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PRACTICE AND APPLICATION OF HIERARCHICAL ANALYSIS

Abstract: *The article reviews key approaches and methods to optimize the location of the regional distribution center. The multi-criteria optimization of hierarchical analysis of the location of the regional distribution center was considered, and the effectiveness of the management process was evaluated.*

Key words: *innovation, regional economics, econometric model.*
Language: *English*
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Introduction

Large companies' management activities are always associated with a variety of complex decisions involving a wide range of economic, social, political, legal and moral factors, leading to multi-criteria optimization involving experts or decision makers. The opinions of a panel of experts should be taken into account in order to enhance the quality and transparency of decision-making. In the decision-making process, uncertainty conditions arise in the form of qualitative and quantitative evaluation. This is due to the lack of knowledge about the nature of decision-makers, the lack of confidence in the accuracy of expert assessments, errors in the provision of information, and so on. Therefore, it is necessary to provide a comparison of factors that do not have quantitative characteristics or to combine qualitative and quantitative characteristics in decision-making in uncertainty. It is much easier to use a hierarchical analysis approach to address such issues.

Literature Review

Hierarchical method of analysis is a mathematical method of systematic approach to decision-making. This method was developed by American scientist Thomas Saati in 1970 and is widely used in practice. This method has been used extensively in the research of transport systems and in the analysis of the efficiency of resource allocation in the Mexican industry. About 100 Chinese universities offer courses in hierarchical analysis, and many researchers have adopted this as an object of research. Every two or three years, the International Symposium on Hierarchical Analysis takes place in the world. In Israel, Professor Ami Arbel has proven that this method can be applied to informal factors, such as analytically unrelated factors. A.S. Vinokurov, Belov IV, RI Bajenov, G.G. Azgaldova and O.V. Daneev used this method in selecting a digital camera [7 - 6].

The advantage of this method is that it is universal and can be applied to a wide range of issues, including analysis of potential event situations, resource allocation, customer rating, and staffing decisions. The disadvantage is that it requires a large amount of data from experts. This method is therefore suitable for processes based on variants of which the majority of data is preferred by experts and has several priorities in the selection process.

Analysis and Results

There are n alternative solutions to achieve the common goal of existing system activities. Each alternative will be assessed by experts based on the selected criteria. Let them choose the best one. The solution consists of the following steps:

1. The initial problem is shaped by the following hierarchical structure: the purpose - the alternative option (Figure 1).

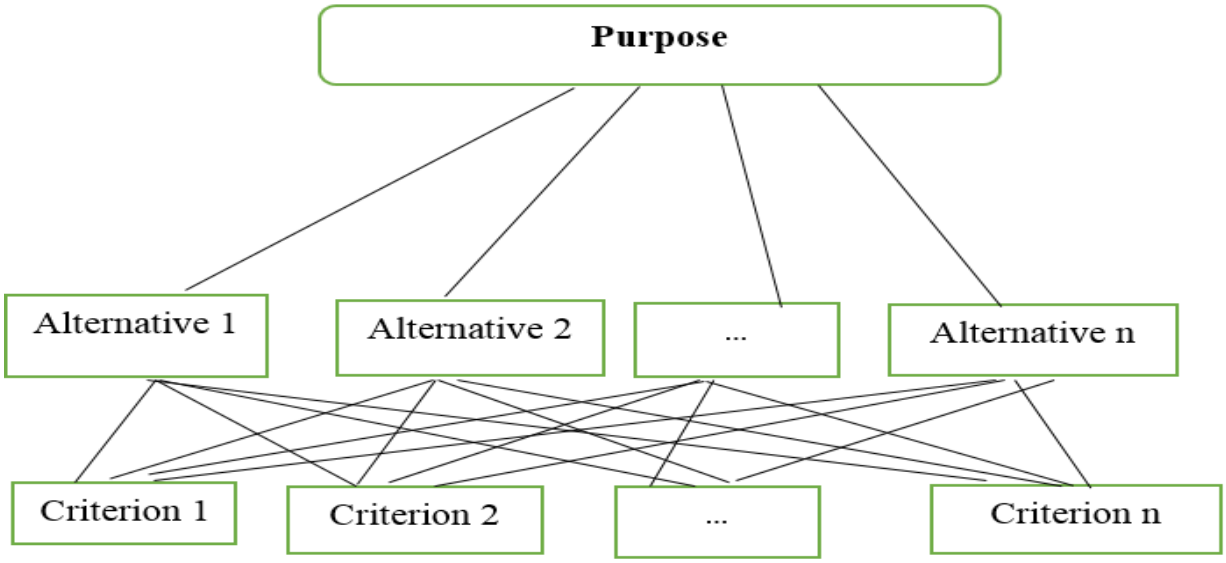

Figure 1. Hierarchical structure

The selected m criteria are compared in pairs. If i set the percentage of the criterion wi, then $a_{ij} = \frac{w_i}{w_j}$. This determines their relationship, not the magnitude of the difference in criteria, namely $a_{ij} = \frac{1}{a_{ji}}$. If the element i is more important than the element j while filling the matrix, enter the integer (i, j) and the decimal number in cell (j, i). If equal, 1 is entered, so the main diagonal elements of the matrix are 1. Therefore, the pairing matrix elements are in the form of a positively defined inverse matrix whose color is 1. (Table 1).

The table is compared in pairs using a corresponding square matrix (nxn) on a 9-point system, taking into account their previous higher-level features. At the same time, each element of the matrix [a $_{ij}$] is constructed based on the importance of the i and j hierarchies, meaning that the results of individual comparisons are given through the matrix, taking into account the decision of the decision maker or expert (expert group). The distribution of points is as follows: 1 equal value, 3-point advantage, 5-sufficient advantage, 7-strong advantage and 9-strong advantage, 2,4,6,8 points in intermediate cases. For example, when comparing item A and B: Which one has the greatest effect on achieving a given goal? Which one is most likely to occur? Which one is better than achieving a given goal? are used.

Based on the values found in the third step, the comparison matrices for each of the comparison matrices are found for the corresponding hierarchy level coefficients for the specific vector component component. The results of this work are generated in the form of custom tables and the algorithm is as follows:

a) In the table, additional column elements are first found in the corresponding comparison matrix. This will increase the array elements;

b) The specific vector of the Sx component for the comparison matrix is determined by deriving the j-level roots from the additional column elements;

c) The specific vector is normalized, that is, the ratio of the specific vector elements to the sum of the specific vector elements is determined;

d) the results are multiplied by 100 and the significance of each criterion is determined (in percentages);

e) the conclusions of the receiving person are checked.

At this stage are the quality indicators for each of the alternatives. These are the priorities of alternatives, through which the most feasible solutions for the existing system are identified.

As an example of using this hierarchical method of analysis, we consider the optimal placement of trade networks to expand.

Solution: The company "X" is a manufacturer of agricultural, forestry and fishery products and has several warehouses and a network of trade points in the Surkhandarya region. The regional distribution center should be optimized to reduce the logic of service flows in the region and to maintain a high level of management and sales network.

1. Creating a hierarchy.

Purpose: To select the best alternative for regional trade networks.

13 regional centers were selected as alternatives to the regional distribution center location. Criteria for comparing regional distribution center alternatives and methods were as follows: average per capita wages (M1), communication and information services

(M2), transport services (M3), permanent population (M4)), proximity to supply (M5).

2. Criteria are evaluated by a dedicated expert in pairs and compared to their importance.

At the same time their quantitative advantage is 1-9.

Table 1. The results of evaluating alternatives in pairs based on each criterion

Criteria	**M_1**	**M_2**	**M_3**	**M_4**	**M_5**
M_1	1	2	0.5	0.5	0.33
M_2	0.33	1	0.33	0.33	0.5
M_3	2	3	1	1	2
M_4	2	3	1	1	0.25
M_5	3	2	0.5	4	1

Table 2. Results of the evaluation of alternatives on the average wage

Alterna-tives	Denov	Sherabad	Uzun	Termez	Jarkurgan	Angor	Baysun	Kizirik	Kumkurgan	Oltinsay	Muzrabad	Sarosia	Shurchi
Denov	1	2	1	0,3	0,1	2	0,25	0,25	0,14	3	0,5	0,14	2
Sherabad	0,5	1	1	0,25	0,1	1	0,2	0,17	0,14	2	0,3	0,13	1
Uzun	1	1	1	0,25	0,1	2	0,2	0,25	0,14	2	0,5	0,13	1
Termez	3	4	4	1	0,1	4	0,5	0,33	0,2	4	2	0,2	3
Jarkurgan	9	9	9	9	1	9	9	9	9	9	9	9	9
Angor	0,5	1	0,5	0,25	0,1	1	0,2	0,2	0,13	1	0,33	0,13	1
Baysun	4	5	5	2	0,1	5	1	1	0,25	5	3	0,25	4
Kizirik	4	6	4	3	0,1	5	1	1	0,33	6	3	0,33	5
Kumkurgan	7	7	7	5	0,1	8	4	3	1	8	6	1	8
Oltinsay	0,33	0,5	0,5	0,25	0,1	1	0,2	0,17	0,13	1	0,33	0,13	0,5
Muzrabad	2	3	2	0,5	0,1	3	0,33	0,33	0,17	3	1	0,17	2
Sarosia	7	8	8	5	0,1	8	4	3	1	8	6	1	8
Shurchi	0,5	1	1	0,33	0,1	1	0,25	0,2	0,13	2	0,5	0,13	1

Alternatively, alternatives are evaluated in pairs based on the same criteria.

3. Calculation of Criteria.

The calculation of the criteria effect is presented in Table 3. In this table, additional column elements are first found in the corresponding comparison matrix. In this case, the array elements are multiplied and then the specific vector with the Sx component for the comparison matrix is determined by deriving the j-level roots from the additional column elements. Then the specific vector is normalized, that is, the ratio of the specific vector elements to the sum of the specific vector elements, and these results are multiplied by 100, and the significance of each criterion is expressed (in percentages).

Table 3. Algorithm of the importance of criteria

Criteria	M_1	M_2	M_3	M_4	M_5	D- extra column	C_i component	N- normal specific vector	M_B- criterion of importance
M_1	1	2	0.5	0.5	0.33	0,165	0,697	0,126	12,641
M_2	0.33	1	0.33	0.33	0.5	0,018	0,448	0,081	8,113
M_3	2	3	1	1	2	12	1,644	0,298	29,79424
M_4	2	3	1	1	0.25	1,5	1,084	0,197	19,657
M_5	3	2	0.5	4	1	12	1,644	0,298	29,794
Total:							5,517		

Table 4. The result of calculating the importance of criteria

Criteria	**Critical criteria**
Average wage	12,64133
Communication and information services	8,113317
transport services	29,79424
Permanent population	19,65687
Proximity to maintenance	29,79424

3. Evaluate the alternative importance of each criterion.

The next step in this algorithm is to evaluate the alternate importance of each criterion. Table 5 presents the calculation of the coefficient of importance of the average wage.

Table 5. Results of the evaluation of alternatives on the average wage

Alternatives	Denov	Sherabad	Uzun	Termez	Jarkurgan	Angor	Baysun	Kizirik	Kumkurgan	Oltinsay	Muzrabad	Sarosia	Shurchi	D- extra column	Ci component	N- normal specific vector	M_B- criterion of importance
Denov	1	2	1	0,3	0,1	2	0,25	0,25	0,14	3	0,5	0,14	2	$4,41*10^{-4}$	0,552	0,025	2,507
Sherabad	0,5	1	1	0,25	0,1	1	0,2	0,17	0,14	2	0,3	0,13	1	$4,641*10^{-6}$	0,389	0,018	1,766
Uzun	1	1	1	0,25	0,1	2	0,2	0,25	0,14	2	0,5	0,13	1	$4,55*10^{-5}$	0,463	0,021	2,105
Termez	3	4	4	1	0,1	4	0,5	0,33	0,2	4	2	0,2	3	3,041	1,089	0,049	4,949
Jarkurgan	9	9	9	9	1	9	9	9	9	9	9	9	9	$2,824*10^{11}$	7,600	0,345	34,52
Angor	0,5	1	0,5	0,25	0,1	1	0,2	0,2	0,13	1	0,33	0,13	1	$1,394*10^{-6}$	0,354	0,016	1,610
Baysun	4	5	5	2	0,1	5	1	1	0,25	5	3	0,25	4	375	1,578	0,072	7,167

Kizirik	4	6	4	3	0,1	5	1	1	0,33	6	3	0,33	5	1411,344	1,747	0,079	7,936
Kumkurgan	7	7	7	5	0,1	8	4	3	1	8	6	1	8	6322176	3,335	0,152	15,15
Oltinsay	0,3	0,5	0,5	0,25	0,1	1	0,2	0,17	0,13	1	0,33	0,13	0,5	$1,955*10^{-7}$	0,305	0,014	1,384
Muzrabad	2	3	2	0,5	0,1	3	0,33	0,33	0,17	3	1	0,17	2	0,034	0,771	0,035	3,502
Sarosia	7	8	8	5	0,1	8	4	3	1	8	6	1	8	8257536	3,405	0,155	15,46
Shurchi	0,5	1	1	0,33	0,1	1	0,25	0,2	0,13	2	0,5	0,13	1	$1,394*10^{-5}$	0,423	0,019	1,922
Total:															22,01		

Table 6. Results of calculating alternative significance for each criterion

The importance of the criteria	12,64133	8,113317	29,79424	19,65687	29,79424
Criteria	M_1	M_2	M_3	M_4	M_5
Denov	2,507	29,823	16,114	24,016	1,949
Sherabad	1,766	1,317	8,533	7,531	9,152
Uzun	2,105	4,562	5,114	4,913	2,056
Termez	4,949	4,516	4,221	1,196	23,674
Jarkurgan	34,529	17,661	11,343	13,175	12,743
Angor	1,6103	5,219	4,177	1,773	16,514
Baysun	7,167	4,763	4,406	1,309	2,771
Kizirik	7,936	6,479	7,670	3,865	7,949
Kumkurgan	15,153	4,407	11,703	13,509	5,845
Oltinsay	1,384	10,122	4,177	5,194	2,917
Muzrabad	3,502	4,968	4,177	3,399	9,566
Sarosia	15,467	0,896	11,095	10,060	1,691
Shurchi	1,922	5,267	7,271	10,060	3,174

Calculation of alternative priority for optimal placement.

To do this, we develop criteria by multiplying the criterion coefficients for each individual alternative by the coefficients of alternative importance.

Termez=4,948834*12,64133+4,515693*8,113317+4,221302*29,79424+1,195758*19,65687+23,67412*29,79424=953,8249

Table 6. Results of calculating alternative priority for optimal placement

The importance of the criteria	M_1 12,641	M_2 8,113	M_3 29,794	M_1 19,657	M_1 29,794	Coefficients of Priority
Denov	2,507	29,823	16,114	24,016	1,949	1283,933
Sherabad	1,766	1,317	8,533	7,531	9,152	707,9418
Uzun	2,105	4,562	5,114	4,913	2,056	373,848
Termez	4,949	4,516	4,221	1,196	23,674	953,825
Jarkurgan	34,529	17,661	11,343	13,175	12,743	1556,373
Angor	1,610	5,219	4,177	1,773	16,514	714,022
Baysun	7,16716	4,763	4,406	1,309	2,771	368,811
Kizirik	7,936	6,479	7,670	3,865	7,949	694,202
Kumkurgan	15,153	4,407	11,703	13,509	5,845	1015,661

Oltinsay	1,384	10,122	4,177	5,194	2,917	413,061
Muzrabad	3,502	4,968	4,177	3,399	9,566	560,861
Sarosia	15,467	0,896	11,095	10,060	1,691	781,477
Shurchi	1,922	5,267	7,271	10,060	3,174	575,983

There are several approaches to optimizing the location of the regional distribution center, which should take into account the economic performance of the region and the economic system indicators, the quality of products and their compliance with international standards. The economic system of the region on the basis of a multidimensional approach requires a comprehensive development of indicators of efficiency of the management process and its practical results, with a greater focus on internal factors. Hierarchical analysis by means of hierarchical analysis leads to successive lowering of goals, which facilitates tactical changes in managerial decision-making as well as activation of the economic system of the region. The following main conclusions were reached in the course of this research:

In selecting the best alternative and criteria for regional trade networks, 13 regional centers were selected as alternatives. According to the average per capita salary (M1) of the district, Jarkurgan district took 1st place, and Kumkurgan district - 2nd place. Denov district is ranked 1st in terms of provision of communication and information services (M2), Jarkurgan district is 2nd place, Transport services (M3) is ranked 1st, Denau district is second, Kumkurgan district is 2nd and Jarkurgan district is 3rd. occupied. Denov district was ranked 1st, Kumkurgan district - 2nd place, Jarqurghon district - 3rd place, Termez district - 1 place, Angor district - 2nd place, Jarqurghon district - was ranked third. 3rd place.

To determine the priority of the alternatives, multiplying the criterion significance coefficients for each individual alternative by the coefficients of importance of the alternative variant, based on the results, the Jarkurgan District Priority Index (1556,373) was ranked 1 and Denau County (1283,933). Baysun district had the lowest index of priority (368,811).

Conclusions and Suggestions

In conclusion, this method can be widely used in evaluating the quality of management processes, transport systems, industry planning, banking optimization, optimizing market and commercial activities, and optimizing the location of free economic and industrial zones.

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