

Matrix Method of Supporting Decision-Making

There are various expert methods of supporting decision-making such as Delphi, brainstorming, commissions, paired comparisons, group analysis of situations, submission of proposals, analytic hierarchy process of T.Saati (AHP), MAUT (multi-attribute utility theory), SMART, ELECTRA, synectics, pros and cons analysis, Kepner-Tregoe decision analysis, cost-benefit analysis and others [1, 2, 3, 4]. Each of the above mentioned methods has its own advantages and disadvantages.

The analytic hierarchy process of T.Saati (AHP) is one of the most widespread methods of supporting decision-making applied in practical work of organizations. The application of the method has been widely covered in various scientific papers of many countries of the world. That's why the method has been chosen as a guiding line for working out the matrix method. However, to improve the AHP method is not our purpose. There are various modifications of the AHP method, for example, the multiplicative method of analytic hierarchy of F.Lutsma [2].

If we take into consideration the multi-attribute utility theory, its methods have axiomatic foundation and allow determining the utility of each alternative. That's why it's expedient to use them for the tasks with a great number of alternatives [2]. At the same time they are complicated in practical use.

The famous heuristic SMART method worked out by B.Edwards [2] is a simple method of multi-criteria estimation. The method uses the additive formula of the considered sum of estimated alternatives without studying the dependence of the criteria and the utility function [2].

B.Edwards states, "The SMART method does not take into consideration possible dependence of measurements and non-additivity in determining the general value of the alternative" [2]. However, it is simple and reliable in practical use.

O.I.Larichev's book gives such advantages of using the ELECTRA method as stages of forming the preferences of a person responsible for decision-making in the process of determining the levels of agreement and disagreement and studying the nuclei. The detailed analysis enables the person to determine his preferences and the compromises among the criteria. The use of the relations of

incomparableness helps to single out the pairs of alternatives with contradictory values and to focus on the nucleus. The separation of the nucleus is sound from the point of view of the information available. The values of the criteria can reflect the opinions of the expert groups [2].

The comparison of various methods of decision-making can't be done within the limits of the dissertation investigation. That's why we shall suggest our own method adapted for the solution of Internet-marketing problems.

The matrix method of supporting decision-making (the matrix method of expert estimation) is worked out on the basis of analytic hierarchy process of T.Saati (AHP) and belongs to the multi-criteria class [1, 3, 4, 5]. The method is different from the AHP by the process of solving the problem: the use of three-dimensional scale; the use of formulae of estimating the ratings of criteria, alternatives and the global rating of alternatives on all criteria different from the AHP formulae; the construction of global matrix. At the same time the matrix method is based on the paired comparison method, on the development of the hierarchy of the problem of multi-criteria choice characteristic for the AHP.

The matrix method includes four stages:

- 1) the construction of the hierarchy of the problem of multi-criterion choice ;
- 2) the construction of paired comparisons matrices;
- 3) obtaining priority criteria and alternatives on each of them;
- 4) the construction of the global matrix and the determination of the global rating of alternatives.

At the first stage it is necessary to construct the hierarchy of the problem of multi-criterion choice (fig. 1) which consists of the following levels:

- the level of goal;
- the level of limitation;
- the level of criterion;
- the level of alternative.

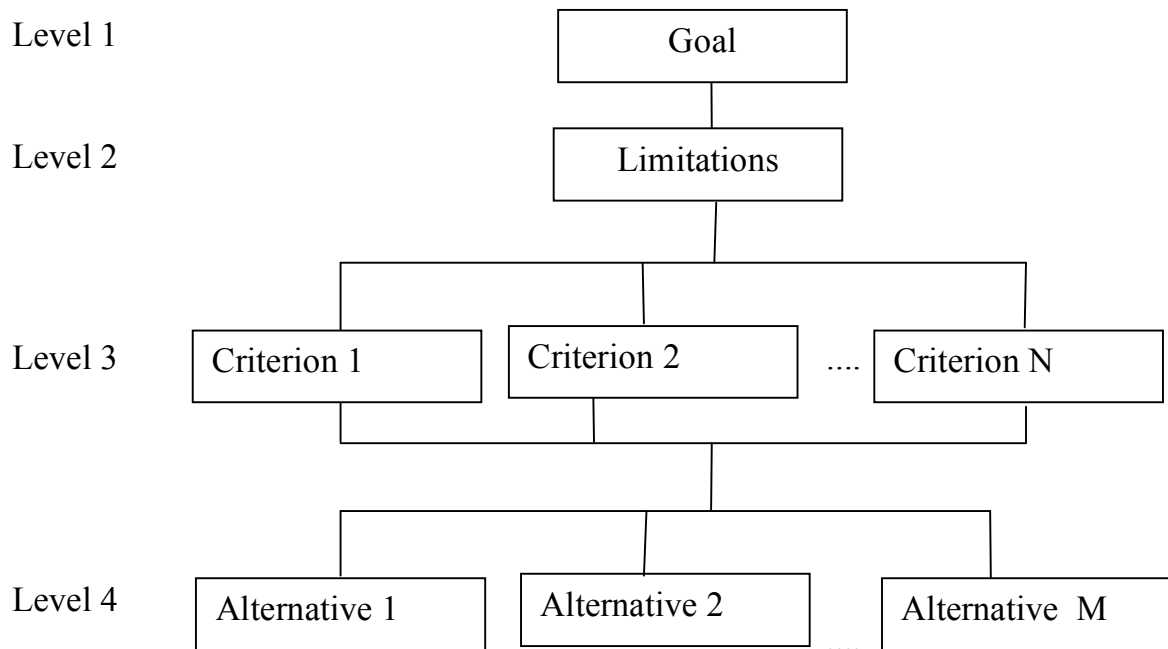


Figure 1 – The hierarchy of the problem of multi-criterion choice

At the stage the tree “goal – limitations – criteria – alternatives” is used.

To take reasoned decisions complete and reliable information is necessary. It helps to determine goals, necessary limitations of the task, criteria and alternatives, and to exercise further analysis of the input data on their basis.

That’s why before using the matrix method it is necessary to obtain reliable information.

To achieve the goal it is necessary to determine priority solutions, i.e. such optimal alternatives at the given limitations and criteria, owing to which the established goal will be achieved at the least expenses. Such alternatives will be the best.

The goal can consist of sub-goals. For each sub-goal the criteria and alternatives are determined and the best alternatives, i.e. the most efficient solutions, are chosen. The totality of all such solutions for all the sub-goals determines the efficiency of fulfilling the established goal.

The limitations mean the requirements to the established problem, i.e. the limitations connected with the determination of the goal, the choice of criteria and alternatives. For example, for some company the goal, criteria and alternatives will be determined based on its activity at the local or international markets, on the completeness and reliability of the information obtained.

At the second stage of the method the paired comparisons matrices are constructed: one matrix of compared criteria and N matrices of compared

alternatives on the given criteria. On the whole it is necessary to construct $N+1$ matrix. The number of matrices of compared alternatives depends on the number of criteria.

The matrices of compared criteria have the dimension $N \times N$. The matrices of compared alternatives on the given criteria have the dimension $M \times M$. The matrices are presented in tables 1 and 2.

Table 1 - The matrix of compared criteria

<i>i</i>	<i>Criteria</i>	<i>k</i>			
		1	2	...	<i>N</i>
		<i>Criterion 1</i>	<i>Criterion 2</i>	<i>Criterion ...</i>	<i>Criterion N</i>
1	<i>Criterion 1</i>				
2	<i>Criterion 2</i>				
...	<i>Criterion ...</i>				
<i>N</i>	<i>Criterion N</i>				

Table 2 – The matrix of compared alternatives on the criterion- *i*

<i>j</i>	<i>Alternative</i>	<i>k</i>			
		1	2	...	<i>M</i>
		<i>Alternative 1</i>	<i>Alternative 2</i>	<i>Alternative ...</i>	<i>Alternative M</i>
1	<i>Alternative 1</i>				
2	<i>Alternative 2</i>				
...	<i>Alternative ...</i>				
<i>M</i>	<i>Alternative M</i>				

Each matrix is filled with the signs «+», «-», «=».

The sign «+» means that

- the criterion *i* is “more important” than the criterion *j*, or the criterion of a line is “more important” than the criterion of a column;
- the alternative *i* is “more important” than the alternative *j* on the given criterion, or the alternative of a line is “better” than the alternative of a column.

The sign “-“ is opposite to the sign “+” and means that

- the criterion *i* is “worse” than the criterion *j*, or the criterion *j* of the column *j* is “more important” than the criterion *i* of the line *i* ;
- the alternative *i* is “worse” than the alternative *j* on the given criteria, or the alternative *j* of the column *j* is “more important” than the alternative *i* of the line *i*

The sign «=» means that compared criteria and alternatives are equal in their importance and quality.

The sign “=” is put in the squares (i,j) ($i=j$) of the main diagonal of the matrix, because the criteria (alternatives) are equally important.

The person responsible for taking a decision compares one variant with the other and puts his mark either “+”, “-“ or “=” in each square of the matrix. The comparison of the criteria (alternatives) is made line by line: the criterion (alternative) of a line is compared with each criterion (alternative) of a column, and the given mark in the form of corresponding signs is put into each square of the matrix.

If the sign “+” (the sign “-“ is put into the square (i,j) the sign “-“ (“+”) is put into the square (j,i) . If the sign “=” is put into the square (i,j) the sign “=” is also put into the square (j,i) .

Let us consider an example of filling the matrix of compared criteria (table 3).

Table 3 – The matrix of compared criteria

<i>i</i>	<i>Criteria</i>	<i>k</i>			
		1	2	3	4
		<i>Criterion 1</i>	<i>Criterion 2</i>	<i>Criterion 3</i>	<i>Criterion 4</i>
1	<i>Criterion 1</i>	=	+	+	+
2	<i>Criterion 2</i>	-	=	=	+
3	<i>Criterion 3</i>	-	=	=	+
4	<i>Criterion 4</i>	-	-	-	=

The signs of the lines $i=2$ и $i=3$ coincide, because criteria 2 and 3 are equally important.

One can simplify the completion of the matrix comparing the criteria of columns on the signs obtained at comparing the criteria of lines. For example, if square 1,2 of criterion 2 contains the sign “=” and square 1,3 of criterion 3 also contains the same sign “=” criteria 2 and 3 are equally important ($1=2, 1=3 \Rightarrow 2=3$). Therefore, the sign “=” is put into squares $(2,3)$ and $(3,2)$. Thus, the matrix can be completed in the following way:

- 1) the criterion of a line is compared with each criterion of a column, and the corresponding sign is put into the matrix square;
- 2) after completing a line neighboring criteria in columns are compared on their signs in the squares of the matrix line;
- 3) If it is possible to compare two neighboring criteria then the remaining squares corresponding to the criteria are filled.

The matrices of the alternatives on given criteria are filled similarly.

It should be mentioned that as a result of experiments R. Strenberg determined the time of one comparison: 35 sec [2].

To save time on the completion of the given matrices it is expedient to take into account the following rules:

1) the criterion A is “more important” than the criterion B and the criterion C (the signs in the squares of the line of the criterion A: “+”, “+”). Therefore, the comparison of the criteria B and C is impossible ($A > B$, $A > C \Rightarrow B ? C$);

2) the criterion B is more important than the criterion A, and the criterion C is “more important” than the criterion A (the signs in the squares of the line of the criterion A: “-”, “-”). Therefore, the comparison of the criteria B and C is impossible ($A < B$, $A < C \Rightarrow B ? C$);

3) the criterion A is more important than the criterion B, and the criterion C is “more important” than the criterion A (the signs in the squares of the line of the criterion A: “+”, “-”). Therefore, the comparison of the criteria B and C is possible ($A > B$, $A < C \Rightarrow B < C$);

4) the criterion A is equally important with the criteria B and C (the signs in the squares of the line of the criterion A: “=”, “=”). Therefore, the comparison of the criteria B and C is possible ($A = B$, $A = C \Rightarrow B = C$).

The use of the symbolic scale is connected with the fact that the given method can be used not only by professional investigators, but also by ordinary marketing analysts who are not always experts. In our opinion, it is easier for an ordinary user to answer «yes», «no» or «equal» («+», «-», «=») than, for example, to put «5» instead of «7» using the scale from «0» to «9» and so making a mistake. Of course, the use of different method of decision-making depends on a particular situation and on the people involved in the process. It is hardly possible to avoid subjectivity. The use of the three-dimensional scale enables to solve multi-criteria tasks with a great number of alternatives by means of the rule of transitivity.

The matrix method of expert estimation assumes the solution of problems with a great number of criteria and alternatives. That’s why the method is based on the method of paired comparisons, because the number of compared objects can be more than 10.

Example The leadership of an Internet company needs to choose better suppliers for their Internet shop. 12 criteria and 500 suppliers (alternatives) were determined for the solution of the problem. It is obvious that in this case it is difficult for a person responsible for decision-making to range the alternatives.

The next stage of the method is obtaining priority criteria and alternatives on each of them.

After the completion of the matrices it is necessary to determine the rating of each criterion and each alternative on the given criterion. To do that supplementary columns are added to the matrices of paired comparisons: the supplementary columns S_i , R_i , V_i – **to the matrices of compared criteria**, the supplementary columns S_{ji} and R_{ji} – **to the matrices of compared alternatives on each criterion (table 4)**.

Table 4 – The designation of indices

Indices	Designation
The sum of points of the i -criterion	S_i
The sum of all S_i in the matrix of criteria	S
The sum of points of the j -alternative on the criterion i	S_{ji}
The rating of the i -criterion, place	R_i
The rating of the j -alternative on the criterion i , place	R_{ji}
The importance of the i -criterion	V_i
The number of the alternatives	M
The number of the considered criteria	N
The number of the last place in the rating of the criteria	l
The maximum value among the numbers of the last places of the alternatives on all criteria.	p

$$S_i = 1 + \sum_{k=1}^N S_{ik}, \quad i = \overline{1, N}; \quad (1)$$

$$S = \sum_{i=1}^N S_i; \quad (2)$$

$$V_i = 1 - S_i / S, \quad i = \overline{1, N}; \quad (3)$$

$$S_{ji} = 1 + \sum_{k=1}^M S_{jik}, \quad j = \overline{1, M}, \quad i = \overline{1, N}; \quad (4)$$

$$R_i = 1, 2, \dots, l, \quad i = \overline{1, N}; \quad (5)$$

$$R_{ji} = 1, 2, \dots, p, \quad j = \overline{1, M}, \quad i = \overline{1, N}. \quad (6)$$

For the matrix of the paired compared criteria the number of pluses in the i -line plus one point corresponds to the sum of points S_i of the i -criterion (formula 1). Based on S_i the rating R_i , the place taken by the criterion i , is determined.

The values R_i for each criteria, i.e. the number of their places in the rating, are put into the column R_i in the matrix of compared criteria.

The maximum sum of points S_i means that the criterion i takes the first place, i.e. the criterion i is “the most important”.

The minimum sum of points S_i means that the criterion i takes the last place.

The same is done for the matrices of compared alternatives on each criterion, i.e. S_{ji} and R_{ji} are determined (formula 4).

In formula 1 “1” is used not to make the value S_i equal to zero in the case when there is at least one line which lacks the sign “+”. It is necessary for the value of importance V_i which must differ from zero to take into account the criterion i in calculating the global rating of the alternatives.

Formulas 1, 2, 3 are used for the calculations connected with the matrix of compared criteria, i.e. the values S and V_i are determined for the criteria only.

The bigger the value V_i is, the lower the rating of criterion.

Thus the matrix of compared criteria (table 5) and the matrix of compared alternatives on the criterion i (table 6) are completed.

Table 5 – The matrix of compared criteria

i	Criterion	k				S_i	R_i	V_i
		1	2	...	N			
		Criterion 1	Criterion 2	Criterion ...	Criterion N			
1	Criterion 1	=						
2	Criterion 2		=					
...	Criterion ...			=				
N	Criterion N				=			
					S			

Table 6 – The matrix of compared alternatives on the criterion i

j	Alternative	k				S_{ji}	R_{ji}
		1	2	...	M		
		Alternative 1	Alternative 2	Alternative ...	Alternative M		
1	Alternative 1	=					
2	Alternative 2		=				
...	Alternative ...			=			
M	Alternative M				=		

It is significant that the criteria (alternatives) which are equally important have the same rating, so the value R_i (R_{ji}) will be the same for them.

The last stage of the matrix method includes the construction of the global matrix and the calculation of the global rating for each alternative.

- Three cases are possible at the stage:
- 1) the criteria are not equally important;
 - 2) all the criteria are equally important;
 - 3) at least two criteria of all are equally important.

The first case: the criteria are not equally important

For the case the global matrix is presented in the form of table 7.

Table 7 – The global matrix

Criteria	Rating of criteria, R_i	Rating of alternatives, R_{ji}			
		1	2	...	p
Criterion i	1	Alternative ji			
Criterion ...	2				
Criterion				
Criterion ...	l				

The data for the completion of the global matrix are taken from the columns R_i and R_{ji} of the paired comparisons matrices, and formulas 5 and 6 are taken into account.

In the column “Rating of criteria” the rating of the i -criterion is given from the first to the last place l . The squares of the column “Criteria” are filled with the names of the criteria in accordance with their ratings at the column “Rating of criteria”. For example, accordingly the name (designation) of the criterion i is given for place 1 in the column “Criteria”.

The next column “Rating of Alternatives” consists of sub-columns from the first to the last place p of the rating of alternatives. The last place p is a maximum number of all the numbers of the last places of alternatives on all criteria. For example, in the matrix of compared alternatives on criterion 1 the rating of the alternatives is determined by the 1-st and 2-nd places, in the matrix on criterion 2 – by the 1-st, 2-nd, 3-d, then $p=3$.

Thus, p is determined:

$$p = \max R_{ji} \tag{7}$$

It is significant that there may be cases when $l=1, p=1$.

The squares of the matrix of the “Rating of Alternatives” column contain the names or designations of alternatives based on their rating in accordance with the rating of criteria.

If the alternatives are equally important their names are put into the same corresponding to them square in the global matrix. Alternatives 3 and 4 take the

first place on the criterion A which takes the first place in the rating of criteria. Then the names of the alternatives are put into square 1,1 of the global matrix.

After the completion the global matrix is analyzed.

The nearer the square of the alternative is to square 1,1 in the global matrix, the higher the global rating of the given alternative is.

Based on the dimension of the global matrix one can visually determine the best alternatives analyzing it.

It is significant that the global matrix is necessary for visual finding optimal solutions, and in the given case the calculation of the global rating of alternatives can be done by means of it.

The index GR_j of the global rating of alternatives is determined in the following way:

$$GR_j = \sum_{i=1}^N V_i * R_{ji}, \quad (8)$$

where $j = \overline{1, M}$, $i = \overline{1, N}$,

j –the number of the alternative;

i –the number of the criterion;

M –number of alternatives;

N –number of criteria;

V_i – the importance of the criterion i ;

R_{ji} – the number of the place of the alternative j in the matrix of compared alternatives on the criterion i (the rating of the j -alternative on the criterion i , place).

The higher the index GR_j is, the lower the rating of alternative.

The lowest index GR_j corresponds to the first place in the rating of alternatives, i.e. the lower GR_j is, the higher the rating of the alternative.

Thus, ranking the indices GR_j increasingly we shall get the rating of alternatives from the first to the last places. The first place corresponds to the best alternative or the optimal solution on the given limitations and criteria.

The second case; all the criteria are equally important.

In the case the global matrix is constructed in the form of table 8.

Table 8 – the global matrix

Criterion	Rating of criteria, R_i	Rating of alternatives, R_{ji}			
		1	2	...	p
Criterion i, \dots, N	1	Alternative ji			

It is significant that $l=1$. The global matrix has only one line, i.e. the number of lines is N times less.

The index GR_j of the global rating of alternatives is determined by formula 8 or in the following way:

$$GR_j = \sum_{i=1}^N R_{ji}, \quad (9)$$

where $j = \overline{1, M}$, $i = \overline{1, N}$,

j – the number of an alternative;

M – the number of alternatives;

N – the number of criteria;

R_{ji} – the number of the place of the alternative j in the matrix of compared alternatives on the criterion i (the rating of the j -alternative on the criterion i , place).

Formula 9 lacks the index V_i , because the criteria are equally important.

The global rating of alternatives is determined like in the previous case.

The third case: at least two criteria of all are equally important

The case is a combination of the cases discussed above.

We shall consider the global matrix in the form of table 9 as an example.

Table 9 – The global matrix

Criterion	Rating of criteria, R_i	Rating of alternatives, R_{ji}			
		1	2	...	p
Criterion i	1	Alternative ji			
Criterion x, y	2	Alternative jxy			
Criterion				
Criterion ...	l				

In the case the generalized rating of alternatives for equal criteria is determined like in case 2. But the calculation is made by formula 8 (case 1). Then the lines in the global matrix corresponding to the equal criteria are filled with the alternatives taking into the account their new generalized ratings.

As it is clear from table 9 the criteria x and y are equal, so the generalized rating of alternatives is calculated for them.

The squares of the global matrix for all the other criteria are filled with the alternatives like in case 1.

The index GR_j of the global rating of alternatives is determined by formula 8 and is interpreted like in case 1.

It is recommended to compare and analyze the obtained solutions by formula 8 with the global matrix, because some alternatives may turn out more favorable for a person responsible for taking a decision based on their better rating with respect to the most important criteria due to the generalized ratings of alternatives for equal criteria.

As a result of estimating the generalized rating of alternatives for equal criteria with account of unequal criteria in the task it may happen that in the analysis of the global matrix the alternative which is not so important in the global rating of alternatives may appear the most important. It happens because of the estimation of generalized rating of alternatives for equal criteria. In this case it is necessary to follow the rating of the given criteria, i.e. the higher their rating is, the more important the generalized rating of alternatives in the global matrix.

The main condition of using the program is complete and true information, i.e. input data, and professionalism of a person responsible for taking a decision

The advantages of the matrix method of decision making:

- *three variants of answers that simplify the work of a person responsible for taking a decision (the risk of a mistake connected with the human element diminishes);*
- *simplified completion of paired comparison matrices: the characters input by a person responsible for taking a decision are analyzed with the synchronous completion of other matrix cells according to the rule of transitivity;*
- *solution of tasks with a great number of criteria and alternatives owing to the use of the advantages of the matrix method mentioned above;*
- *the method takes into account the importance of each criteria;*
- *the global matrix allows to determine the best decisions visually;*
- *the dimensions of the global matrix decreases due to taking into account the criteria of equal importance;*
- *it calculates the generalized rating of alternatives for equal criteria that is input to the global matrix which simplifies for a person responsible for making a decision its visual analysis ;*
- *the method presents the solution of a problem in the form of the rating of alternatives on all the criteria.*

The software realization of the matrix method of decision making “Matrix Method” has a comfortable interface, takes into account all the advantages of the

matrix method, allows to solve the problems with a great number of criteria and alternatives, excludes user's mistakes connected with calculations, saves time and means for decision making.

Examples

The Choice of the Best Advertising Site in the Internet

Target setting The Internet shop of the UAB «IVL» enterprise wants to increase its sales by means of allocating its advertisements on the Internet portals X, Y, Z. The problem is to determine optimal advertising site with the help of the matrix method of decision-making using three main values: the price of an Internet advertisement to attract one target user to the site of the advertiser (the price of the transition of a user from the advertising portal to the site of the advertiser (CTR)), the level of coverage of target audience (the number of target users, demographic characteristics of the users), the level of competition on the advertising portal (the number of competitors using similar advertising site).

Solution At the initial stage of the matrix method it is necessary to construct the hierarchy of the problem (fig. 2) which consists of four levels. Here one should take into account that there must be much more criteria of the estimation.

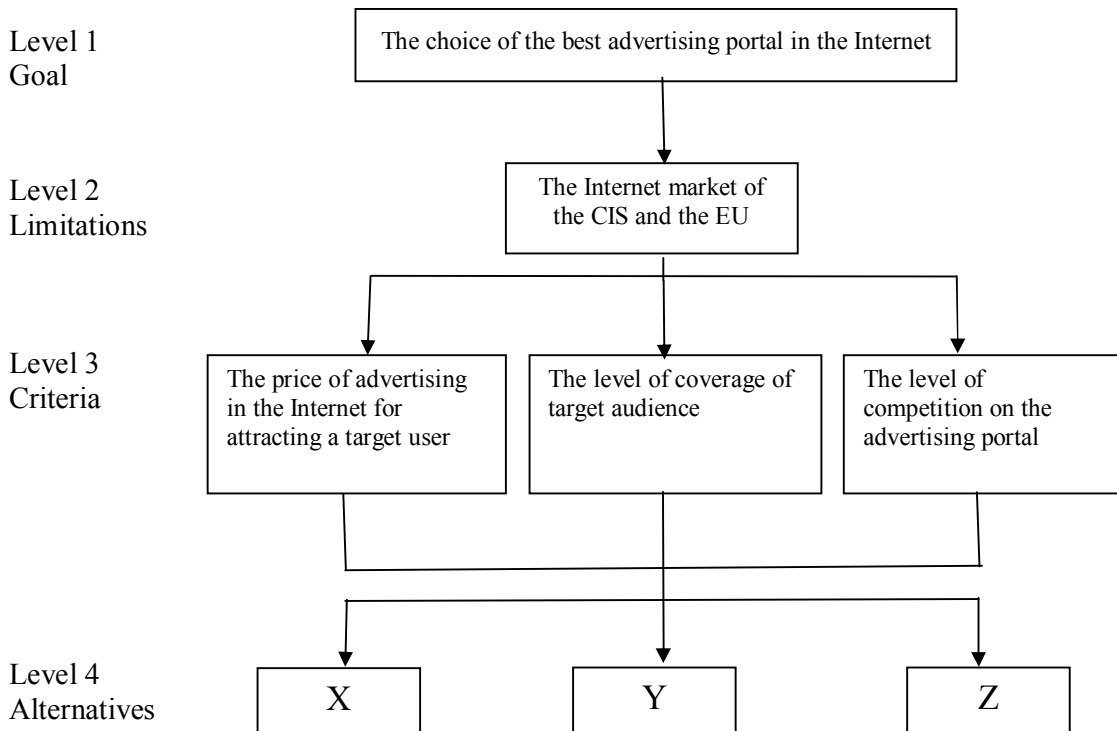


Fig. 2 – The hierarchy of the problem “The determination of optimal advertising sites in the Internet ”

At the next stage it is necessary to construct matrices of paired comparisons. Four such matrices are constructed. The first matrix is a matrix of paired comparisons, and the three others are matrices of alternatives on given criteria.

To simplify the completion of the matrices of compared criteria let's introduce the following designation of the criteria (table 10):

Table 10 – Criteria designation

Criterion	designation
the price of advertising in the Internet for attracting a target user	A
the level of coverage of target audience	B
the level of competition on the advertising portal	C

Table 11 – Matrix of compared criteria

<i>i</i>	Criterion	<i>k</i>			<i>S_i</i>	<i>R_i</i>	<i>V_i</i>
		<i>1</i>	<i>2</i>	<i>3</i>			
		A	B	C			
<i>1</i>	A	=	+	+	3	1	3/6
<i>2</i>	B	-	=	+	2	2	4/6
<i>3</i>	C	-	-	=	1	3	5/6
				<i>S</i>	6		

Thus, the first place is taken by the criterion “The price of advertising in the Internet for attracting a target user” (criterion A), the second – by the criterion “the level of coverage of target audience” (criterion B), the third – by the criterion “the level of competition on the advertising portal” (criterion C) (table 11).

The next stage of the matrix method is the construction of the matrices of compared alternatives on given criteria (tables 12 – 14).

Table 12 – Matrix of compared alternatives on the criterion “The price of advertising in the Internet for attracting a target user”

<i>j</i>	Alternative	<i>k</i>			<i>S_{ji}</i>	<i>R_{ji}</i>
		<i>1</i>	<i>2</i>	<i>3</i>		
		X	Y	Z		
<i>1</i>	X	=	+	+	3	1
<i>2</i>	Y	-	=	=	1	2
<i>3</i>	Z	-	=	=	1	2

Table 13 – Matrix of compared alternatives on the criterion “The level of coverage of target audience”

j	Alternative	k			S_{ji}	R_{ji}
		1	2	3		
		X	Y	Z		
1	X	=	+	+	3	1
2	Y	-	=	-	1	3
3	Z	-	+	=	2	2

Table 14 – Matrix of compared alternatives on the criterion “The level of competition on the advertising portal”

j	Альтернатива	k			S_{ji}	R_{ji}
		1	2	3		
		X	Y	Z		
1	X	=	-	-	1	2
2	Y	+	=	=	2	1
3	Z	+	=	=	2	1

The next stage of the matrix method is the construction of the global matrix (table 15).

Using formula (8) we get the following global ratings of the advertising portals:

$$GR_X = 3/6 \cdot 1 + 4/6 \cdot 1 + 5/6 \cdot 2 = 2,83;$$

$$GR_Y = 3/6 \cdot 2 + 4/6 \cdot 3 + 5/6 \cdot 1 = 3,83;$$

$$GR_Z = 3/6 \cdot 2 + 4/6 \cdot 2 + 5/6 \cdot 1 = 3,17.$$

Table 15 – Global matrix

Criterion	Rating of criteria, R_i	Rating of advertising portals - alternatives, R_{ji}		
		1	2	3
A	1	X	Y/Z	–
B	2	X	Z	Y
C	3	Y/Z	X	–

Thus, we get:

The first place – Internet portal X

The second place – Internet portal Z

The third place – Internet portal Y

The answer: the best Internet portal for the advertising campaign is X.

The program “Matrix Method”

The matrix method of supporting decision-making was used to determine priority clients for an Internet company.

Target setting. Determination of priority clients for an Internet company.

An Internet company needs to determine priority clients to offer them such services that will most completely meet their demands.

The criteria of estimating the clients are as follows: clear profit of the company from each client (with the account of all the expenses); the number of purchasing; adherence of the client to the products of company (the period of cooperation of the company with the client (months)).

Limitation: clear profit and the number of purchasing are considered for a period of 18 months.

The number of alternatives considered: 200 clients.

Solution. At the initial stage of the matrix method it is necessary to construct the hierarchy of the problem (fig.3) which consists of four levels

To solve the problem the information about the clients was collected: clear profit from each client for 18 months; the adherence of each client to the products of company, i.e. the period of cooperation of the company with the client on the basis of the dates of signing the first and the last contracts; the number of purchasing made by each client for 18 months.

At the next stage matrices of paired comparisons are constructed. The first matrix is a matrix of compared criteria with the dimension 3x3, and the three

others are matrices of compared alternatives on given criteria with the dimension 200x200.

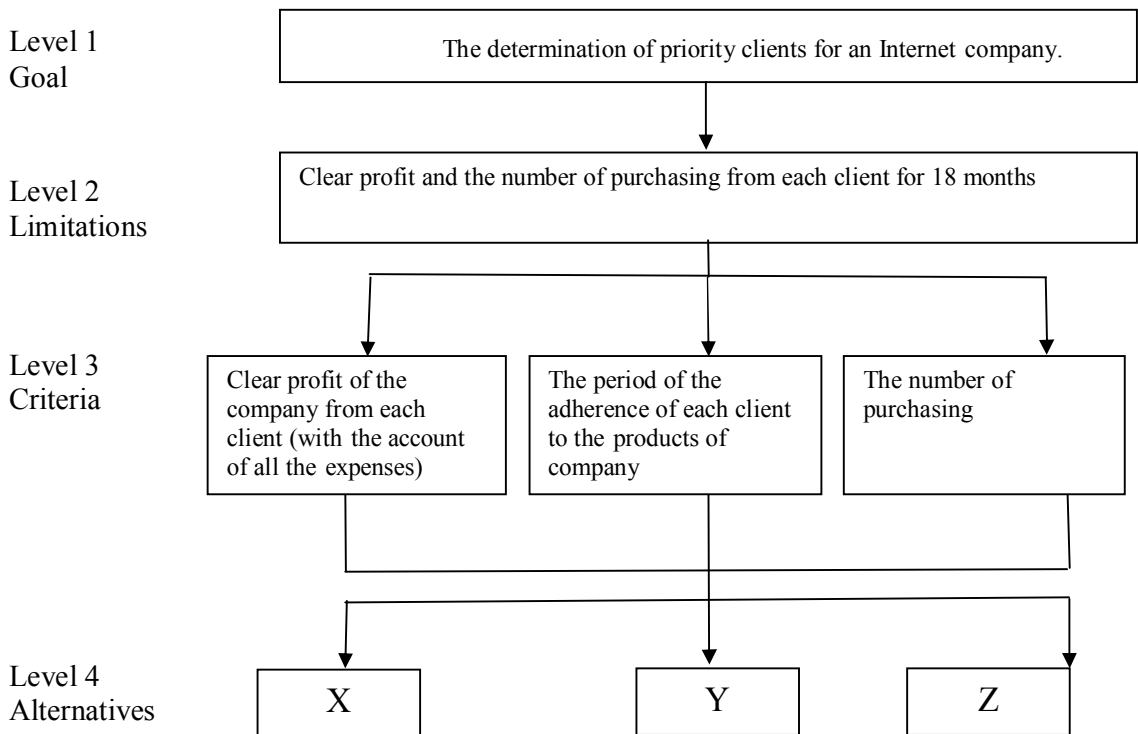


Figure 3 – **The hierarchy of the problem “Determination of priority clients for an Internet company”**

Then the initial data are input into the computer program “Matrix Method”. “Clear profit from each client for 18 months” is considered as the main criterion, then follows “The period of the adherence of each client to the products of company”, and the last place in the rating is taken by the criterion “The number of purchasing made by each client for 18 months”

The program determines the importance of each criterion.

Then the user compares the clients on given criteria. If clear profit from the client i is higher than clear profit from the client j the user puts the sign «+» into the square (i, j) ; if it is lower – the sign «-»; if equal – the sign «=».

Similarly the alternatives are compared on the criteria “The adherence of each client to the products of company” and “The number of purchasing”. If the period of adherence of the client i to the products of company is higher than the period of the client j the user puts the sign «+» into the square (i, j) ; if it is lower – the sign «-»; if equal – the sign «=».

On the basis of comparison the program automatically puts corresponding signs in the other squares of the matrix using the rule of transitivity. On the whole 40 thousand squares of each matrix of comparing alternatives on given criterion

are completed. According to data on each alternative the program “Matrix Method” reduces the number of user’s operations on completing the squares of the matrix by some per cent from the general number. For example, the user performs 745 operations completing the matrix “The comparison of the clients on the criterion “The adherence of each client to the products of company”, or 1,8625% squares from the whole number ($745/40000 \cdot 100\% = 1,8625\%$), all the other 98,1375% were completed by the program.

After completing the matrix the user obtains the result in the form of the global matrix and the general rating of 200 clients on three criteria. The global matrix enables to determine priority clients of the Internet Company visually. The most suitable client of the company is client #139 (fig. 4).

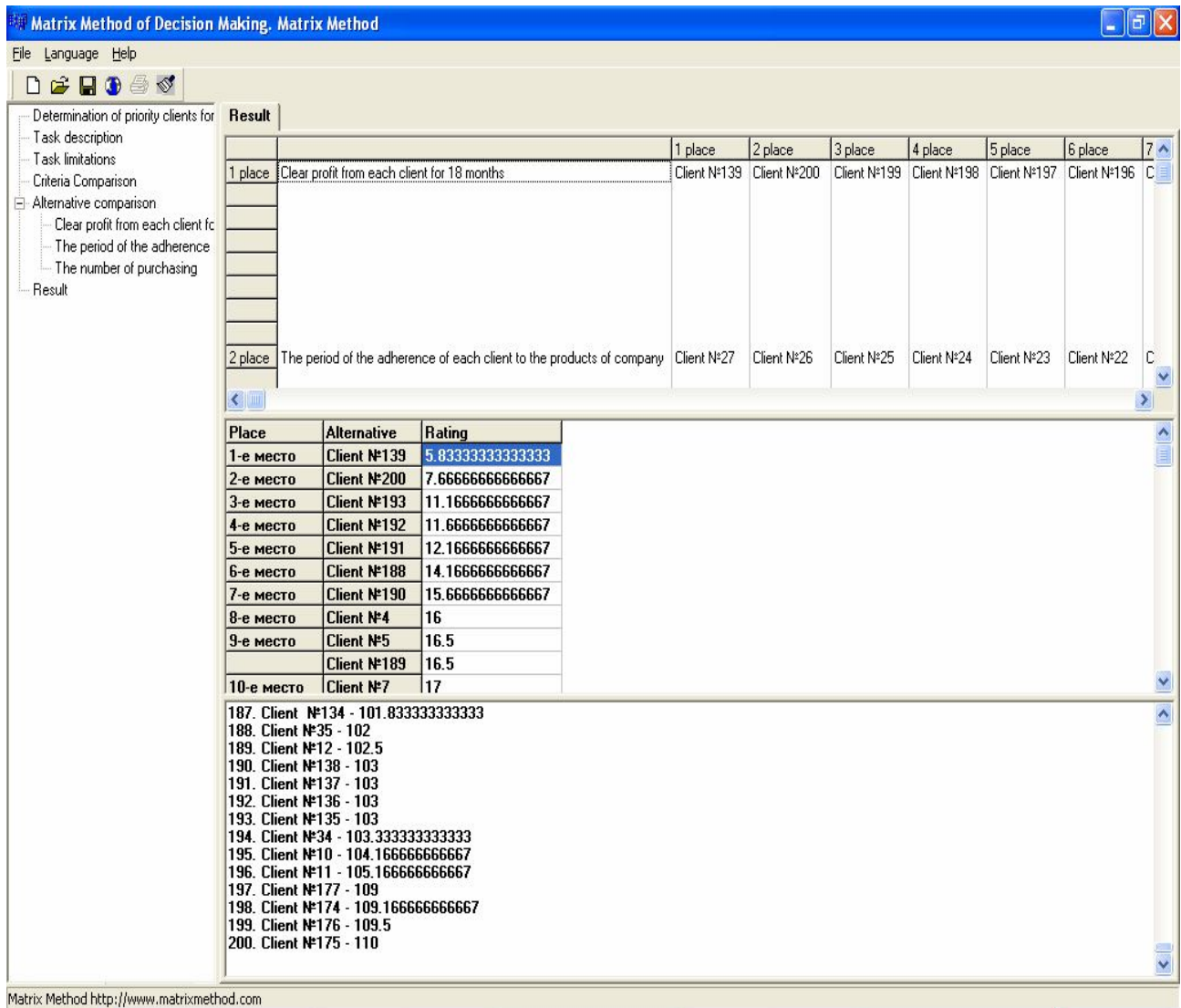


Figure 4 – Determination of priority clients for an Internet company

The following task that can be solved with the help of the matrix method is the choice of the best Internet project.

A company needs to choose the best of N Internet projects basing on the following 8 criteria: the level of interest of the target audience, the model of the Internet business, pay-back period, the level of complexity of the project development, the term of its realization, the degree of its realization complexity, risks (international economic situation, political and economic situation of a particular country, the competition on the segment), the index of profitability.

To do it the program «Matrix Method» is used.

For the solution of the problem 9 matrices are completed: one matrix of compared criteria with the dimension 8x8, and 8 matrices of compared alternatives on each of the criteria with the dimension NxN. After the input of the information the program gives the result.

The program can be applied for the determination of priority segment of the Internet market, i.e. the group of consumers that possess one or several common features determining the behavior of the consumers on the Internet market [5].

Professor Hrutskiy gives 7 main criteria of market segments [6]. In our opinion, they are suitable for the Internet market. The criteria of estimating Internet market segments are the size (volume) of the segment, the accessibility of the segment for an enterprise, availability of the segment, profitability of the segment, compatibility of the segment with the market of the main competitors and protectability of the segment from the competition, the efficiency of the work at the chosen segment of the Internet market, correspondence of the chosen segment to the mission and goals of the company [6].

On the basis of the given above criteria one can determine a priority segment of the Internet market of N ones using the matrix method of decision-making.

The program is used to choose the best supplier for the Internet shop «IVL» of the UAB company. The estimation is done on nine criteria: reputation, quality of products, possible volume of supplies, timeliness of the supplies, price, terms of supplies, forms of payment, system of discounts, after-sales service. For the alternatives 50 suppliers are suggested. There are no limitations to the solution of the problem.

With the help of the computer program the market analyst entered necessary initial information for the given task. The program created 10 matrices of paired

comparisons: 1 matrix of compared criteria with the dimension 9x9, and 9 matrices of compared alternatives on each of the criteria with the dimension 50x50 each.

The program analyzed the data input into the matrices of paired comparisons and automatically put the corresponding signs into the bigger part of each of the ten matrices of paired comparisons. While the market analyst was entering information, the program was analyzing the data in the squares of the matrix and completing the blank ones according to the rules of transitivity.

The program “Matrix Method” displayed the number of blank squares for each matrix and provided automatic switch to them. It considerably simplified the work of the market analyst in data input.

Thus, the program analyses the information entered by a market analyst and considerably simplifies his work in completing the necessary matrices. It is one of the main advantages of the matrix method application.

In the given task for equal criteria the matrix method of decision-making calculated the general rating of alternatives. As a result, 2 lines of 8 in the global matrix for such criteria turned out to be completed, and its dimension decreased and became 3x34. Owing to that the market analyst could visually determine the best suppliers.

As a result, the solution for the problem in the form of the global matrix and the rating of suppliers was obtained. The program will automatically determine the best supplier.

On the basis of all that the market analyst considered the data of the global matrix and the rating of suppliers and took the corresponding decision based on the positions of alternatives with respect to the best criteria in the global matrix.

Solving the problem without the program will take the market analyst quite a lot of time to make the analysis and, besides, taking into account the human element there may be mistakes even at the initial stage of data comparison. It should be noted that the solution of any problem requires complete and reliable information.

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