Expert assessment of the most effective use of the land plot

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Abstract. This article considers the Highest and Best Use Analysis of the property in an underdeveloped market by analyzing preference choices using analytic hierarchy process. Ranking alternative uses of a plot as well as complete expert evaluation of main factors' of most effective use influence are carried out for a vacant land plot. As a result of the research the most desirable alternatives and the most important indicators of the factors have been revealed.
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Introduction

It is known that the value of any property (including land) is determined by the income from its usage. This income is directly dependent on the efficiency of use of the object. Hence the application of Highest and Best Use Analysis (HBU) allows you to identify the usage of real estate object that brings maximum benefit to its owner.

Modern methods of analysis of HBU includes real estate market research, property valuation, analysis of popular uses, coordinated with the characteristics of an object, the calculation of return on all variants and calculation of real estate cost. When deciding on the HBU you need to analyze certain indicators of the following major factors (table 1) [1,2].

The analysis of various versions of the use of the plot lies at the basis of four criteria: competence, physical feasibility, financial viability, maximum efficiency [1,3].

Thus, to determine the HBU variant, the appraiser needs to implement a coherent assessment of the above criteria for every possible use case.

However, there are certain difficulties. In an underdeveloped real estate market, that is typical for many small and medium-sized towns in Russia, the use of standard market approaches to determine the maximum efficiency options (the income approach, the sales comparison approach and the cost approach) are often ineffective, due to the lack of market data.

In this case, we need to employ a qualitative analysis method of the object's possible use options. This method suggests a sequence of stages [1]:

- Market analysis and identification of competitive uses;
- Evaluation of the property's parameters in terms of their suitability for each of the variants;
- Preparing a reasonable opinion of the appraiser about the HBU variant.

Table 1. Factors and indicators of HBU

#	Factors	Indicators
1	Location advantages	- correlation with predominant land uses; - accessibility
2	Resource potential of the plot	- square of the plot; - shape of the plot; - size of the plot; - landscape; - quality of the soil; - susceptibility to flooding; - presence of roads, etc.
3	Market demand	- stage of development of target market; - level of infrastructure development of the property; - existence of competing properties; - competitive differential.
4	Technological feasibility	- adequacy of resources; - existence of restrictions to construction; - level of professional skills of the staff.

Technical and methodological aspects of such an analysis are currently insufficiently regulated, there is no unified approach to justification of the HBU variant. This leads to the right to determine evaluator's own research methodology. The authors' analysis of a number of reports showed that very often factors of HBU were not sufficiently substantiated. The alternatives are not ranked on the basis of their satisfaction with the factors, and the degree of preference (weight) of each indicator is not taken into account.

These defects often lead to the need to perform additional expert opinion to justify the most effective use of the object.

As an alternative solution of this problem, we suggest applying one of the expert appraisal methods - *analytic hierarchy process (AHP)* - to determine the degree of preference of four key factors: *Location advantages, Resource quality of the plot, Market demand and Technological feasibility*, as well as the priorities of variants on these factors.

Research methods

Expert methods are an integral part of any individual assessment of any personal property or real estate object. And it is not surprising, because the very notion of "assessment" is associated with the professional subjective judgment on the value of the object. One of the widely used expert methods is the AHP, created by the famous scientist T.L. Saati [4,5].

This method can be equally successfully applied in practice of decision-making on the most various questions: from a choice of purchase of the book to justification of a location of strategic objects. Now AHP is widely spread in sociology, economy, psychology and other spheres. It is successfully applied in problems of settlement of disputes [6], planning and distribution of resources [7], and also at the solution of problems of forecasting [8].

AHP is based on making a decision by carrying out paired comparisons. These comparisons can be made on the basis of the measured data values, and using the basic scale contains numerical evaluation of preference a pair (*A1*) relative to another element of the couple (*A2*) for the given criteria *B1*. As a result of the paired comparisons, the matrix of domination is formed, which shows the scale of the relations on the basis of the calculation of eigenvector [4].

Main elements of the vector represent weights of the relevant elements of the matrix, that is, express a preference of elements *A1 ...An* to the specified criteria *B1*.

Criterion may be one or more. In this case, the matrix of domination is generated separately for each criterion. All of the principal eigenvectors of matrices of domination forms a block. A set of blocks (the principal eigenvectors of matrices by various criteria) forms a block matrix, or "super matrix". Matrix decision results are the weights of the constituent elements (indicators) [4].

The object of the research

As an example we chose a vacant plot located in the central part of town Yanaul in the Republic of Bashkortostan (27, Azina Street, Yanaul).

Immediate surroundings of this object is predominantly residential areas with well-developed infrastructure. Administrative and commercial buildings are also in close proximity to the object.

The object has excellent transport accessibility by public transport. The municipal transport and taxi are accessible. The roads are covered with asphalt and are in good condition.

Initially, the real estate property market was investigated. In the zone of 10-minute car drive from the assessed area (competitive environment zone)the following businesses are located: a shopping center; 10 shoe stores; 11 clothing stores; 1 fabric shop; 15 grocery stores, represented mainly by individual entrepreneurs, as well as two online shops; 2 stores selling computers and office equipment; 2 large floral shops; 3 beauty salons; 6 bank branches; 5 pharmacies.

Main part

The object is located in the border zone of *OD-2*. It is the area of all types of social and business development with the inclusion of residential construction and engineering infrastructure facilities servicing the area. In this zone the following types of capital construction are allowed:

1) For permanent and temporary residence (residential development);

2) Educational institutions;

3) Health institutions;

4) Sports, entertainment, and health and fitness centers;

5) Trade enterprises, public catering and consumer services;

6) Objects of recreational purpose.

Four hierarchical models for each factor have been formed to solve this task. Each model contains three levels: goal, indicators, and alternatives (possible use cases) (Figure 1-4).

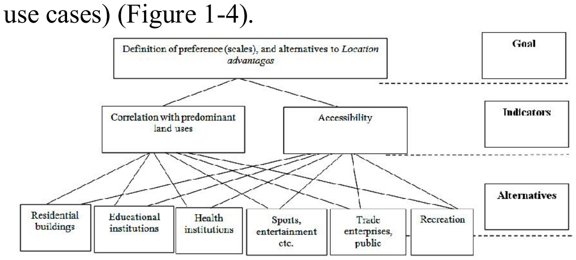

Figure 1. Hierarchical model for the "Location advantages" factor

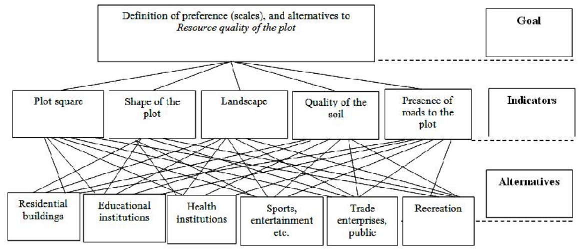

Figure 2. Hierarchical model for the "Resource quality of the plot" factor

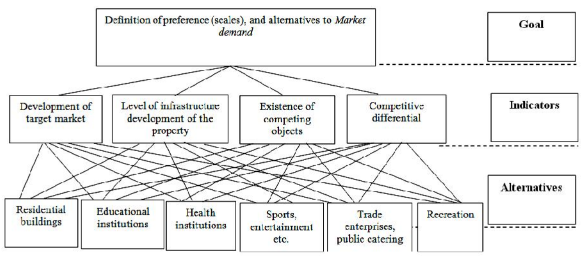

Figure 3. Hierarchical model for the "Market demand" factor

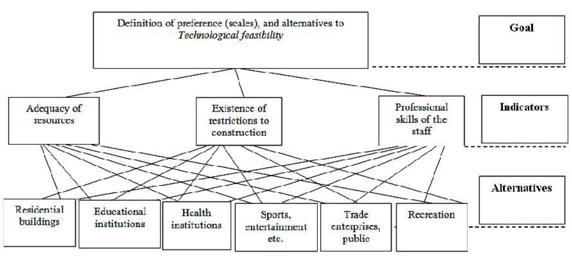

Figure 4. Hierarchical model tasks for the factor "Technological feasibility"

In the second phase for each generated model it is necessary to create a block matrix, consisting of the following parts (units):

1. Indicators - Indicators;
2. Alternatives - Indicators;
3. Indicators - Alternatives;
4. Alternatives - Alternatives.

Elements of each of these blocks are eigenvectors, characterizing the influence of items in lines on items in columns. Two blocks forming the diagonal of the matrix are zero because the mutual influence of criteria and alternatives to each other is not defined (table 2).

The further task was to determine elements of eigenvectors of two nonzero blocks: *A1* and *B1*.

For each eigenvector of the block *B1*, paired comparisons of alternatives for each indicator were carried out. When carrying out paired comparisons the expert was asked: "Which of the two alternatives is preferable proceeding according to this indicator and how much more preferable?"

Table 2. Block matrix model

Goal	Indicators	Alternatives
Indicators	0	A_1
Alternatives	B_1	0

A_1 – matrices of eigenvectors of indicators
B_1 – matrices of eigenvectors of alternatives

Similarly, eigenvectors of the block *A1* were calculated. The question was: "Which of the two indicators increasingly impacts the alternative, and by how much?"

To show preference of alternatives and indicators fundamental scale was used. This scale contains numbers showing a preference for one of the two elements of the pair over another element on a specified criterion or property [4, 9, 10]. The number of formed matrices was 38 units, two of which are shown (table 3,4).

Table 3. Preference matrix of alternatives of the factor "Resource quality of the plot" quality indicator "Size of the plot" and the eigenvector of alternatives

Indicator *Size of the plot*	1	2	3	4	5	6	Eigenvector
Residential buildings (1)	1	1/3	1/3	3	3	5	0,19
Educational institutions (2)	3	1	1	3	5	5	0,31
Health institutions (3)	3	1	1	1	3	3	0,24
Sports, entertainment, and health and fitness centers (4)	1/3	1/3	1	1	3	3	0,14
Trade enterprises, public catering and consumer services (5)	1/3	1/5	1/3	1/3	1	3	0,07
Objects of recreational purpose (6)	1/5	1/5	1/3	1/3	1/3	1	0,05

Table 4. Preference matrix of indicators of alternative "Residential buildings" and the eigenvector of indicators of the factor "Resource quality of a site"

Alternative *Residential buildings*	1	2	3	4	5	Eigenvector
Size of the plot (1)	1	3	1/3	1/5	1/3	0,10
Shape of the plot (2)	1/3	1	1/5	1/7	1	0,07
Landscape (3)	3	5	1	1/5	1/3	0,16
Quality of the soil (4)	5	7	5	1	3	0,48
Presence of roads to the plot (5)	3	1	3	1/3	1	0,19

Based on these calculations four block matrices of considered factors were formed.

The matrices were tested for the condition of stochasticity in columns (each column elements must be equal to 1). All of the formed matrices are initially satisfied the condition of stochasticity as the sum of the elements of eigenvectors is equal to 1. It should be noted, however, that in case of violation of this conditions normalization must be carried out [4,9].

The matrices were raised to the limit power to evaluate the lasting influence of the elements to each other. The result was four limit matrices containing the weight of each factor and the weight of the alternatives (table 5).

Table 5. The result of raising factor "Resource quality of the plot" matrix to the limit power

0,0767	0,0767	0,0767	0,0767	0,0767	0,0767	0,0767	0,0767	0,0767	0,0767	0,0767
0,0356	0,0356	0,0356	0,0356	0,0356	0,0356	0,0356	0,0356	0,0356	0,0356	0,0356
0,0587	0,0587	0,0587	0,0587	0,0587	0,0587	0,0587	0,0587	0,0587	0,0587	0,0587
0,2001	0,2001	0,2001	0,2001	0,2001	0,2001	0,2001	0,2001	0,2001	0,2001	0,2001
0,1289	0,1289	0,1289	0,1289	0,1289	0,1289	0,1289	0,1289	0,1289	0,1289	0,1289
0,1354	0,1354	0,1354	0,1354	0,1354	0,1354	0,1354	0,1354	0,1354	0,1354	0,1354
0,0974	0,0974	0,0974	0,0974	0,0974	0,0974	0,0974	0,0974	0,0974	0,0974	0,0974
0,0866	0,0866	0,0866	0,0866	0,0866	0,0866	0,0866	0,0866	0,0866	0,0866	0,0866
0,0753	0,0753	0,0753	0,0753	0,0753	0,0753	0,0753	0,0753	0,0753	0,0753	0,0753
0.0689	0.0689	0.0689	0.0689	0.0689	0.0689	0.0689	0.0689	0.0689	0.0689	0.0689
0,0364	0,0364	0,0364	0,0364	0,0364	0,0364	0,0364	0,0364	0,0364	0,0364	0,0364

Columns of the resulting matrix are absolutely identical, the sum of the weights (priorities) for each column is equal to 1. The first five items in the column matrix correspond to the weights of indicators, the remaining six are scales of possible alternative uses of the property [4,9]. The aggregate weight of the alternatives and indicators showing their rank are presented in tables 6-10.

Table 6. Weights and ranks of indicators on a factor "Location advantages"

Indicator	Correlation with predominant land uses	Accessibility
Weight	0,0969	0,4031
Normalized weight	0,1938	0,8062
Rank	2	1

Table 7. Weights and ranks of indicators on a factor "Resource quality of the plot"

Indicator	Size of the plot	Shape of the plot	Landscape	Quality of the soil	Presence of roads to the plot
Weight	0,0767	0,0356	0,0587	0.2001	0.1289
Normalized weight	0,1534	0,0712	0,1174	0,4002	0,2578
Rank	3	5	4	1	2

Table 8. Weights and ranks of indicators on a factor "Market demand"

Indicator	Development of target market	Level of infrastructure development of the property	Existence of competing facilities	Competitive differential
Weight	0,1572	0,2432	0,0893	0,0103
Normalized weight	0,3144	0,4864	0,1786	0,0206
Rank	2	1	3	4

Table 9. Weights and ranks of indicators on a factor "Technological feasibility"

Indicator	Adequacy of resources	Existence of restrictions to construction	Professional skills of the staff
Weight	0,1345	0,2673	0,0982
Normalized weight	0,269	0,5346	0,1964
Rank	2	1	3

Thus, to assess options for using this plot, the most vital are the indicators of accessibility, soil condition, the level of infrastructure development and the existence of contraindications for construction.

Table10. Weights and rankings of alternatives (land use) on the factors

Alternative	1.Residential buildings	2.Educational institutions	3. Health institutions	4. Sports, entertainment, and health and fitness centers	5. Trade enterprises, public catering and consumer services	6.Recreation
Factor *Location advantages*						
Weight	0,0812	0,0762	0,0667	0,0938	0,1225	0,0597
Normalized weight	0,1623	0,1523	0,1334	0,1876	0,245	0,1194
Rank	3	4	5	2	1	6
Factor *Resource quality of the plot*						
Weight	0,1354	0,0974	0,0866	0,0753	0,0689	0,0364
Normalized weight	0,2708	0,1948	0,1732	0,1506	0,1378	0,0728
Rank	1	2	3	4	5	6
Factor *Market demand*						
Weight	0,0983	0,0628	0,0673	0,1063	0,0883	0,0772
Normalized weight	0,1965	0,1256	0,1346	0,2125	0,1765	0,1543
Rank	2	6	5	1	3	4
Factor *Technological feasibility*						
Weight	0,0718	0,0662	0,0580	0,0934	0,0994	0,1114
Normalized weight	0,1435	0,1324	0,1159	0,1867	0,1987	0,2228
Rank	4	5	6	3	2	1
Total rank	10	17	19	10	11	17

Based on the values of the indicators of the factors you could predict that the most desirable alternatives are the 1st and 4th, the least preferred - #2 and #6.

The accuracy of scales and alternatives also depends on the extent of consistency of the expert's judgments in paired comparisons.

To assess the consistency of judgment matrix indexes of randomness were calculated. All calculated indexes do not exceed the permissible values, indicating a good consistency of judgments.

Conclusions

Application of an expert method "analytic hierarchy process" for an assessment of indicators and alternatives of the most effective use of a real estate object allowed us to define degree of preference of possible alternative types of use for an estimated real estate object taking into account its specifics. It also allowed us to carry out an assessment and ranging of extent of influence of each studied indicator on the object. In the conditions of limited possibility of application of one of three market methods of an assessment such analysis can significantly increase objectivity and validity of the chosen option of HBU.

It should be noted that this type of analysis is appropriate not only for HBU analysis but also to assess the investment attractiveness of the land.

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