The Mass Assessment Model of Real Estate Based on GIS and VIKOR Method

Xiuli Wang[1, a], Liu Yang[2,b], Hengkai Li[2,c] and Jun Lei[2,d]

[1] College of Economic Management, Jiangxi University of Science and Technology, Ganzhou 341000,China

[2] College of Architecture and Surveying Engineering, Jiangxi University of Science and Technology, Ganzhou 341000, China

[a]itisher@126.com, [b]gisliusn@126.com, [c]giskai@126.com, [d]2471776198@qq.com

Abstract. The need for estate mass appraisal imposed by the information-based for the current property tax, estate mass appraisal model what is composed GIS and VIKOR method was proposed. Firstly, house price effect factors were quantified by using GIS spatial analysis methods, secondly, combined with quantitative values, it calculated the price's influence factor of weight with Entropy method. Thirdly, real estate mass appraisal model was built by VIKOR method. Fourth, appropriate real estate valuation system was developed who based on this real estate mass appraisal model. By using this system, five appraisal real estate of Ganzhou were estimated. And the calculated real estate prices are close with the actual trade price. It can be showed that the model had high accuracy, so this model will have a wide range prospect in terms of rapid mass appraisal real estate, and it can provide technical support for the levy of estate duty.

Introduction

Property tax policy in Shanghai and Chongqing has firstly tried for three years, playing an important role in market regulation has been a growing number of people in the industry consensus[1]. Real estate tax assessment value is more scientific, but mass appraisal on property value needs high technical requirements[2]. Some scholars applied to real estate mass appraisal with smart algorithm such as neural networks and support vector machine, and achieved good results. However, as there are many variables involved in the real estate appraisal, complex variables and price, these intelligent algorithm has a strong data dependent, and assess the accuracy of some volatility[3]. Multiple attribute decision method which is compromise and linear standard (VIKOR) was proposed by Opricovic and Tzeng, which group benefits can be maximized and opposition unfortunately minimized, also can improve the data-dependent problems[4]. In recent years, some scholars had applied geographic information system (GIS) technology in extraction and quantification of house price effect factors[5]. This technology can greatly improve the accuracy of quantification factor. With the combination of GIS technology and theory of VIKOR, blending the advantages of both, a new real estate mass appraisal model and its application is built, which will be able to provide technical support for the real estate tax system reform.

Build Assessment Model

Establishment of evaluation model is shown in Fig 1. Firstly, to set up a trade case database and an appraised real estate library based on data from trade case and estimated property. Combined with powerful GIS data management capabilities, application input and managed property information. Geospatial location of the trade cases was represented by a point on the map. So the trade case database and appraised real estate library can be set up. Secondly, taking the appraisal real estate as the center, system search around a range of cases. It can find N comparable trade case by rules which the type property and the property structure of search cases are the same as the real estate. If the screening result is less than n, or you need to expand your search radius to increase trade cases, until the trade case number is over N. Comparable trade case and appraised real estate case are quantified

by the quantitative rule. The quantitative results are saved to the database. Thirdly, reading the quantitative impact factor values in the database, entropy weight method is used to calculate the price factor weights. While comparable trade case is corrected deal time, and comparable trade cases price of time are modified as the same time of the current estimated property prices. Lastly, correlation coefficient of VIKOR method, such as Hamming distance weighted, weighted Chebyshev distance, and interest rates, are calculated. Based on sorting results which interest rates is sorted from smallest to largest by bubble sort method. So depending on the appraised property sorted result of interest rates, the estimated real estate prices can be calculated by linear interpolation. The critical points of the process are to quantify factors impact on housing prices, calculate weight and construct the VIKOR method of valuation model.
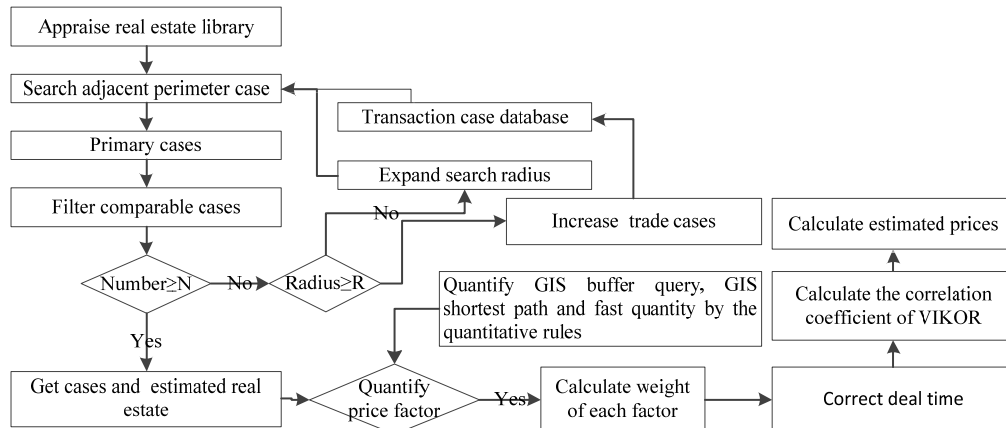

Fig.1 Logic diagram for Evaluation model

Real estate price impact factor and quantitative methods can be sure as table 1.In this table, from P1 to P6 stand impact of location on housing price in real estate area, from P7 to P15 stand impact of housing qualifications on housing price. Using GIS analysis to quantify the real estate, the same factors on different distances have different effect on the housing price. So this model uses a hierarchical buffer query method to quantify. Depending on the degree of setting different values to quantify, quantifiable results can be more objective and reasonable.

Tab.1 Real estate price impact factor and Quantitative methods

Housing Price Impact Factor	Quantitative Method of Housing Price Impact Factor
The Distance To CBD(*P1*)	Shortest distances to the city center,10 points for 0 to 5 km;8 points for 5 to 10 km;5 points for 10 kilometers away.
Transportation Convenience（*P2*）	Each with 1 point for bus stations within 500m ;each with 0.5 point for bus route through the site;2 points for near the main road;each with 0.6 point for bus stations and bus routes through the site from 500m to 800m,top 10 points.
Supporting Education（*P3*）	3 points for kindergarten within 600m;2 points for primary school and university;1 point for kindergarten,primary school,university around the house from 600m to 1000m,top 10 points.
Sports Facility（*P4*）	Each with 1.5 points for playground,stadium,library and theatre within 600m;each with 1 point for playground,stadium,library and theatre around the house from 600m to 1000m, top10 points.
Supporting Life（*P5*）	Each with 1.2 points for supermarket,bank,shopping mall,hospital,farm within 600m;each with 0.8 point for supermarket,bank,shopping mall,hospital,farms around the house from 600m to 1000m,top 10 points.
Natural Environment （*P6*）	Each with 5 points for park and river within 1000m around the house;reduce each with 1 point for highway, railway, urban main road within 500m,top 10 points.
Building Facilities （*P7*）	Each with 3 points for water and electricity;each with 1 point for gas,broadband, TV,air-conditioning,parking,communications,anti-theft prevention,clean,top 10 points.
New Rate（*P8*）	With 8-10 points for good condition;with 6-8 point for basic good housing;with 4-6 point for general damage to the housing;under 4 points for serious damage to the housing and dangerous rooms.
Apartment（*P9*）	With 10 points for more than 3 rooms 2 hall and 2 guard;with 8 points for 3 rooms 2

	hall and a guard;with 6 points for 2 rooms 2 hall and a guard;with 4 points for 2 rooms a hall and a guard;with 2 points for others.
Towards（P10）	With 10 points for south;with 8 points for southeast, southwest, north and south;with 6 points for east;with 4 points for west, northeast;with 2 points for north.
Floor（P11）	No elevator: with 10 points for layer 3;with 8 points for layer 4;with 6 points for layers 2 and 5;with 4 points for layer 1;with 2 points for the top.Elevator: with 10 points for layers 25 above;with 8 points for layers 19 to 24;with 6 points for layers 13 to 18;with 4 points for layers 7 to 12;with 2 points for layers 1 to 6.
Community Environment（P12）	With 10 points for optimal: more than 30% green rate,very quiet;with 8 points for better: 20% - 30% green rate,quiet;with 6 points for general: 15% - 20% green rate, no noise;with 4 points for inferior: 10% - 15% green rate, big noise;with 2 points for bad: less than 10% green rate, seriously noise..
Property Management（P13）	With 10 points for optimal: first-level management,all day security patrol,video monitoring.With 8 points for better: second-level management,all day security patrol,video monitoring.With 6 points for general: second-level management,security patrol.With 4 points for inferior: third-level management.With 2 points for bad: no management.
Ventilation and Lighting（P14）	With 10 points for optimal: average 8 hours sunshine per day,window wall area above 1/3,air convection;with 8 points for better: average 6 hours sunshine per day, window wall area above 1/4, air convection;with 6 points for general: average 5 hours sunshine per day,window wall area above 1/5,no air convection;with 4 points for inferior: average 2 hours sunshine per day,window wall area above 1/7,no air convection;with 2 points for bad: average below 2 hours sunshine per day or no window .
Repair Situation（P15）	With 8-10 points for luxury decoration;with 6-8 points for fully decoration;with 4-6 points for simple decoration;with 2-4 points for no decoration.

Property influence factors of weight are calculated by objective entropy weight method. The entropy weight of each real estate price effect factor is calculated by entropy, then its for all price factors are weighted. The steps are as follows: Firstly, construct matrix by 15 effect factors quantitative scores of N comparable trade case. Secondly, calculate proportion P_{ij}, $P_{ij} = p_{i,j} / \sum_{i=1}^{N} p_{i,j}$ .Where p_{ij} stands the j-th real estate price effect factor value of the i-th comparable trade case.Thirdly, calculate entropy E_j. $E_j = (-1/\ln N)\sum_{i=1}^{N} P_{ij} \ln P_{ij}$ .Fourth, calculate entropy weight W_j, $W_j = (1 - E_j) / \sum_{j=1}^{15} (1 - E_j)$ .At last, get a weight vector, $W = (W_1, W_2, \cdots\cdots, W_{15})$.

As the time factor effect on real estate prices, it need correct the trade cases transaction price to the current appraisal real estate prices at the same time. Estimating property price of comparable trade case in the same time calculated by product of chain and comparable trade case price.

Every comparable trade case and appraisal real estate has 15 factors. VIKOR is a method making multiple attribute decision of selecting the best. According to the distance appraisal properties with comparable trade cases as weights, estimating price is interpolated by revised price of comparable trade cases. The steps are as follows: Firstly, construct matrix by appraisal real estate and comparable trade cases. Secondly, matrix is normalized by formula as $f_{ij} = p_{ij} / Max_i(p_{ij})$. Where p_{ij} stands the j-th real estate price effect factor value of the i-th comparable trade case. Positive ideal solution and negative ideal solution of appraisal and trading estate effect factors are calculated by new normalized matrix, $f_i^* = (Max_i f_{ij})$ $f_i^- = (Min_i f_{ij})$. f_i^* and f_i^- stand for positive ideal solution and negative ideal solution. Fourth, hamming weighted distance S_i and Chebyshev weighted distance R_i of all the appraisal real estate and the trade cases are calculated, $S_i = \sum_{j}^{15} W_j (f_j^* - f_{ij})/(f_j^* - f_j^-)$, $R_i = Max_j[W_j (f_j^* - f_{ij})/(f_j^* - f_j^-)]$ .Where W_j stands the j-th weight of price effect factor,and the weight is calculated by entropy weight method.Fifth, compute the value Q, $Q_i = \frac{v(S_i - S^*)}{S^- - S^*} + (1 - v) \frac{(R_i - R^*)}{R^- - R^*}$,where $S^* = Min_j S_j$, $S = Max_j S_j$, $R^* = Min_j R_j$, $R = Max_j R_j$, v is 0.5,stands coefficient of decision mechanism. Appraisal real estate and comparable trade

cases are sorted by Q. At last, appraisal real estate price is interpolated by sorted Q value, $P_k' = [\frac{(P_{k+1}' - P_{k-1}')(Q_k - Q_{k-1})}{(Q_{k+1} - Q_{k-1})} + P_{k-1}']$, where P_k' stands appraisal real estate price, P_{k+1}'、P_{k-1}' stand revised trade case price near this appraisal real estate by sorting Q. Q_k belongs to appraisal real estate, Q_{k+1}, Q_{k-1} belongs to trade cases.

Application

Combited with above assessment model idea, application was developed by C# programming language with ArcEngine as GIS software platform. By using this application, five appraisal real estate of Ganzhou were estimated. The steps are as follows: Firstly, information was collected and trade case database and appraisal real estate database were established. While you record, a point was draw in the map that stand the actual location of trade case and appraisal estate, and other basic property information was deposited in corresponding database. Secondly, effect factors of comparable trade case and appraisal estate was quantified as quantitative rule in table 1, and this quantitative results were deposited in database. Thirdly, appraisal real estate price was calculated by VIKOR model. Taking appraisal real estate as center, around its 2km, 5 comparable trade cases whice are the same estate type and structure and closed transaction time with appraisal estate. Then system quantified effect factors of 5 comparable trade case and appraisal real estate, calculated its weight, adjusted trade time, calculated related parameter of VIKOR, sorted by Q value, interpolated the appraisal real estate. The result present that 5 appraisal real estate prices are above 96% with the corresponding actual trade case price, and this model has a high accuracy can be proved.

Conclusion

Combined with advantages of GIS technology and VIKOR theory, this model has high accuracy and efficiency. Using GIS technology in collect data, manage and spatial analyze not only can solve subjective problem caused by experts giving estate price effect factors points, but also infinitely improve quantification accuracy and efficiency of effect factors. On the other hand, VIKOR method can make appraisal estate price more reliable because it solve problem of normal intellectual algorithm depending on large trade cases. so this model will has a wide range prospect in terms of rapid mass appraisal real estate, and it can provide technical support for the levy of estate duty.

Acknowledgements

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