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IDENTIFICATION OF NETWORK STRUCTURE OF CADASTRAL COST INDICATORS OF LANDS UNDER COMMERCIAL BUILDINGS OF THE SMALL CITIES OF MURMANSK REGION

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Abstract: *The article is devoted to the identification of structure of cadastral cost estimated indicators of land plots occupied with objects of commercial building in small towns of Murmansk region, Russia. The technique of research includes forming of objects of an appraisal, collection of indicators' values to estimate factors, checking of their statistical interdependence, making structure of indicators and* rationalizing *method of calculation of their scales for the purpose of cadastral appraisal of land plots. Results have shown that for commercial lands network the nature of structure of indicators occurring causes need of application of a method to analyze network structures for calculation of their scales. Results of research and conclusions can be used for adjustment and addition of the contemporary system of mass cadastral appraisal of the towns in Russian Federation.*

Keywords: *estimated indicator, mass appraisal, cadastral cost, expert method, method of the analysis of network structures, analytic hierarchy process.*

1. INTRODUCTION

According to the land title regulations of the Russian Federation the state cadastral appraisal represents a complex of the legal, administrative and technical events held for the purpose of establishment of cadastral cost of land plots. The cadastral cost of an appraisal is the market value determined by methods of mass appraisal and established according to the legislation regulating cadastral appraisal.

The subject of cadastral appraisal of urban lands and its methodology has found reflection in many publications of Russian and foreign researchers. So, for example, in works (Baltyzhakova, 2013, Kiselev, 2013, Tributs, 2012, Chernetskaya, 2014, Shabayeva, 2015, Baumane and Celms, 2013) the major factors exerting impact on real estate value in settlements are analyzed. Researches (AL-Oqla and Hayajneh, 2010, Bagdonavicius and Deveikis, 2005, Baumane, 2011) are devoted to the main approaches applied in mass and individual appraisal. Articles (Baumane, 2010, Baumane, 2011,

[1] Saint Petersburg Mining University, Russia, 199106, Saint Petersburg, 21st str. V.O., 2

Lepikhina, 2009) contain requirements imposed to the market information used for doing cadastral appraisal.

The history of development of institute of cadastral appraisal in Russia has been lasting for one and a half decades. It begins with adoption of the Order of the Government of the Russian Federation ("On the state cadastral appraisal of lands", 1999) in which it is offered to perform mass cadastral appraisal of land plots of all categories for the taxation and other purposes. At this time development of a methodology for state cadastral appraisal which underwent essential changes subsequently has begun. First methods of urban land mass estimation were based on the expert approach to definition of land plot's cost (for example, method of expert estimation of urban sections by A.V. Sevostyanov). It was method of state cadastral estimation of urban territory (Technique of the state cadastral appraisal of urban lands, 2002), where the statistical estimation component has been used for the first time together with the expert one. The method of the state cadastral estimation of urban territory ("On the approval of Methodical instructions by the state cadastral appraisal of urban lands", 2007) and its technical recommendations ("On the approval of Technical recommendations about the state cadastral appraisal of lands of settlements", 2007), has formally abolished the expert estimation component, using only the statistical approach based on the analysis of market prices for the real estate of a city. Thus, since 2007, state cadastral estimation of urban territory should be conducted in compliance with the method.

However, there are obstacles to application of this method, especially under the conditions of small and middle cities of Russia, related to missing and unreliable initial market information on real estate transactions for creation of adequate statistical model (Lepikhina, 2009). In this situation, application of the expert approach in case of determination of scales of indicators of cadastral cost of lands in towns with weak real estate market is justified.

2. METHOD

At the present stage, the cadastral cost of urban lands is the base for calculation of tax payments therefore need of receipt of reasonable and fair sizes of cost of land plots does not raise doubts. This task is very actual in connection with introduction of the real estate tax, which directly depends on the cadastral cost of a plot. However, the existing methodical base of land cadastral cost calculation does not duly provide unbiased appraisal results which is evidenced by numerous suits claiming such results. The reasons of the situation are in many respects caused by methodology-related appraisal faults as evidenced in numerous scientific publications. Previous researches (Lepichina, 2009, 2011) have been in the field connected with cadastral appraisal of lands of residential development of small towns of the Northwest region of Russia. The analysis of indicators of cadastral cost of lands has revealed availability of strong correlation interdependence between some of them based on which the conclusion has been drawn on impossibility to apply an expert Analytic hierarchy process for calculation of scales of indicators. Method of the analysis of network structures offered

by the authors as an admissible option for calculation of scales of indicators has been approved within a developed technique for the estimated sites. The received cadastral costs of objects have been brought more closer to market that testifies to higher objectivity of such appraisal. Results of research for the city lands occupied with housing were very curious, have received a large number of responses, and authors have made decisions to continue work on this subject. The network structure of indicators of cadastral cost of lands of a residential development of small and middle cities is proved, however by other types of use of lands, for example, of commercial building, the type of structure is not determined that does not allow to choose the correct expert method of calculation of their scales. It has predetermined the purpose of this research consisting in determination of structure of cost indexes of the lands occupied with commercial objects, small cities of the Northwest region of Russia for the purpose of reasons for a method of calculation of scales of indicators. As the researched settlements the group of the small cities of Murmansk region is chosen: Monchegorsk, Olenegorsk, Kirovsk, Kovdor.

The research technique includes the following stages:

1. Forming the list of the estimated objects – land plots occupied with commercial objects, the researched group of the small towns.
2. The choice of indicators of cadastral cost of the lands participating in an appraisal.
3. Definition of estimated indicator values for each urban land plot with the help of GIS MapInfo.
4. The statistical analysis of received estimated indicator distribution character.
5. Checking of indicator distributions for conformity with the normal law.
6. Revealing of dependent estimated indicators based on factor correlation calculation.
7. Forming the structure of cadastral cost indicators of the land parcels studied and choosing a method to calculate their scales.

According to the method of the state cadastral estimation of urban territory, confirmed in 2007 (further – Method), scales of cadastral indicators are defined using Analytic hierarchy process (AHP) created by the famous scientist T.L. Saati. AHP is widely spread in many areas, such as sociology, economy, psychology and others (Al-Oqla and Hayajneh, 2010, Vaidya and Kumar, 2006). Use of a method in cadastral works is highlighted in (Giluca et al., 2011). Works of the Russian and foreign researchers are devoted to various aspects of applying a method for massive real estate appraisal (Belton and Stewart, 2003, Ishizaka and Labib 2009). In articles (Shabaeva, 2009, Kornilov and Sapozhnikova, 2013) the option of the modified method of the analysis of hierarchies for ensuring more approved results of judgments of experts in case of determination of scales of value drivers is offered.

The method is based on decision making by carrying out pair comparisons of estimated indicators with use of the fundamental scale containing numerical estimates of preference of one of couple indicators (for example, A1) in relation to other indicator of couple (for example, A2) by the set criterion of B1. The domination matrix from which scales of the relations on the basis of calculation of the main own vector are removed (Saaty, 2008) is as a result created. Elements of a vector represent the weight of the corresponding indicators of cadastral cost of the parcels of land.

The main condition of AHP application is absence of dependences and feedback between elements (indicators) at various levels of hierarchy.

In case of establishment of interdependence of elements at one or different levels or proofs of availability of feedback such structure is not hierarchical, but network. In this case for the solution of a task of calculation of weight coefficients of elements generalization of the AHP method – method of the analysis of network structures (NSAM) is used.

The essence of a method consists in creation of the square block matrix describing dependences between factors and indicators of cadastral cost of lands. In case of creation

		C_1				C_2				...	C_m			
		e_{11}	e_{12}	...	e_{1n1}	e_{21}	e_{22}	...	e_{2n2}	...	e_{m1}	e_{m2}	...	e_{mnm}
C_1	e_{11}	W_{11}				W_{12}				...	W_{1m}			
	e_{12}													
	...													
	e_{1n1}													
C_2	e_{21}	W_{21}				W_{22}				...	W_{2m}			
	e_{22}													
	...													
	e_{2n2}													
...	...	...				...				...	...			
C_m	e_{m1}	W_{m1}				W_{m2}				...	W_{mm}			
	e_{m2}													
	...													
	e_{mnm}													

Symbols:

$C_1..C_m$ – components (pricing factors)
$e_{11}...e_{mnm}$ –elements (indicators)
$W_{11}...W_{mm}$ – matrix blocks

Figure 1: Block matrix structure

of a matrix it joins dependent factors and dependent indicators entering each factor. Blocks of a matrix (fig. 1) are as a result created.

Each column in the W_{ij} block is the main own vector of influence of an estimative indicator of *i* of a factor on factor *j* indicators. Zero elements of a vector correspond to the factors and their indicators which are not exerting impacts on others. The blocks standing on the main diagonal of a matrix describe intra group influences of indicators, other blocks characterize intergroup influences. A vector of priorities is received on the basis of pair comparisons of indicators with use of a fundamental scale.

When carrying out pair comparisons of indicators it is necessary to answer the following question: for the set indicator on which influence is estimated and the compared couple of indicators, for the set indicator by which the influence is assessed and the pair of indicators compared, how strong is the influence of this indicator out of the pair on the assessed indicator as compared to another?

Own vector of matrixes of pair factor comparisons are used as weight coefficients by which the blocks of a block matrix located in a column under this factor are multiplied. As a result the weighed block matrix which is stochastic on columns turns out.

At the following stage the stochastic matrix is built in limiting degrees for the purpose of an assessment of distribution of influence along all possible routes of the scheme of influences. The received limiting elements of a block matrix are interpreted as limiting estimates of long-term influence of each element of system on other elements, they also are scales of estimative indicators.

So, to create a structure of indicators of cadastral cost of the land parcels occupied with commercial real estate in the studied group of cities it is necessary to perform check of correlation interdependence of assessment indicators.

For the solution of an objective on identification and a quantitative assessment of narrowness of their interrelation depending on the distribution law of indicators use of coefficient of correlation of Pearson or the rang coefficients of correlation of Spearmen (Kendall) is possible. Admissibility of application of each of these coefficients is caused, first, by type of a statistical scale of an indicator, secondly, by compliance to its normal distribution law. Thus, for reasons for the choice of correct coefficient of correlation it is necessary to check these two conditions for the received selections of values of estimative indicators. Depending on availability and degree of interdependence of indicators of cadastral cost of the parcels of land it is possible to create structure of indicators, and also to prove a method of determination of weight coefficients, as is resulting effect of research.

3. RESULT

Objects of research of this article are the parcels of land occupied with objects of commercial appointment, the small cities of Murmansk region of Russia located in group:

Monchegorsk, Olenegorsk, Kirovsk, Kovdor. The cadastral appraisal is carried out concerning the parcels of land created and considered in the State Immovable Property Cadastre by each type of use. Thereof based on the cartographic and text materials containing on the Public cadastral map of area of initial selection of the parcels of land of the cities belonging to commercial types of use has been created. Sites, under objects of trade, public catering, consumer services, office buildings and other commercial objects have got to this selection. In total selection has included data on 134 parcels of land.

Market research of real estate of the cities for this segment of real estate has revealed that most the cost of lands is caused by influences of such factors as location, a level of development of transport and engineering infrastructure, an ecological condition of the territory. Authors suggest to express each of the specified factors by means of system of estimative indicators (tab. 1)

Collection of values of estimative indicators for each researched site is performed with use of tools of the spatial analysis and modeling of the GIS MapInfo 11.5 system. It should be noted that for factors of engineering infrastructure and ecology, essential differentiation of values of their indicators is not observed owing to which, for creation of final model of cadastral cost of the parcels of land, they most likely will not be chosen. Thus, for calculation of correlation dependences indicators of factors location and transport infrastructure have been chosen.

For the solution of a task in view on revealing and a quantitative estimation of communication narrowness between estimated indicators depending on the law of

Table 1
The list of factors and estimated indicators of cadastral cost of lands of the studied group of the cities of Murmansk region

Factor	*Indicators*	*Characteristic of indicator*	*Scale*	*Measure unit*
Location	Proximity to city centre	Distance from the centre of the land plot to the city centre	Interval	Meter
Engineering infrast-ructure	Heat supply Power supply Sewerage Water supply	Supply of the object	Dichoto-mous	Yes/No
Transport infrast-ructure	Proximity to the next thoroughfare of the leading city directions	The ratio of the area of a roads with solid covering to a road total area on a section	Interval	Meter
	Proximity to urban transport stations of different route directions	Number of transport stations in radius of walk proximity	Ratio scale	Piece
	Proximity to taxi parking Proximity to bus station	The shortest distance from the centre of a section to the object	Interval	Meter Meter
Ecological situation	Level of water pollution Level of soil pollution Level of air pollution	Frequency rate of excess of maximum concentration limit on the polluting substances	Ratio scale	Times Times Times

indicator distribution two basic coefficients may be used: Pearson's correlation coefficient or one of the class correlation coefficients of Spearmen and Kendall. In order to check the conformity of received distributions to the normal law of distribution Kolmogorov-Smirnov's test has been used. At the same time, it is necessary to take into account that the specified statistical test can be used in case data are measured in interval, serial scales, or in a scale of the relations (in this case all indicators are measured on an interval scale and a scale of the relations). The defining characteristic of conformity to the normal law of distribution is value of the bilateral statistical importance, which in case of an essential deviation from normal distribution accepts values less than 0.05. By results of calculations it has been revealed that some of considered distributions do not submit to the normal law. Therefore, it is necessary to use the Spearmen's class correlation coefficient to check communication narrowness between considered indicators.

According to Cheddok's scale, strong communication between indicators is present at value of correlation coefficient more than 0.7.

Spearmen's class correlation coefficients have revealed presence of correlation of estimated indicators from table 2.

Table 2
Revealed dependent estimated indicators*

	Indicator 1	*Indicator 2*	*Indicator 3*	*Indicator 4*	*Indicator 5*
Indicator 1	1	**0.73**	**0.76**	**0.72**	**0.78**
Indicator 2	–	1	0.45	0.54	0.64
Indicator 3	–	–	1	0.63	0.57
Indicator 4	–	–	–	1	**0.76**
Indicator 5	–	–	–	–	1

* Indicator 1 – Proximity to city centre; Indicator 2 – Proximity to the next thoroughfare of the leading city directions; Indicator 3 – Proximity to urban transport stations of different route directions; Indicator 4 – Proximity to the taxi parking; Indicator 5 – Proximity to the bus station.
The table is symmetric.

Thus, research has revealed existence of strong correlation dependences between separate estimated indicators. In particular, the indicator of availability of the downtown has been strongly interconnected with other indicators. In this connection, when calculating their scales it is necessary to pass from hierarchical model of representation of factors to the model of network structures providing existence of interrelations of factors of various levels (fig. 2).

However, correct use of NSAM for calculation of scales of pricing factors causes also need of definition of influences of indicators at each other. Definition of the directions and nature of influence of indicators is carried out on the basis of expert judgments of authors (fig. 3)

We will explain nature of some of the provided directions of interference of indicators.

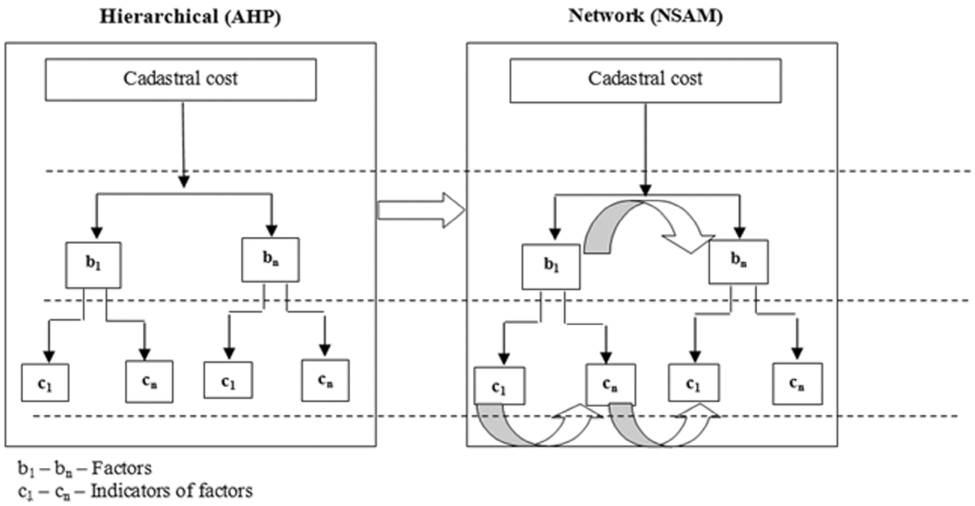

Figure 2: Transition from hierarchical model to model of network structures of factors and indicators of cadastral cost of the lands occupied with commercial real estate, the researched group of the small cities of Murmansk region

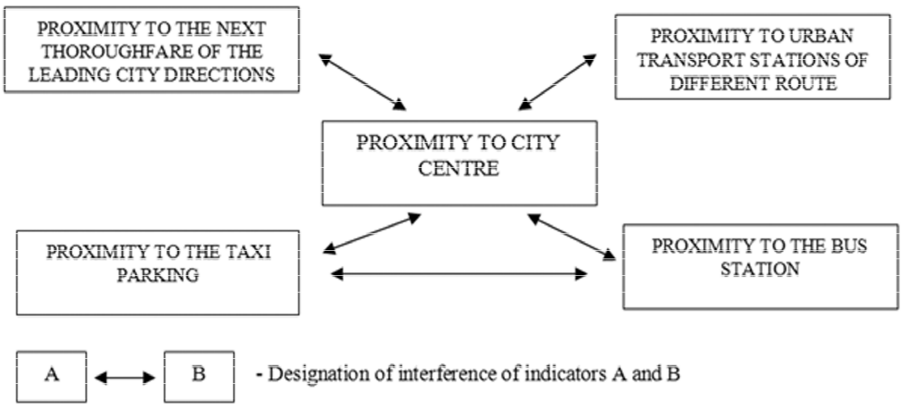

Figure 3: Graphical representation of mutual influence of estimated indicators of cadastral cost of lands

Interference of indicators of availability of the center of the settlement, city bus station and the taxi stand in the researched cities is caused by the accommodation of the last in the center of intercity transport connections which is territorially matching the downtown. It creates certain conveniences to the population: there is opportunity for the minimum period to reach a destination from a station or a bus station, or to use services of a taxi.

The indicator of availability of the downtown is also closely connected with availability of public transport stops. This circumstance is explained by the historical

and town-planning layout of the cities. Really, as approaching the downtown density of routes of an urban transportation, and, therefore, quantity of public transport stops increases.

4. DISCUSSION

The conducted research has led to the following results. For the parcels of land occupied with objects of commercial real estate of group of the small cities of Murmansk region as well as for lands of a housing estate, the network type of structure of estimative indicators is established. It results in need of rejection of the AHP method accepted in the state techniques for determination of scales of indicators in view of violation of requirements of its application. Under these conditions it is necessary to use correct approach – the NSAM method allowing for any dependences between elements in structure. Cadastral costs of the parcels of land in many respects depend on the scales of indicators considered in model in this connection, it is possible with big degree of probability to predict increase of objectivity and rationalization of appraisal results.

5. CONCLUSION

The institution of cadastral appraisal has been functioning for fifteen years, during this period several techniques of appraisal have been developed and approved within three rounds, however today there are many questions concerning degree of objectivity of the received cadastral costs. It demonstrates the existence of problems in that area.

In addition to the methodological faults of appraisal mentioned in this article, there are also objective problems connected with the weak market level in small cities of Russia. In the cities few real estate transactions are made, process of accounting and registration of transaction prices with real estate is not completely adjusted. Market information often is doubtful owing to aspiration of participants of the market to hide true transaction prices and differences of the prices of demand and offers on real estate from the subsequent transaction prices. The described situation interferes with application of adequate statistical methods of calculation of cadastral cost. On the other hand, conditions of application of expert techniques shall not be violated, and applicability of this or that method shall be correctly and is appropriately proved.

The population dissatisfaction with results of appraisal leads to attempt of enhance standard, legal and methodology-related issues a cadastral appraisal at the national level. So, quite recently the President of Russia announced fast adoption of the new federal act on approval of a new technique of a cadastral real estate appraisal. The act "is urged to remove … concerns" of the business community and individuals in connection with unfair cadastral real estate appraisal. Prime-minister D. Medvedev supported the idea of development and introduction of a new appraisal technique. It is necessary to hope that the new act at least will partially solve the related problems and will provide more objective results of cadastral real estate appraisal.

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Baumane V. (2010) Cadastral valuations models. In: Proceedings of the International Scientific Conference: Economic science for rural development, No. 22. Jelgava: LLU. P. 68-75.Cadastral valuation models2010 In accordance with legislative enactments cadastral or mass valuation shall be used for calculation of cadastral value, which is used for administration of real property tax. Cadastral valuation is based on the real property market information in market economics of European and other countries. There are some countries where taxes are calculated as a down payment area – expressed as a fixed amount per unit, depending on the land or buildings in use – the so-called normative value, but this practice is not common internationally, since the normative value does not describe the object, and it is not conducive to the economic development. The aim of the article is to survey the present cadastral valuation process in Latvia. The study provides the research results in the field of cadastral valuation, describes calculation of cadastral value reposing on base values and different models of cadastral valuation. The cadastral value shall be based on cadastre objects data of the State Cadastre of Real Property (hereinafter – Cadastre information system) as well as on the real property market information – information regarding purchases, lease, construction costs, real property market offer and demand, real property market activity, etc. Consequently, the cadastral

valuation process can be implemented successfully implying the use of approved cadastral valuation models and proper data of cadastral objects.

[investigacion, models, letonia, valeur d'estimation, catastros, propiedad, lettonie, modelos, cadastres, cadastre, research, recherche, market economies, estimacion, valuation, ownership, latvia, modele, economias de mercado, propriete, economie de marche]

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