

## DETERMINATION OF CRITERIA WEIGHTS IN TERMS OF COMPUTER SOFTWARE

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**Summary** This article takes down the knowledge with determination of criteria weights in the terms of computer software of superconductive materials. This software relieves processing of considerable enters data. The criteria of the weights were determined by Fuller triangle and Saaty's methods. These methods are used by MCA7 programme. Last time there is more talked about superconductive materials as materials in industrial plants in future. These materials are amazing, because their resistance on critical temperature is zero. There were defined 10 basic criteria at material compensation (copper, aluminium) by superconductive materials in industrial plant.

### 1. INTRODUCTION

In this article we were deal by criteria weights determination in terms of computer software MCA7 for superconductive materials. This computer programme was created at the department of electrical power engineering and it relieves the processing of considerable enters data. These values of weights are very important for the others arithmetic and for using some methods of multicriterial analysis, e.g. (IPA - Ideal Point Analysis, TOPSIS, and WSA - Weighted Sum Approach, CDA - Concordance-Discordance Analysis).

### 2. PROGRAM MCA7

The title of this programme is composed of the type of English title "Multicriterial analysis". Reason rise of the programme MCA 7 was a pursuit facilitation of processing of considerable enters data processing.

If we want to solution of multicriterial analysis use MCA7, we will have to create of file with enters data. We create this input file in terms of MS Excel. Methods were developed for simplification determination of weights, which them in MCA7 commonly used and whose application makes it possible to divide by 100 percent of weight among separate criteria without of what user would be obliged judge all criteria together. The criteria weights were determinate by Fuller triangle and Saaty's methods. These methods are used by programme MCA7.

Fuller's triangle method - principle of this method consists in comparing every criterion with everyone by couples.

Saaty's method - principle of this method consists in comparing degree of two criteria and we mean it numerically according to our opinion their rate of importance. We mean this rate by numbers from 1 to the 9.

At determination weights of criteria so-called Saaty's method it is necessary to use arithmetic but

also incident to number of matrix geminate collation. This programme just throws MCA7 one that employs the next following procedure for this operation.

We search maximum of real eigenvalue  $\lambda_1$  given matrix.  $\alpha^p$  is p-power of matrix  $\alpha$ , it is defined as

$$\alpha^p = \sum_{r=1}^n \lambda_r^p \cdot Z_r, \quad (1)$$

where,

$$Z_r = \prod_{s \neq r} \frac{(\alpha - \lambda_s [1])}{(\lambda_r - \lambda_s)} \quad (2)$$

$Z_r$  is evidently independent agency on p. We supposed, that the n of equation roots is sequenced descending by decreasing absolute value.

$$|\lambda_1| > |\lambda_2| > \dots > |\lambda_n| \quad (3)$$

If p is minimal we can neglect  $\lambda_2^p, \dots, \lambda_n^p$  on  $\lambda_1^p$  and write

$$\alpha^p \approx \lambda_1^p \prod_{s \neq 1} \frac{(\alpha - \lambda_s [1])}{(\lambda_1 - \lambda_s)} \quad (4)$$

The biggest problem of application there methods of multicriterial analyses is obtaining of enters data, above all then it determination weights of criteria. It is comprehensible, if we use some of the methods multicriterial analyses or we express weights of criteria directly with per cent, it is always discussed with subjective opinion of one person. So as to total resulting vector of weights was the most objective, it is necessary to obtain the most number of vectors, which we can still statistically set up and then we get more objective expression of weights.

In practice there exist various methods for obtaining weights of criteria.

1) We address experts from the areas which are given to concerned exercise. For these experts are introduced single criteria and result will be set of vectors of weights from different persons. These vectors we can statistically work up and after we use them as the entry in program MCA7.

2) There exists some possibility of mutual corporation special engineering, who purpose after mutual tutorial suggest of one vector weights for given to criteria.

3) There is possibility set of multicriterial exercises; suggest weights of criteria as only one expert. It is necessary consult that the responsibility is given only for one person, which doesn't need necessarily describe all aspects of solve the problem or he can simply is mistaken.

### 3. OPTION CRITERIA AND HIMSELF DETERMINATION VALUES OF WEIGHTS BY THE HELPS OF MCA7

In the next text we will deal with the first case from introduced enumeration. We assume, that we keep at one's disposal more formulations about the values of weights from engineering (in our case engineers in industrial plants) we have to work with them so the result was the most objective formulation of criteria weights from received data.

In the last time it is often talked about superconductive materials as the future materials in industrial plants. These materials are amazing because their resistance at critical temperatures is zero. Therefore it happens to huge reduction of losses but purchase costs are high. Titles and orders of importance of single criteria were consulted with the engineers in industrial plants in the North Moravia.

It was given quite 10 basic criteria at compensation material (cooper, aluminium) by superconductive materials in industrial plants. Among determine criteria were registered:

1) Energy not supplied at outage - most of customers require to power supply would be fluent. At planned or unplanned outage non-delivery energy in industrial plants can be a big problem.

2) Investment costs - acquisition spending for superconductive materials

3) Degree of service reliability - conservation reliability of all parts of electricity supply system

4) Impact on environment - claims due arrangements on environment

5) Load terminal of reactor - whether is get past burden reactor on rated values or on values are less than one.

6) Operational costs - costs connecting with servicing, revision and reparation

7) Placing of reactor - whether is better place of reactor among busbar or in turn, eventually before important arrangement

8) Safeness important arrangement before short circuit current - whether superconductive reactor would be able limit size of short-circuit current.

9) Return rate of investments - how long companies would returned expended on investment

10) Frequency of handling - number of handling with closing elements necessary to limitation of crack superconductive reactor

To calculation weights of criteria from above-mentioned methods we have to create input file in setting MS-Excel.

	A	B	C
1	Number of criteria		
2	Number of variants		
3			
4			
5	Name of criteria		
6	Better/Worse = 1/0		
7	Weight of criteria		
8			
9			
10	Variant/Criteria		

Fig.1. Blank input file

We set number of criteria to the cell B1. The cell has to contain positive integer valuables (from 1 to the 230) and it hasn't been empty.

We set number of variant to the cell B2. The cell has to contain positive integer valuables (from 1 to the 65000) and it hasn't been empty.

We set text to the cell B5, D5 etc., which characterizes single of criteria.

There must be intended in line 6, it is discussed about maximize (profitable) criterion, then we will write 1 to the cell or minimalist (unprofitable) criterion then we will write 0 to the cell.

We write weights of criteria to the line 7, which we obtain after design of calculation in programme MCA7.

Input file looks in our case subsequently:

Number of criteria	10						
Number of variants	1						
Name of criteria	Return rate of investments	Degree of service reliability	Safeness	Impact on environment	Operational costs	Investment costs	Load terminal of reactor
Better/Worse = 1/0							
Weight of criteria							
Variant/Criteria							

Fig.2. Filled input file for concrete case

This modified input file we can use for determination weights of criteria. We start the programme MCA7 and menu (Váhy kritérií/Návrh vah/otevřít) and we choose file and relevant sheet.

All information on source file we can see in MCA7. After clicking on tuck-in Fullerova/Satyho metoda we switch over to the next sheet, where we can do determination of weights mentioned above methods. We press a button to data entry at determination weights of criteria by Fuller's triangle method.

We label first couple of criteria to the next couple and we get press a button Další>.The programme will offered step by step to confrontation all couple of criteria. We can return and eventually to change previous setting with the helping of button <Zpět. As soon as it will comparing collation last couple of criteria, altering button Další> in the End. Calculation engaged of values is performed after his pressing. In this table there will be near appropriate of criteria on introductory weights of criteria and their weights. These weights will be calculated of method Fuller's triangle how we can see on Tab.1.

Tab.1. Resulting weights calculation by the help of method Fuller's triangle

Name of criteria	Weight of criteria
Return rate of investments	0,1978
Degree of service reliability	0,1761
Safeness	0,1543
Impact on enviroment	0,1326
Operational costs	0,1109
Investment costs	0,0891
Load terminal of reactor	0,0674
Energy not supplied	0,0457
Placing of reactor	0,0239
Frequency of handling	0,0022

Principle of Saaty's method consists in comparing degree of two criteria and we mean it numerically according to our opinion their rate of importance. We mean this rate by numbers from 1 to the 9.

Programme MCA7 is written in such a way, when we set valuables into matrix geminate comparison, which automatically check would be set only integral numbers in referred to range and after we set of numerator fraction cursor moves at once into patches denominator. At the setting can be enough only to put in numbers and press key Enter for shift to the next couple compared with criteria. When we set of couple numbers and matrix is spaced by geminate comparison at right-handed, where on her main diagonal full marks and below her are reciprocates values of element, which is given on the place above main diagonal.

As soon as we compare last couple of criteria it altering the button Další> in the End and after his pressing is performed calculation of engaged values. In the table it will be near appropriate criteria on introductory weights of criteria and their weights.

These weights will be calculated of Saaty's method, which we can see on Tab. 2.

Tab.2. Resulting weights calculation by the help of Saaty's method

Name of criteria	Weight of criteria
Return rate of investments	0,1957
Degree of service reliability	0,1739
Safeness	0,1522
Impact on enviroment	0,1304
Operational costs	0,1087
Investment costs	0,0870
Load terminal of reactor	0,0652
Energy not supplied	0,0435
Placing of reactor	0,0217
Frequency of handling	0,0217

#### 4. CONCLUSION

In this article we wanted to show, how we calculate weights of criteria with the help of computer software. In our case it was programme MCA7. It is necessary to remind that no methods MCA substitute in the human determination process when this person is decider, but it rather transports its action for qualitatively higher level. In these methods some subjective factor (e.g. at determination of relative importance single criteria - stress criteria) always gets off. Effectiveness of these methods MCA consists of making decider to orientate in a case of big set off variants and criteria very well.

We use to determination of optimal variants some of the methods of multicriterial decision making (WSA, TOPSIS, CDA and IPA). Nowadays we can use computer software MCA8. With reference to high investment in these elements it is necessary to this compensation there was performed where is it the mostly needed. Therefore methods of multicriterial valuation variants (VHV) fall to the areas of multicriterial analyses (MCA), which designates sequence to compensation. This sequence is given on the basic evaluation of several different criteria, which concern to operational and economical aspects.

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