 95%, while buyers offer and NJOP is 89%. If data PPAT and seller offer are merged, Sales data correlation coefficient becomes 65%.

If it is seen from data spreading, the seller offer data is more disseminatingly than PPAT data.. Standard deviation of Seller Offer data is Rp.900.888,00, PPAT data is Rp. 791558,00, so that standard deviation of transaction data becomes Rp. 1.012.576,00. Therefore, seller offer data and PPAT need to be Adjusted.

Adjustment passed to the transaction data covers adjustment of time and adjustment of data. Adjustment of time applies rule applied in Circular Letter of Director-General of Number Tax: SE-55/PJ6/1999 about the handbook of analysis determination for Average indication value (NIR). All of these research the transaction data is specified on certain assessment, where the date of calculation is commencing at 1 January 2007 for the land assessment.

Adjustment for data type is done by using regression analysis. Based on regression analysis, adjustment of data type for PPAT is 20%, while for seller offer equal to 22%. The relation of transaction data after adjustment of data the year 2007 with NJOP of land was dated in the year 2006 as shown at Figure- 4.

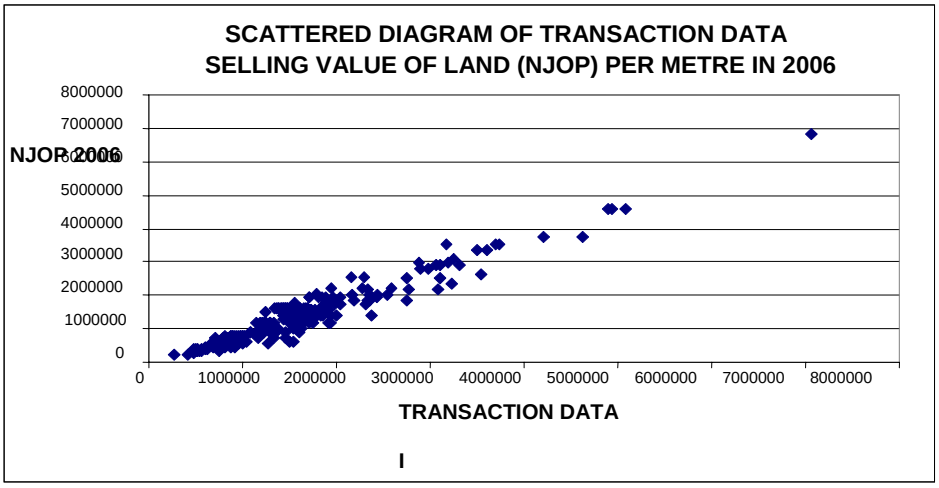

Figure 4. Relationship of Sales Data and NJOP in 2006

3.2 Result of Model Design

At this research, land value determinant selected is the accessibility, what consisted of distance to Commerce Center, distance to Main road and distance to College. Meanwhile, political factor, economics, social and public culture, assumed gives influence that is same relatively to one administration regions of district because this factors is difficult to be measured and existence of limitation of time, and expense.

Object taken as as independent variable is :

a. Center Commerce (3 Object) : Bandung supermall, plaza, market kosambi
b. School (27 Objects): SDN Suryalaya, SD VI Cijagra, SMP Negeri 28, Sekolah, SMUN 8, SMKN 3 Bandung, SMKN 8 Bandung, SMP Negeri 13 Bandung, SMEA Binawarga, SMKN 2, SDN Putraco, SDN Pelita, SD Buah Batu Baru, Yayasan Pendidikan Kebangsaan, SD Terang I-II, SDN II-IV Turangga, SDN Turangga I 3, SDN Halimun I S/D 8, YPPM, SD BPI, SDN, SMP YPM, Yayasan Perguruan Taman Siswa, SMP, SD Nilem, SD Lengkong Kecil, SMAN 07
c. University (4 Object) : STIE Nasional, Universitas Pasundan, Universitas Langlang Buana
d. Health Facility (7 Object) : Puskesmas Kec Lengkong, Puskesmas Suryalaya, Puskesmas Cijagra Baru, RS Bersalin, Puskesmas Cijagri Lama, Klinik Laboratorium, RS Muhamadiyah
e. street (17 Objects) : Jl Dalem Kaum, Jl. Gatot Subroto, Jl. Palasari, Jl. Lodaya, Jl. Cikawao, Jl. Talaga Bodas, Jl. R A A Martanegara, Jl. Jend. A. Yani, Jl. Karapitan, Jl. Burangrang, Jl. Sada Keling, Jl.

Buah Batu, Jl. KH A Dahlan, Jl. Lengkong Kecil, Jl. Lengkong Besar, Jl. Gurame, Jl. Asia Afrika, Jl. Turangga, Jl. Sukarno Hatta, Jl. Pelajar Pejuang

3.3 Modelling

1. Regression Land Value Model

Based on result of land value determinant factors influence analysis, knowable that factors influencing land value are Sekolah and distance to street group of 4 or street having wide 12m. But factor influence center commerce, college and health facility need to be analysed furthermore in model forming. Variable taken away from third factor is variable having big correlation. At factor aparts to center commerce, variable aparts to plaza to have the biggest correlation coefficient. At factor aparts to college, variable aparts to university Langlang Buana and distance to university Pasundan has the biggest correlation coefficient. While at aparting to health facility, aparts to puskesmas district of lengkong has the biggest correlation coefficient.

Choosing a model matching with doing regression to dependent variables (NT) and its(the independent variable with four alternative of model who has been made or modeled that is linear model, model Log – Line, model Lin-Log and model Double Log. Based on result of this regression obtained coefficient value each variable with sign (+) or (-), value t, F value, and also coefficient of determination (R2). Choosing a model is determined by comparing level of value R^2. Good Model is model who is having higher R^2 value.

Table 1 Test Result F and Test t-statistik

Uji	Lin-Lin	Log-Lin	Log-Log	Lin-Log
R	0.891	0.857	0.896	0.915
R^2	0.794	0.734	0.802	0.838
F	0	0	0	0
RMS	349321	399421	346508	308829

Based On Above 1 tables, hence model which having highest correlation coefficient value is model Lin-Log with value R^2 = 83.8%. R^2 which is high enough indicates that joinly all independent variables has power clearly which is high enough in explaining variable is not its free is assessing soil;land;ground (NT). While low RMS value is logarithms model, that is 308829. Result of uji-multikolinearity to only one independent variables in model lin-log and logarithms that is is not is found existence of multikolinearity symptom, that is variable aparts to SD Nilem. Therefore, at test multikolinear most all variables doesn't get away test. The that is becoming lacking of linear regression method.

Good examination entirety tested apriori economics, statistical test and also classic assumption test of shows that there is no variable getting away all examinations

2. Artificial Neural Network Land Value Model of Backprogation

Land value determinant factors influence analysis process marginally divided to become 2 phase. First phase is analysis subfactor influencing land value in significant. Object significantly

influencing land value in and chosen to be analysed phase hereinafter is object having R^2 more than 50% (Tabel 2).

Table 2 Chosen object

No	KODE	RMS	R^2
Commercial Centre			
1	CBD3	459666	0.643
School			
1	S3	539790	0.507
2	S4	453249	0.654
3	S7	493454	0.589
4	S9	520449	0.542
5	S11	349673	0.793
6	S17	516216	0.550
7	S18	467426	0.631
8	S20	527206	0.532
9	S21	543372	0.501
10	S22	510615	0.559
11	S24	490311	0.594
University			
1	PT2	533698	0.519
2	PT3	533316	0.520
3	PT4	488521	0.603
Health facility			
1	K4	530963	0.524
2	K6	490272	0.595
Road			
1	J13	517031	0.550
2	J31	504021	0.571
3	J32	536656	0.514
4	J44	463012	0.638
5	J46	547895	0.493
6	J47	476183	0.617

After obtaining data from land object, the correlation shows a bit higher to the land value, that was done by Artificial Neural Network Model. The Artificial Neural Network Structure consisted of 23 node at input layer, 1 output layer and 1 hidden layer, with 46 node at hidden layer. Data applied in making of model or training amounts is 140. Result of prediction of land value by using artificial neural network models has value R^2 09.2 %. While assessing mistake of RMS result of prediction Rp. 149320,00.

Test of multicolinear cannot be done because relation between land determinant variable with land value doesn't have the character of linear.

3. Comparison of Regression Land Value Model and ANN

Shortly, difference of regression model and ANN can be see at table :

Table 3 Comparison of Models

Test	Regression	ANN
Multicolinearity	High	Not Tested
Linearity	Linear	not Linear
Outlier Data	Unpredictable	predictable
Mathematical Equation	Y = f(X)	Y=g(f(X))
RMS	Mean= 375.656	149.320
R^2	Mean= 79%	92%

After model have been made, land value model applied in predicting land value in district of Lengkong in the year 2007. At model applying, regression model analysed is lines model.

Table-4 shows description of regression model statistic and model ANN.

Table 4 Description of land Value Model Statistic

	Regresion	ANN	NJOP
Min	-324,437	202,791	243,000
Max	8,482,777	5,341,251	6,805,000
Mean	1,572,858	1,647,985	1,189,058

Land value predicted by regression model there is negativity value. Regression minimum value is – 324.437,00. The value doesn't express land value that is actually because land value shouldn't valuable of negativity. Value which more closing is reality predicted by soil;land;ground value model ANN. Minimum Value ANN is Rp. 202.791,00 and almost near minimum value NJOP 2006.

Implementation of regression land value model and ANN for PBB is done with converting land value result of prediction of model into land class. land class yielded by regression model is more varies than model ANN. Example of various visible land class at Figure- 5. The Area encircled is example of area with various highvalue of land class. That Condition can cause conflict between taxpayers against the exercise officer..

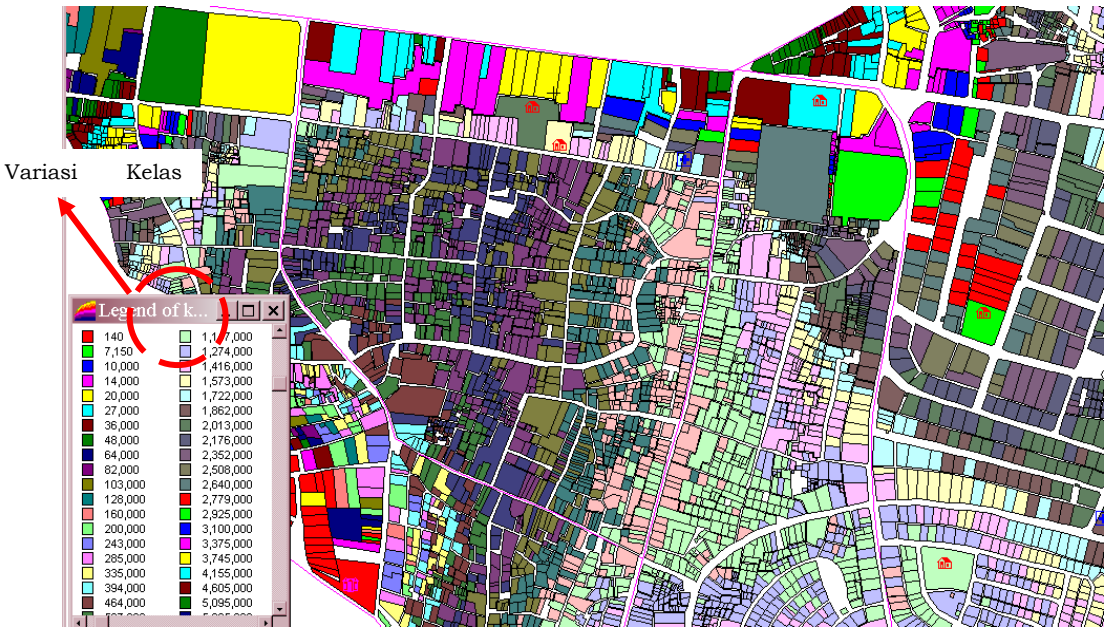

Figure 5 Regression of Land value (Land valuation class map)

Various lower value of land valuation class is obtained by using valuation of model ANN. The Figure below shows land valuation class map by ANN.

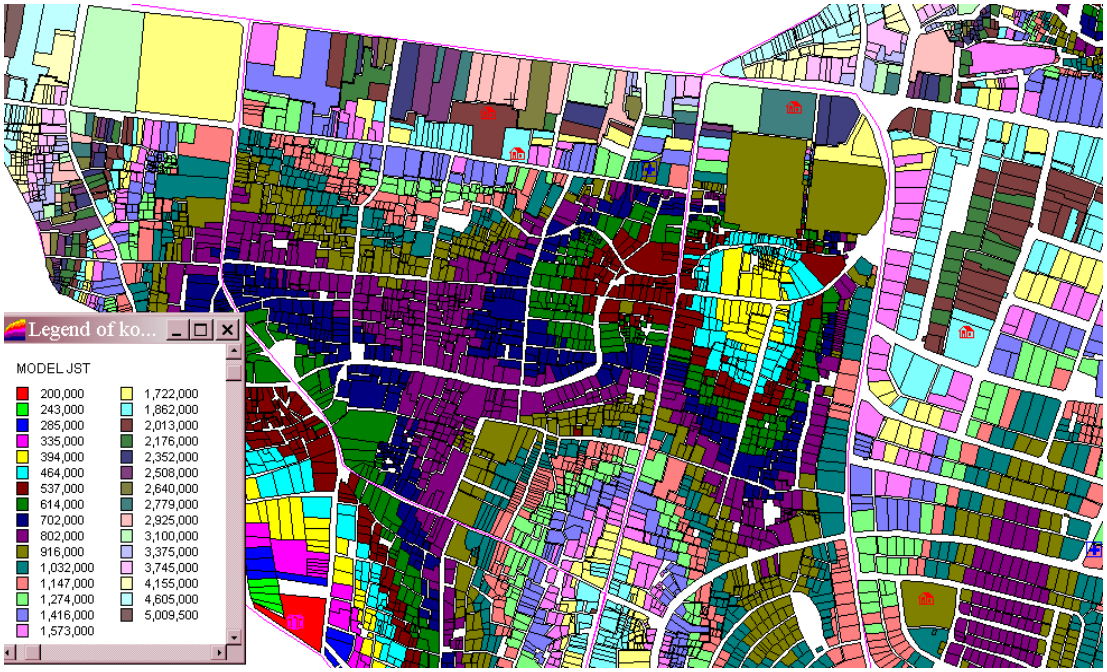

Figure 6 Land Valuation Class Map by ANN

Based on analysis at knowable regression model that there is no variable getting away examination. While at artificial Neural network models there are 23 variables applied in model. Therefore analysis modeled only done at artificial neural network models.

JST Model then is tested with test data. Number of test data applied amounts to 40. Result of the examination is analysed by using coefficient COD, PRD, RMS and R^2.

Value PRD is scored 0996 meaning the value resides in in tolerance range (0,98 up to 1,03) so that inferential that level of uniformity of model in predicting good relative land value.

From calculation to value COD is scored a 1.28 %, shows level of accuration of model in predicting land value to exceed tolerance range (<15 %). This mean ANN model has level of accuration that is good to predicting land value.

Correlation coefficient, R^2, model ANN equal to 92%. While RMS error of Model ANN is Rp.269.089,00.

Conclusion

Based on validation test of Model ANN is obtained COD equal to 1.28% and PRD 0.996. Therefore model ANN still can be used to predict land value..

Accuration of ANN Model is higher than models Regresi. RMS error ANN land value model is Rp. 149.320,00 while Model Nilai Tanah Regresi has mean Rp.375.656,00

Variable having an in with regression model is School and Road/Street. While at modeling ANN, school variable, street, health facility and center commercial has the same influence, but each object at the variable has different influence.

Test result of multikolinear at regression model filters all variables. At model ANN, multicolinearity can't be tested.

For further study is suggested performance of model depend on data. Data sample at this research amounts to 140 data for forming of model and 30 data utuk examination. If it is compared to number of tax objects which amounts to 14559 (SISMIOP, 2006), data research only amount to 1%. Therefore needs existence of addition of data example of causing model can predict land value eminently.

Other land value variable can improve;repair accuration of model. Therefore needs other variable influence study to soil;land;ground value.

REFERENCES

1) AIREA. 1987. *The Appraisal of Real Estate.* American Institute of Real Estate Appraisal. Chicago.
2) Bambang Hariadi, 2003. pengaruh faktor lokasi, kepadatan penduduk dan bentuk tanah terhadap nilai tanah perumahan sebagai dasar penentuan nilai jual objek pajak (Studi Kasus : Kecamatan Mlati, Kabupaten Sleman). Tesis. Program Studi Teknik Geomatika. Universitas Gadjah Mada, Yogyakarta
3) Direktorat Jenderal Pajak. 2000. *Keputusan Direktur Jenderal Pajak Nomor KEP-533 tentang petunjuk Pelaksanaan Pendaftaran, Pendataan dan Penilaian Objek dan Subjek Pajak Bumi dan Bangunan dalam Rangka Pembentukan dan atau Pemeliharaan Basis Data SISMIOP (Sistem Manajemen Informasi Objek Pajak*). Direktorat Jenderal Pajak. Jakarta.
4) Eckert, J.K., Gloudemans, R.J. and Almy, R.R. 1990. *Properti Appraisal and Assessment Administration*. IAAO. Chicago.
5) Fausett, L. 1994. Fundamental of Neural Networks: Architectures, Algorithms, and applications. Prentice Hall, Inc. New Jersey.
6) Hidayati, W dan B. Harjanto. 2003. *Konsep Dasar Penilaian Properti.* BPFE. Yogyakarta.
7) Kusumadewi, S dan Sri H. 2006. NEURO FUZZY: Integrasi Sistem Fuzzy dan Jaringan Syaraf Tiruan. Graha Ilmu, Yogyakarta.
8) Pragola, D. 2003. Peramalan Harga Saham Menggunakan Jaringan Syaraf Tiruan. Tesis. Departemen Teknik Elektro. Institut Teknologi Bandung, Bandung
9) Siang, J. J. 2005. Jaringan Syaraf Tiruan dan Pemrogramannya Menggunakan Matlab. Andi, Yogyakarta.
10) Subhan. 2005. Analisis Data Saham Menggunakan Jaringan Syaraf Tiruan. Tesis. Departemen Teknik Elektro. Institut Teknologi Bandung, Bandung
11) Supardi, U. 2002. Modul Statistika I dan Ekonometrika Dasar. Badan Pendidikan dan Pelatihan Pajak. Jakarta
12) Sumodiningrat, G. 2004. Ekonometrika Pengantar. BPFE. Yogyakarta.
13) Turban, E., Aronson, and Liang. 2005. Decision Suport Systems and Intelligent Systems (Sistem Pendukung Keputusan dan Sistem Cerdas). Andi. Yogyakarta.

BIOGRAPHICAL NOTES

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