Automated Valuation Model: An Alternative Property Valuation Procedure

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Abstract

Accurate value and fast delivery are the main an objectives when an exercising property valuation. Sales Comparison Method (SCM) is the most popular approach for valuing properties worldwide but the theory is criticized for its subjectivity constrain. Furthermore, the practice of property valuation in Malaysia has remained human intensive tasks which are prone to mistakes and most importantly cannot meet the current demand for fast and accurate valuation. This alternative procedure which also calls automated valuation model (AVM) is invented to produce more efficient valuation. AVM is a mathematically based computer software program that produces an estimate of market value based on market analysis. AVM will follow sound statistical and mathematical modelling practices and be tested for accuracy and uniformity for application. AVMs are not meant to replace valuation professionals; they are tools to aid valuation tasks. Any valuer can just click on the value map and the valuation is done automatically within a minute. This paper proposes an alternative property valuation procedure to make automated valuation possible and subjectivity can be eliminated. The proposed procedure uses precise rules for selecting, adjusting and weighting of comparable. An empirical example is provided. A limited accuracy analysis shows high potential of the procedure as evidenced by a relatively high prediction capability. It is recommended that the procedure be extensively studied.

Keywords: Property Valuation, Alternative property, automated valuation model

INTRODUCTION

The Sales Comparison Method (SCM) is one of the simplest methods to determine the value of a property. Obviously, it is the most widely used method of property valuation world-wide. The SCM is based upon the economic principle of substitution; it uses direct evidence of market values for the property to be valued (subject property). The approach involves the analysis of sales of similar properties that have been transacted (comparable properties). The comparable properties for which sale prices are known are compared to the subject property and making adjustments for the differences between them in order to establish the value of the subject property.

The SCM generally considered as the most direct approach in determining market value because it uses recent sales with similar property characteristics in the same market area as the comparables for the subject property. The sales will be verified and adjusted to represent the market. The process requires the valuer to match the property characteristics of the subject property with recently sold properties that have the most comparable property characteristics. Usually there will be several sales that are comparable to the subject property and the valuer need to select the appropriate value for the subject property from the value range formed by the sale of the comparable properties

In all profession advance technologies have taken place to improve quality of output, same goes to valuation profession, especially when records of recently sold properties are of quality, abundant and easily accessible data, the SCM can be automated to fulfil the need of speedy and accurate valuation. The automated valuation which also known as AVM can produce reliable estimated value of a subject property within accepted time. Thus, when information and communication technologies advance making storing and accessing transaction data easily automated SCM or AVM can be reality.

However, a major critic of SCM is its subjectivity (Colwell et at, 1983; Lipscomb and Gray, 1990; Vandell, 1991; Gau et al, 1992, 1994). The procedure within SCM is informal requiring input based on the experience of valuers in selecting comparables, determining indicated comparable values by adjusting the difference between the comparable and subject property values due to the difference in their characteristics, and reconciling the different indicated comparable values to come up with a single predicted value of the subject property. Valuers are essentially free to select comparables (how and how many to choose), determine indicated values (what adjustment factor to use and how much to adjust for each factor) and reconcile indicated values (how to weight comparables) even though there may be some rules that vaguely regulate how these are to be carried out. As a result, a property may be predicted with different values by different valuers even if the same set of transaction records is made available to them because personal judgment are allowed to enter in the valuation process. However with AVM, objective valuation can be achieved as the model use statistical and mathematical basis to arrive at the valuation.

The aim of this paper is to propose a new implementation procedure of the SCM with the objectives is (i) make automated valuation favourable and (ii) eliminate subjective estimation. The composition of this paper is as follows. Section two presents the fundamentals of SCM and Section three discusses the practice of SCM following the current procedure. Section four describes the proposed implementation procedure while Section five provides an example with assessments of prediction accuracy. Section six presents some discussions and Section seven concludes the paper.

THE PRACTICE OF SALES COMPARISON METHOD

Guided by the MVS and ASP, valuers have found a way for performing SCM. The valuation process is usually presented in a table format. Examples of valuations by SCM as carried out by valuers are presented. Exact location and address of properties have been substituted for confidentiality. Table 1 shows the valuation of a vacant land identified as Lot 004, Mukim T, District Y, carried out on 24th November 2008. Four comparables are found. Adjustment for time factor is only given to comparable 4 because of the two years gap between the date of its transaction and the date of valuation of the subject property. Other comparables are not adjusted for time factor because their transaction dates are close enough to the date of valuation. The adjustment for location factor is given to all comparables because none of them is located in the same neighbourhood as the subject property (all comparables are in different villages relative to the subject property) Comparable 3 receives 10% adjustment because it is located in the adjacent neighbourhood while others receive 20% adjustment for being in the second order neighbourhood in relation to the subject property. Other adjustments given to the comparables include accessibility, land condition and land use plan which ranges from 5% to 10%. No adjustment given for size factor. The total adjustment for comparables ranges from RM224.00 m-2 to RM247.80 $^{m-2}$ which average out to RM238.86 $^{m-2}$. This value is rounded up to RM240.00 $^{m-2}$ giving the predicted market value of the subject property of RM9,967,200.

Table 1: Valuation of a vacant land

	Comparable 1	Comparable 2	Comparable 3	Comparable 4
Address/Lot no	Lot 010	Lot 444	Lot 200	Lot 8
Mukim	U	U	T	U
District	Y	Y	Y	Y
Transaction Date	3/4/2008	15/11/2007	22/10/2007	5/7/2006
Transaction Price	RM2,892,613	RM7,232,302	RM2,000,000	RM6,200,000
Land Area	1.227 hectare	4.072 hectare	1.558 hectare	38,750 ^{m2}
Analyses	RM160 $^{m-2}$	RM177 $^{m-2}$	RM197.69 $^{m-2}$	RM160 $^{m-2}$
Adjustment				
Time	0%	0%	0%	10%
Location	20%	20%	10%	20%
Accessibility	5%	0%	0%	0%
Land Condition	5%	10%	0%	10%
Land Use Plan	10%	10%	10%	10%
Size	0%	0%	0%	0%
Total Adjustment	RM224 $^{m-2}$	RM247.80 $^{m-2}$	RM237.23 $^{m-2}$	RM240.00 $^{m-2}$
Average Adjustment	RM237.28 $^{m-2}$, rounded up to RM240 $^{m-2}$			
Value of Subject Property	41,530 ^{m2} @ RM 240 m^{-2}= RM9,967,200			

The example presented above clearly shows that the selection of comparables is not guided by any rules to ascertain the best comparables (most similar) have been chosen. The adjustments of comparable values are not backed by any quantitative analysis of data; they are based on the knowledge and experience of the valuers. The indicated values of comparables are reconciled using simple average violating the concept of comparability. An SCM procedure of this nature does not support automated valuation apart from prone to subjective prediction.

THE PROPOSED PROCEDURE

The proposed implementation of SCM compliments and enforces MVS and ASP, the two standards and regulations that guide property valuation in Malaysia. The proposed implementation focuses on provisions in the ASP that (i) require quantitative analysis of data, and (ii) using MRA method to obtain accurate and justified values in adjusting comparables. These provisions are given less attention by valuers. We present the proposed procedure in the following three subsections following the three major issues in SCM.

Selecting Comparables

The selection of comparables begins with determining candidate comparables. The required k comparables will be selected from the determined candidate comparables and the remainder will be used to determine the adjustment factors. The criteria used in identifying candidate comparables is property type such as one storey linked, two storey semi-detached, two-and-half storey detached, etc. The candidate comparables are searched in the same neighbourhood as the subject property failing which the search area is extended to its neighbouring areas of first order contiguity. If necessary, the search area is extended to higher order contiguity (second, third, and so on). The minimum number of candidate comparables to be found is $m + 1 + k$ where m is the number of property characteristics (attributes) and k is the number of comparables to be selected.

After n candidate comparables are found, their similarities to the subject property is determined using Minkowsky metric. The Minkowsky metric for each of the n candidate comparables, ξ_j is calculated using the expression (Todora & Whiterell, 2002).

$$\xi_j = \sum_{i=1}^{m} pi \left[\frac{|(x_i^s - x_i^c)|}{x_i^s} \text{ x } 100\right];\ \text{for } j = 1, 2, 3, \dots, n$$
(1)

where x_i^s is the value of i^{th} characteristic of the subject property; x_i^c is the value of i^{th}characteristic of a candidate comparable; p_i is weight of i^{th} characteristic; m is the number of property characteristics; n is the number of candidate comparables and $|(x_i^s - x_i^c)|$ denotes the absolute value of the difference of the i^{th} value of the subject and a comparable characteristic. The weight p_i can be taken to be the percentage of the absolute value of the correlation between candidate comparable values, **y**, and each of m property characteristics, given as,

$$p_i = \frac{|r_{y,xi}|}{\sum_{i=1}^{m} r_{y,xi}} \text{ x } 100;\ \text{for } i = 1, 2, 3, \dots, m$$
(2)

where $r_{y,xi}$ is the Pearson's correlation coefficient between candidate comparable values y and the i^{th} property characteristic. The Pearson's correlation coefficients can be obtained from the expression,

$$r_{y,xi} = \frac{n\sum_{j=1}^{n} xj\, yj - \left(\sum_{j=1}^{n} x_j\right)\left(\sum_{j=1}^{n} y_j\right)}{\sqrt{\left[n\sum_{j=1}^{n} x_j^2 - \left(\sum_{j=1}^{n} x_j\right)^2\right]\left[n\sum_{j=1}^{n} y_j^2 - \left(\sum_{j=1}^{n} y_j\right)^2\right]}};\ \text{for } i = 1, 2, 3, \dots, m$$
(3)

where y_j is the j^{th} element of candidate comparable values; x_j is the j^{th} element of i^{th} property characteristic; m is the number of property characteristics and n is the number of candidate comparables. The coefficients of correlations between candidate comparable values y and all property characteristics are used as the basis of weight in the Minkowky metric.

A small value of Minkowsky metric means large similarity (small dissimilarity) between the comparable and subject property and a large value means small similarity (large dissimilarity) between the two properties. The candidate comparables are then ranked using values of Minkowsky metric with the smallest value at the top and largest value at the bottom. The top k comparables from the ranked list are taken to be the required k comparable properties for being the most similar to the subject property. It is also guaranteed that the k selected comparables require the least adjustment among all candidate comparables.

There may be situations that one of more candidate comparables that is identical to the subject; they have exactly the same characteristic values as the subject property. This may happen when the subject and concerned candidate comparables are located in the same row of terraced houses, barring renovations. The identical candidate comparables will be selected as comparables for having Minkowsky metric of zero. It is possible that all *k* comparables are identical to the subject if there are at least *k* identical candidate comparables.

Adjusting Comparable Values

The values of the *k* selected comparables must be adjusted for the differences between them and the subject property if the comparables are not identical. The differences in the values are due several factors, quantifiable and non-quantifiable. The quantifiable factors can be obtained by analysing the transaction records of the same property type as the subject property. The estimated coefficient of an OLS regression of the remaining candidate comparables are used as the adjustment factors. The estimated coefficients are obtained using the expression,

$$\hat{\mathbf{b}} = \left(\mathbf{X}^{\mathbf{T}}\mathbf{X}\right)^{-1}\mathbf{X}^{\mathbf{T}}\mathbf{y}$$
(4)

where $\hat{\mathbf{b}}$ is a (m + 1, 1) vector of estimated coefficients, **X** is a (n □ k, m+1) matrix of characteristics of candidate comparables with ones in the first column, y is a (n□ k, 1) vector of values of candidate comparables, n is the number of candidate comparables; k is the number of comparables; and m is the number of property characteristics.

The first element of $\hat{\mathbf{b}}$ is the intercept while the rest of the elements represent the estimated relationships between property characteristics and property values. These relationships are taken to be the adjustment factors. Thus for m property characteristics, we have m adjustment factors,

$$f_i = \hat{b}_{1+i} \quad ; \text{for } i = 1, 2, 3, \ldots, \text{m}$$
(5)

The adjustment for each of the k comparables, δ_j is calculated using the expression,

$$\delta_j = \sum_{i=1}^{m} f_i \left(x_i^s - x_i^j\right) \text{for j} = 1, 2, 3, \ldots, \text{k}$$
(6)

where x_i^s is the value of i^{th} characteristic of the subject property; x_i^j is the value of i^{th} characteristic of the j^{th} comparable; f_i is the adjustment factor for the ith characteristic and k is the number of comparables. The indicated value for each of the comparables, v_i is calculated using,

$$v_i = y_i^c + \delta_i$$
(7)

where y_i^c is the value of the i^{th} comparable and δ_{i} is its adjustment. Identical comparable properties receive zero correction because $x_i^s - x_i^j$ in Equation (6) equals zero.

The OLS regression is used in determining the adjustment factors because of its strong mathematical and statistical bases; OLS being the BLUE (Best Linear Unbiased Estimator)(Lentz & Wang, 1998). We choose to use □ k candidate comparables in the OLS regression because these properties represent properties that are most similar to the subject property and thus the coefficients are more likely to be equal to the subject; the concept of the economic principle of substitution is upheld. The use of all properties in a region of interest that are of the same type as the subject property is ruled out because this would degrade the accuracy of adjustment coefficients; dissimilarity increases as the distance between two properties increases. It is for this reason that the searching for candidate comparables starts from the neighbourhood of the subject property and extending to higher order contiguity neighbourhoods only if necessary.

As indicated earlier, it is possible that one or more comparable properties are identical to the subject property; it is a situation that valuers are aiming at. Comparable properties that are identical to the subject property receive zero corrections. Comparables that are not identical to the subject receive positive or negative corrections. The adjusted value of a comparable is called an indicated value because it represents a value indicant of the subject property. For many situations the indicative values from the k comparables are not the same due to unaccounted and unquantifiable factors.

Weighting of Comparables

So far the procedure has produced *k* indicated values of the subject property from the k selected comparables and these indicated values should be the same. The different indicated values must be reconciled using the expression,

$$\hat{y}^{s} = \sum_{i=1}^{k} w_i \, v_i$$
(8)

such that,

$$\sum_{i=1}^{k} w_i = 1$$
(9)

where $\hat{y}^{s}$ is the predicted value of the subject property; v_i is the indicted value from the i^{th} comparable; *k* is the number of comparables and w_i is the weight for the i^{th} comparable.

The weighting scheme used is that a comparable with the most comparability receives the largest weight and a comparable with the least comparability receives the smallest weight. The weighting scheme of squared adjustments that satisfies the criterion is used and the weight w_i of comparable *i* is given as,

$$w_i = \frac{\sum_{p=1}^{k}\sum_{j=1}^{m}\left[\hat{b}_j\left(x_j^s - x_{p,j}^c\right)\right]^2 - \sum_{j=1}^{m}\left[\hat{b}_j\left(x_j^s - x_{i,j}^c\right)\right]^2}{(n-1)\sum_{p=1}^{k}\sum_{j=1}^{m}\left[\hat{b}_j\left(x_j^s - x_{p,j}^c\right)\right]^2} 1; \text{ for } i = 1, 2, 3, \ldots, k$$
(10)

where $\sum_{p=1}^{k}\sum_{j=1}^{m}\left[\hat{b}_j\left(x_j^s - x_{p,j}^c\right)\right]^2$ is the sum of squared values of all adjustments made for all comparables; $\sum_{j=1}^{m}\left[\hat{b}_j\left(x_j^s - x_{i,j}^c\right)\right]^2$ is the sum of squared of all adjustments made for the i^{th} comparable; *k* is the number of comparables and *m* is the number of property characteristics.

If all *k* comparables are identical to the subject property, Equation (10) breaks down because both terms in the numerator are zero and the denominator is also zero. In such a case, the reconciliation process is a simple average. The equation makes sense when there is at least one comparable that is not identical.

AN EMPIRICAL EXAMPLE

The proposed SCM implementation to estimate the value of a single storey linked house is demonstrated. Table 2 shows 14 transaction records in a neighbourhood and the first transaction (house No. 1) is taken to the subject property and the remainder to be candidate comparables. The transacted prices and characteristic values of the candidate comparables are used to calculate the Pearson’s correlation coefficients to be utilized as the basis of weights in the calculation of Minkowsky metrics (Table 3). The ranked Minkowsky metrics of the candidate comparables are then determined (Table 4). The three selected comparables are property No. 5, 4 and 3. OLS regression of the rest of the candidate comparables provides the adjustment factors for the house characteristic (Figure 1). Table 5 shows the adjustment and reconciliation of the comparables giving the predicted value of RM70, 000.

Table 2: Transaction records of single storey houses in a neighbourhood

House ID	LA	MFA	AFA	BED	COS	POS	Price (RM)
1	97.0	47.38	18.59	2	1	1	65,000
2	97.0	47.38	4.87	3	1	1	65,000
3	97.0	47.38	18.5	3	1	1	69,000
4	97.0	47.38	18.605	3	1	1	70,000
5	97.0	47.38	18.605	3	1	1	71,000
6	121.0	47.38	14.86	3	1	1	75,000
7	145.0	80.38	19.35	3	1	2	100,000
8	143.0	87.75	10.03	3	4	1	118,000
9	143.0	87.75	16.73	3	4	1	120,000
10	143.0	87.75	16.55	3	4	1	120,000
11	163.504	87.75	16.526	3	4	1	125,000
12	163.504	87.75	16.526	4	4	1	125,000
13	143.0	87.75	32.916	4	4	1	128,000
14	143.0	85.31	11.16	4	4	1	139,000

Table 3 Weighting of house characteristics

Characteristic	Coefficient	Absolute Difference	Weight (%)
LA	0.9173	0.2530	25.2997
MFA	0.9669	0.2667	26.6673
AFA	0.1410	0.0389	3.8888
BED	0.6516	0.1797	17.9717
COS	0.9415	0.2597	25.9682
POS	0.0074	0.0020	0.2042

Table 4: Ranking of candidate comparables according to Minkowsky metrics

House ID	Minkowsky Metric	Ranked
1	-	-
2	0.171018000	5
3	0.060119012	3
4	0.059958971	1
5	0.059958971	1
6	0.119963437	4
7	0.255539479	6
8	0.492170194	10
9	0.463864614	8
10	0.463377581	7
11	0.484944465	9
12	0.514908054	13
13	0.505642743	11
14	0.510617887	12

Table 5: Adjustment and reconciliation of comparables

House ID	Transacted Value (RM)	Total Adjustment (RM)	Indicated Value (RM)	Weight	Weighted Value (RM)	Predicted Value (RM)
5	71,000	-230.45029	70,769.55	0.33503	23,710.42	69,789.63 round-up to 70,000
3	69,000	-183.82126	68,816.79	0.32992	22,703.83	
4	70,000	-230.45029	69,769.55	0.33503	23,375.38	

The subject house was transacted at RM65,000 giving a prediction error of RM5,000. Upon examining the characteristic values of this house, it was found that they are more similar to houses No. 4 and 5 that was transacted at RM70,000 and RM71,000, respectively.

Cross validation of the transacted prices of Table 2 produces prediction accuracy measures shown in Table 6. All measures are significantly high indicating the ability of the procedure to provide accurate property values.

Table 6: Cross validation statistics

Median Ratio	Coeff of Dispersion	Prediction <10 %Error	RMSE	Hit Rate
1.0	5.4	92.86%	9400.79	14.29%

Accuracy Assessment

Table 7: Accuracy Assessment for property in a Neighbourhood

Year	R-square	Adjusted R-square	LA	MFA	AFA	COD	PRD	RMSE	hit	10% Range	20% Range	Total Data
2004	53.8%	53.3%	495.2423 (0.000)		2357.46 (0.000)	10.92	1.07659	55033.7382	8	71%	90%	174
2005	57.4%	56.4%	526.71 (0.000)	1324.74 (0.000)	-	11.141	0.97138	33849.6977	2	61%	91%	88
2006	72.2%	71.9%	462.55 (0.000)	1400.12 (0.000)	-	6.9735	0.9635	19953.4709	16	71%	97%	232
2007	65.9%	65.8%	437.16 (0.000)	-	-	6.177	1.07854	19954.732	2	89.10%	96%	413
2008	61.4%	61.05	623.73 (0.000)	1022.16 (0.000)	1107.90 (0.02)	10.646	1.09769	37176.9693	4	66%	87%	287
2009	82.3%	82.0%	228.21 (0.000)	2368.32 (0.000)	4296.50 (0.01)	11.87	1.13402	134255.277	4	54%	87%	233

The result in Table 7, shown that the model recommended is more than acceptable as R squared for all years is more than 50%. The coefficient of dispersion (COD) calculated less than 15 is associated with good appraisal uniformity and and price related differential (PRD), statistics measuring assessment comply with International Association of Assessing Officers (IAAO, 2009). The table shown 10% range of value compared to transaction price agree with Fradie Mac criterion for evaluating automated valuation model whereby Fredie mac AVM specify at least 50% of predictions must be within 10% of actual market price (Fredie Mac,). We believe this finding can be acceptable to the Valuation Department and finally the model can be recommended to the Board of Valuers, Estate Agent and Appraisal Malaysia.

DISCUSSIONS

The practice of property valuation in Malaysia has remained a human-intensive task although similar practices in the several advanced countries have move to automated valuations. Human-intensive property valuations are slow and prone to mistakes and most importantly cannot meet the current demand for fast and accurate valuation (Downie & Robson, 2007). The demand for fast valuation can be seen from several examples: clients should know the amount of stamp duty incurred when submitting the application at counters instead of having have to wait for a number of days; bank is providing an excellent service if its officers can advise clients of the maximum amount that they can borrow, and having greater chances of being approved, at the time of application instead of having the applications rejected one week later; an educated buyer would like to know if the asking price of a property by a seller is actually the current market value of the property. There are many other situations that automated valuations are useful and in demand, especially in providing an initial accurate estimate of the value of property.

Automated valuations are not meant to replace valuation professionals; they are tools to aid valuation tasks (Bahjat-Abbas, Carron, & Johnstove, 2005; Mitropoulos, Wu, & Kohansky, 2007). Valuing a property involves many steps and factors. Comparables properties most similar to the subject properties have to be found from the available past transaction records; comparables may not match the subject exactly in all of their characteristics and the differences which reflect in their values must be adjusted. The adjusted values of the comparables may still differ from one another and thus must be reconciled to obtain the predicted value of the subject. These complicated but routine tasks which have to be performed by valuers can be left out to automated valuations because computers are more efficient in carrying out those tasks. Valuers can spend more time on non-routine tasks that require personal and human input.

Subjective predictions have haunted the valuation profession for a long time. Valuation professionals were able to live with them because they are immune to the phenomena; subjective predictions exist long before they are in the profession. However, subjective predictions are something hard to accept for people outside the valuation profession simultaneously shows not good image of the profession. It does not take more than shifting to another procedure and a little adjustment to what has been accustomed to, in order to discard subjective prediction and raise the image of the profession.

A formal implementation procedure is proposed so that automated valuations may be implemented and subjective predictions eliminated. A limited accuracy assessments show the procedure is capable of providing accurate prediction. It is recommended that extensive study of the procedure is carried out to look at several other issues such as outliers in transaction records, insignificant adjustment factors (regression coefficients), insufficient candidate comparables, etc. Other variations for each of the steps are also possible such as alternative way to determine adjustment factors and other strategies to weight comparables.

CONCLUSIONS

The objectives of the proposed SCM implementation procedure are to (i) enable automated valuations to be realized, and (ii) eliminate subjective predictions. Automated valuations and objective predictions are not possible with the current procedure of SCM due to its informal nature. The proposed procedure formalizes the three major activities of SCM (selecting, adjusting and weighting of comparables) providing precise rules how they must be carried out. By prescribing to a set of rules, subjectivity is eliminated and automated valuations become possible.

The most important issue in a property valuation procedure is the ability of the procedure to provide accurate prediction of property values. A limited prediction accuracy assessments show relatively high prediction capability of the proposed procedure signifying a high potential of it to be adopted. It is recommended that extensive study of the procedure is carried out to resolve other issues and ascertain its merit.

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