Original Article

Specialised property valuation: Multiple criteria decision analysis

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ABSTRACT The aim of valuation is to achieve the best estimate of the transaction price of property. The market of specialised properties is very diverse as property does not transact sufficiently often to allow the establishment of price by comparison with previously sold assets. This article describes a multiple criteria decision analysis method that can be used for specialised property valuation. This method is based on a market decision-making principle and is in line with the traditional comparative methods. To estimate the property price, information on as little as two comparable properties is required. The method takes into account a number of different criteria, such as qualitative, quantitative aspects and market conditions. In this article, I describe a theoretical model of the method and provide an example of the estimation of price for a specialised property.

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INTRODUCTION

The valuation of property is an important constituent for many businesses. Depending on the type and use, properties are divided into non-specialised and specialised (French, 2004; Maliene *et al.*, 2010). For non-specialised property, there exists sufficient transaction activity, and thus the level of prices can be established without having to interpret the property's underlying essentials. The final price is determined by comparison. The market of specialised properties is significantly more diverse than the non-specialised one. The main reason for this is that specialised properties do not transact sufficiently often (or there is no established market of transactions) to allow establishing the price of property by comparison with previously sold assets (Pagourtzi *et al.*, 2003). Under these circumstances, the process of valuation is based on

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a restricted number of methods, which assess the nature and underlying essentials of property in a way that its value can be established by referring to the cost of replacement, income- or profit-producing qualities of the property. This is the foundation of the valuation methods used for the valuation of specialised property (Sayce, 1995; Askham, 2003).

Traditional methods of property valuation cannot always be expressed mathematically to meet the needs of the interested parties – buyers, sellers, investors. Although valuation standards are available (IVSC, 2007), experts are increasingly confronting the shortcomings inherent in the traditional valuation methods when estimating the price of property. The valuer's task is impeded by the fact that the customer demands the analysis of real property, which is precise and easy to understand, and the valuation that is performed by using popular methods. In addition to that, the application of unconventional methods of property analysis and valuation has no legal framework. Therefore, the valuer is frequently forced to use such valuation methods, which have a superficial mathematical description. In such cases, the valuer cannot avoid subjective decisions being made, which make the property valuation methods unreliable. The fact is that a reliable and objective valuation method is key to the correct estimation of property price (McParland *et al.*, 2002). Such a situation has brought the need for innovations in the price estimation methodology.

In addition to the mathematical model of the property valuation method and its application opportunities, a number of other criteria determining the price of property are important in the valuation process, that is, qualitative (local infrastructure, physical status of the property, site location, legal restrictions) and quantitative (area of the property, number of buildings on the land plot, volume, number of floors, year of construction) characteristics of the property, market conditions (real property supply and demand, investment opportunities, local economic and demographic situation), as well as other criteria. Comprehensive description of the criteria ensures the maximum precision in estimating price of property. Depending on the purpose for which it is used and the types of real property, the value is predetermined by economic, legal, social, political, public planning and psychological criteria, the assessment of which depends not only on the valuer's efficiency and skills, but also on the capacity of the valuation methods to analyse the above-mentioned criteria.

A number of problems in property valuation can be eliminated by the methods of multiple criteria decision analysis (MCDA) (Belton and Stewart, 2002). The article describes the method that is based on the market analysis and valuation principle. It facilitates the universal and more extensive multiple criteria analysis of the property (Urbanavičiene *et al.*, 2009; Zavadskas *et al.*, 2010), as the method takes into account a number of different criteria and can satisfy the demands of many interested parties.

METHODOLOGY

To carry out the MCDA of the specialised property, the decision-making matrix must be prepared in the following stages: (1) all information about specialised property to be valued is collected; (2) the criteria defining the

aims of the multiple criteria analysis are determined; (3) values, levels of significance and units of measurement of criteria of comparable alternatives are defined; (4) criteria, their value and levels of significance make up the grouped decision-making matrix (Zavadskas *et al.*, 1997; Maliene, 2001).

One of the most important stages in multiple criteria analysis of property is the determination of the values and levels of significance of the criteria describing the properties. Levels of significance of the criteria defining the quality and quantity of the properties to be valued and values of the qualitative criteria for the alternatives are estimated through the application of expert, social, normative, calculation and analogue methods.

When the calculation is carried out in accordance with the expert method, the qualitative values of criteria can be expressed in a certain number of points. Criteria can be estimated according to the increasing or decreasing valuation scale.

To estimate the proportional values of the quantitative criteria, the expert valuation is based on comparison. In this case, the values of the qualitative criteria are estimated as follows: (1) the best suitable value of the criterion x_{best} is selected; (2) the value of the best selected criterion is set equal to the magnitude of one point ($x_{best} = 1$); (3) the ratio between the best criterion's value ($x_{best} = 1$) and the remaining values (x_i) of the same criterion is estimated and expressed in percentage (p_i); (4) the relative values are attributed to the remaining values of the criterion ($x_i = (1 - p_i) \div 100$); (5) relative values of all the criteria are set equal to the magnitude of one point (Table 1).

Initial significance of the criteria is determined in a similar way. The market price of specialised property reflects quality and quantity, as well as supply and demand for the property; therefore, the significance of the market price criterion for the given specialised property is equal to the total sum of significance of all the remaining criteria, that is, to one point

Table 1: The grouped decision-making matrix of the MCDA of properties to be valued

Quantitative information on property									
Criteria		Significance	Measuring units	Property objects to be valued					
				1	2	...	j	...	n
Quantitative criteria	z_1	q_1	m_1	x_{11}	x_{12}	...	x_{1j}	...	x_{1n}
	z_2	q_2	m_2	x_{21}	x_{22}	...	x_{2j}	...	x_{2n}
	...	...	...	...	...	...	...	...	...
	z_i	q_i	m_i	x_{i1}	x_{i2}	...	x_{ij}	...	x_{in}
	...	...	...	...	...	...	...	...	...
	z_t	q_t	m_t	x_{t1}	x_{t2}	...	x_{tj}	...	x_{tn}
Qualitative criteria	z_{t+1}	q_{t+1}	m_{t+1}	$x_{t+1\ 1}$	$x_{t+1\ 2}$	...	$x_{t+1\ j}$	...	$x_{t+1\ n}$
	z_{t+2}	q_{t+2}	m_{t+2}	$x_{t+2\ 1}$	$x_{t+2\ 2}$	...	$x_{t+2\ j}$	...	$x_{t+2\ n}$
	...	...	...	...	...	...	...	...	...
	z_j	q_j	m_j	x_{j1}	x_{j2}	...	x_{jj}	...	x_{jn}
	...	...	...	...	...	...	...	...	...
	z_m	q_m	m_m	x_{m1}	x_{m2}	...	x_{mj}	...	x_{mn}
Conceptual information on property (texts, drawings, graphics, tapes)									
K_k	K_z	K_q	K_m	K_1	K_2	...	K_j	...	K_n

or 100 per cent. The levels of significance of other criteria are determined by the expert method.

The decision-making matrix must be prepared in order to carry out the multiple criteria analysis of specialised property. The matrix is prepared through the analysis of the quantitative and conceptual information of the specialised properties to be valued, as well as by estimation of the criteria values and levels of significance of the properties.

The value of the property under valuation is determined by means of reiteration through several repetitive cycles of refinement until the mean deviation k_x of the degree of utility N_j of the property a_x under valuation satisfies the condition $k_{ax} < \pm 1\%$. The initial price of the property under valuation is estimated according to the purchase prices of the comparable properties and is equal to the mean of purchase prices of the comparable properties.

The essence of the method of multiple criteria analysis in estimating property price is presented in Figure 1. The method is composed of a total of four stages, of which two are stages concerned with the preparation of initial data.

Stage three is a reiteration of refinement cycles, which results in stage four, at which the specialised property price is determined. A normalised decision-making matrix D is formed. The purpose of this stage is to obtain dimensionless weighted values from comparative indexes. When the dimensionless weighted values are known, it is possible to compare all the indexes of different units of measurement. The following formula is used for that purpose:

$$d_{ij} = \frac{x_{ij} \cdot q_i}{\sum_{j=1}^n x_{ij}}, \quad i = \overline{1, m}; \quad j = \overline{1, n}. \quad (1)$$

Figure 1: MCDA method overview

The sum of the dimensionless weighted values d_{ij} of each criterion x_i always equals the significance q_i of this criterion.

$$q_{ij} = \sum_{j=1}^n d_{ij}, \quad i = \overline{1, m}; \quad j = \overline{1, n}. \quad (2)$$

The sums of the minimising indexes S_{-j} and maximising indexes S_{+j} characterising the j variant are calculated. They are calculated according to the following formula:

$$S_{+j} = \sum_{i=1}^m d_{+ij}; \quad S_{-j} = \sum_{i=1}^m d_{-ij}, \quad i = \overline{1, m}; \quad j = \overline{1, n}. \quad (3)$$

In this case, the values of S_{+j} and S_{-j} express the degree to which the property being compared achieves its purposes.

In any case, the sums of all the pluses S_{+j} and minuses S_{-j} of the properties being compared are always equal to all the sums of significance of the maximising and minimising criteria:

$$\begin{aligned} S_{+j} &= \sum_{i=1}^n S_{+j} = \sum_{i=1}^m \sum_{j=1}^n d_{+ij}; \\ S_{-j} &= \sum_{i=1}^n S_{-j} = \sum_{i=1}^m \sum_{j=1}^n d_{-ij}, \quad i = \overline{1, m}; \quad j = \overline{1, n}. \end{aligned} \quad (4)$$

The relative significance (effectiveness) of properties being compared is determined in accordance with the positive (pluses) S_{+j} and negative (minuses) S_{-j} qualities that characterise these properties. The relative significance Q_j of each alternative a_j is determined according to the following formula:

$$Q_j = S_{+j} + \frac{S_{-\min} \cdot \sum_{j=1}^n S_{-j}}{S_{-j} \cdot \sum_{j=1}^n \frac{S_{-\min}}{S_{-j}}}, \quad j = \overline{1, n}. \quad (5)$$

The prioritisation of the properties is determined. The larger the Q_j , the larger the effectiveness (prioritisation) of that alternative. The summarised criterion Q_j directly and proportionately depends on the relative influence of the value and the initial significance of the criteria under comparison on the final result.

The degree of utility N_j of the property a_j is determined according to the following formula:

$$N_j = \frac{Q_j}{Q_{\max}} 100\%. \quad (6)$$

The degree of effectiveness E_{xj} of all the alternatives a_j is determined. It shows by what percentage a property a_x is better or worse in comparison with another property a_j :

$$E_{xj} = N_x - N_j, \quad j = \overline{1, n}. \quad (7)$$

The mean deviation k_x of the degree of utility N_j of the property a_x is determined:

$$k_x = \sum_{j=1}^n E_{xj} / (n-1). \quad (8)$$

If the mean deviation k_x of the degree of utility N_j of the property a_x under valuation does not satisfy the condition:

$$k_{ax} < \pm 1\%. \quad (9)$$

then proceed to formula 10.

The value V_{xp} of the property under valuation is refined according to the following formula:

$$V_x = C_x (1 + k_x / 100). \quad (10)$$

V_{xp} is the refined value of the property under valuation. C_x is the refined value of the property under valuation after the n th iteration. k_x is the mean deviation of the degree of utility N_j of the property under valuation.

The price of the specialised property under valuation is refined by means of reiteration through several repetitive cycles of refinement until the mean deviation k_x of the degree of utility of the property under valuation satisfies condition (9). After condition (9) is satisfied at stage 10 by the method of multiple criteria analysis in estimating the property price, proceed to stage 12.

The value V_x of the property being valued is determined according to the following formula:

$$V_x = C_x (1 + k_x / 100). \quad (11)$$

V_x is the value of the property under valuation, C_x is the refined value of the property under valuation after n th iteration, k_x is the mean deviation of the degree of utility N_j of the property under valuation.

EXAMPLE OF APPLICATION

Two specialised properties were selected for the comparison with the asset that has been valued. All three properties contain differences in quality, quantity and market conditions. The details on the properties were collected and summarised in Table 2 as a grouped decision-making matrix formed by property experts.

Table 2: Data on specialized properties for MCDA matrix

Criteria		Units of measurement	Weight, %	Property under valuation	Comparable property A	Comparable property B
1. Selling price	–	£1000	100	X	204.6	143.0
<i>Evaluation of the building</i>						
2. Construction design	+	Points	3.50	0.85	0.80	1.00
3. Physical depreciation	–	Percent	3.00	57.00	34.00	29.00
4. Functional depreciation	–	Percent	2.50	37.00	42.00	42.00
5. Economic depreciation	–	Percent	3.50	13.00	24.00	33.00
6. Number of Auxiliary buildings	+	Units	4.00	0.00	1.00	0.00
<i>Quantitative assessment of premises</i>						
7. Total area	+	Square m	5.50	490	334	308
8. Number of salerooms	+	Units	1.50	2	1	2
9. Area of salerooms	+	Square m	3.50	230	150	216
<i>Qualitative assessment of premises</i>						
10. Interior	+	Points	4.00	1.00	0.60	0.55
11. Exterior	+	Points	2.50	0.75	0.80	1.00
12. The need for renovation	–	Points	3.50	0.15	0.70	0.50
13. Trading equipment	+	Points	4.50	1.00	0.75	0.00
14. Number of entrances	+	Units	1.00	2.00	1.00	2.00
15. Entrances with respect to the street	+	Points	5.50	1.00	0.95	0.60
16. Position of showcases	+	Points	4.50	0.90	1.00	0.50
17. Advertising possibilities	+	Points	4.00	0.90	1.00	1.00
18. Location with respect to parts of the world	+	Points	0.50	0.60	0.80	1.00
<i>Assessment of communications</i>						
19. Engineering communications	+	Points	3.50	1.00	1.00	1.00
20. Number of telephone lines	+	Units	1.50	1.00	1.00	2.00
21. Assessment of alarm systems	+	Points	5.00	0.00	0.00	1.00
22. Assessment of air conditioning	+	Points	2.00	0.75	1.00	0.25
<i>Estimation of the place</i>						
23. Distance from city center	–	Km	5.50	2.00	4.00	1.00
24. Public transport	+	Points	5.00	0.80	1.00	0.75
25. Distance from bus stops	–	Km	1.50	100	200	50
26. Car Park	+	Points	5.00	0.70	0.50	1.00
<i>Other criteria</i>						
27. Prestige of locality	+	Points	7.50	0.90	0.80	1.00
28. Assessment of market conditions	+	Points	6.50	0.95	0.95	1.00

Table 3: Estimation of changes in the mean deviation of the utility degree, the refined price and the market value of the specialized property under valuation

Cycle of refinement	Refined price in £ of the property, V_{xp}	The mean deviation of the utility degree for property	Market value in £ of the property under valuation V_x
1	171,600	8.83 > 1	—
2	189,145	3.96 > 1	—
3	181,841	2.11 > 1	—
4	178,002	1.14 > 1	—
5	175,978	1.03 > 1	—
6	174,163	0.58 < 1	—
			173,151

The price of the specialised property was estimated in six cycles of refinement, until the mean deviation k_x , of the degree of utility of the property under valuation, was calculated to satisfy the condition $k_{ax} < 1$ per cent. Table 3 illustrates changes in the mean deviation of the degree of utility of the property and the refined price of the property throughout all six cycles of refinement. In the last (sixth) cycle of refinement, the required condition was satisfied and the market price of the specialised property was estimated to be £173 151.

CONCLUSIONS

The method of MCDA for estimating the price of specialised property enables to estimate not only the property price, but other values as well. The application of this method facilitates the performance of a complex analysis of the property, the utility of the given properties and their prioritisation in terms of one another and the significance of criteria affecting the specialised property price and marketability of the given properties.

The method can be applied not only as a separate method for estimating price, but also as a composite method within the traditional valuation methods: in the comparative method – to evaluate specific criteria influencing the market value (for example, local infrastructure, location of a property under valuation and so on); in the method of cost of replacement approach – to evaluate the depreciation of a building under valuation.

The MCDA is based on the market and specialised property analysis and on the application and evaluation of the qualitative and quantitative criteria and market conditions influencing the price of property. Therefore, this method is instrumental in carrying out the complex analysis of property with not only qualitative and quantitative differences, but with different market conditions as well.

The method is useful for specialised property valuation, as it does not require large number of properties for comparison. The example demonstrates that two comparable properties are sufficient to perform analysis.

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