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EFFICIENT ALGORITHM FOR EVALUATING NEW PRODUCTS AND TECHNOLOGIES

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Abstract. *The paper presents an original and efficient algorithm for the comparative evaluation of the new products and technologies, an algorithm based on the fundamental elements of the Value analysis method and of the multicriterial decision method.*
Being given a new product whose performances should be evaluated as against the existing similar products, the algorithm requires that:

1. The products functions should be associated in four groups, namely, technical, technological, exploitation, ecological;

2. The importance coefficients (basic elements in the multicriterial decision method) which classically are differentiated only according to their functions value, should be of three degrees in the suggested alogorithm: importance coefficients for the functions parameters, importance parameters for the functions but established according to the value of each function in each group, and importance coefficients of the functions groups.

Under these conditions, the computation of the global utility (one which gives the measure of the products performance) is done specifically, according to its own logical diagram.

Keywords: *Value analysis, Multicriterial decision method, Products evaluation algorithm*

1. INTRODUCTION

The algorithm presented in this paper constitutes an “adjustment” and an “improvement” of the multicriterial decision method, [1], [5], its aim being the designation of the most performant product from “m” similar products, only in the case when the functions of the respective products have been established beforehand using the Value analysis techniqe, [2], [3], [4]. The algorithm is based on a series of notions and elements from the Value analysis and the Decision processes, which we shall present in the following.

The Value analysis is a creative, systemic and functional research and design method for which any object is perceived as a set of functions. The function is a quality of the object, which makes it desired by the buyer. The function has one or more technico – economic parameters. The functions of an object can be principal or secondary, objective or subjective, specific or general. Two or more similar products have the same functions as name and significance.

The multicriterial decision method. Being given "m" similar objects, noted with V_i , $i = 1, m$ and "n" estimation criteria for them, noted with C_j, $j = 1,n$, characterized by parameters a_{ij} and by the importance coefficients K_j – see matrix M_1 (table M_1) – the most performant product need to be determined.:

$[a_{ij}]$; $[u_{ij}]$ Table M_1.

K_j	K_1		K_j		K_n	U_{gi}
V_i \ C_j	C_1		C_j		C_n	
V_1	a_{11} / u_{11}	…	a_{1j} / u_{1j}	…	a_{1n} / u_{1n}	U_{g1}
. . .			. . .		. . .	
V_i	a_{i1} / u_{i1}	…	a_{ij} / u_{ij}	…	a_{in} / u_{in}	U_{gi}
. . .			. . .		. . .	
V_m	a_{m1} / u_{m1}	…	a_{mj} / u_{mj}	…	a_{mn} / u_{mn}	U_{gm}

With this aim in view we resort to the multicriterial decision method, which has the following stages:

- Adimensional quantities u_{ij} named utilities are associated to the parameters a_{ij} , according to the following rules: $u^1_{ij} = 1$ or any other value corresponding to the variant V_1 for which the parameter a_{ij} is the most important and $u^0_{ij} = 0,2$ or any other value for the product variant for which the parameter a_{ij} is the most unfavorable for a given j.

$$u^1_{ij} \Rightarrow a^1_{ij} \; ; \; u^0_{ij} \Rightarrow a^0_{ij}$$

The utilities of the other variants (for the same criteria) are determined by linear interpolation with relation 1, thus, resulting the utilities matrix, M_1(table M_1):

$$u_{ij} = \frac{a_{ij} - a^0_{ij}}{a^1_{ij} - a^0_{ij}} \tag{1}$$

- The global utility U_{gi} for any V_i is computed with relation 2:

$$U_{gi} = \sum_j k_j \cdot u_{ij} \tag{2}$$

- The optimum variant is given by relation 3:

$$V_{opt} = MAX \sum_{j} k_j \cdot u_{ij} \qquad (3)$$

The criteria C_j. The estimation criteria are principles, point of view or standard specifications on the basis of which more similar products are analysed and compared for estimating their performances.

The importance coefficients k_j are quantities through which the decider establishes the difference existing between the estimation criteria. The more subjective the process of the establishing their quantity is, the greater the criteria number (C_j) will be.

2. THE ALGORITHM PRESENTATION

The “adjustment” of the multicriterial decision method to the concepts of the Value analysis technique consists in the following:

- The generally used estimation criteria C_j will be replaced this time with the functions of the respective products;
- The functions will be associated, according to their specific character, in four homogeneous groups, namely, technical functions, technological functions, exploitation functions, ecological functions.

The “improvement” of the multicriterial decision method has two components, namely, the diversifying of the importance coefficients and the phasing of the global utility computation.

The “diversifying” of the importance coefficients. The importance coefficients will be established on the following three levels:

- Level 1 - the importance coefficients for the parameters of the same function, noted with k_{dj}’ (d = number of parameters of the same function);
- Level 2 - the importance coefficients for the parameters of the same group, established on the basis of the comparative analysis and estimation of the functions inside the respective group, noted with k_j ;
- Level 3 - the importance coefficients of the functions groups, noted with q_t (t = number of functions groups).

The computation of the global utility (U_{gi}) will be done in the following stages (see also table M_2):

Table M_2.

<table>
<tr><td rowspan="5">V_i</td><td colspan="4">Technical functions</td><td rowspan="5">$U_{it=1}$</td><td colspan="2">Technological function</td><td rowspan="5">$U_{it=2}$</td><td colspan="2">Exploitation functions</td><td rowspan="5">$U_{it=3}$</td><td colspan="2">Ecological functions</td><td rowspan="5">$U_{it=4}$</td><td rowspan="5">U_{ig}</td></tr>
<tr><td colspan="2">F_1</td><td>F_2</td><td>F_3</td><td>F_4</td><td>F_5</td><td>F_6</td><td>F_7</td><td>F_8</td><td>F_9</td></tr>
<tr><td colspan="4">q_1</td><td colspan="2">q_2</td><td colspan="2">q_3</td><td colspan="2">q_4</td></tr>
<tr><td colspan="2">k_1</td><td rowspan="2">k_2</td><td rowspan="2">k_3</td><td rowspan="2">k_4</td><td rowspan="2">k_5</td><td rowspan="2">k_6</td><td rowspan="2">K_7</td><td rowspan="2">k_8</td><td rowspan="2">K_9</td></tr>
<tr><td>k_{11}</td><td>k_{12}</td></tr>
<tr><td>V_1</td><td>u_{111}</td><td>u_{112}</td><td>u_{12}</td><td>u_{13}</td><td>$U_{1t=1}$</td><td>u_{14}</td><td>u_{15}</td><td>$U_{1t=2}$</td><td>u_{16}</td><td>u_{17}</td><td>$U_{1t=3}$</td><td>u_{18}</td><td>u_{19}</td><td>$U_{1t=4}$</td><td>U_{1g}</td></tr>
<tr><td>V_2</td><td>u_{211}</td><td>u_{212}</td><td>u_{22}</td><td>u_{23}</td><td>$U_{2t=1}$</td><td>u_{24}</td><td>u_{25}</td><td>$U_{2t=2}$</td><td>u_{26}</td><td>u_{27}</td><td>$U_{2t=3}$</td><td>u_{28}</td><td>u_{29}</td><td>$U_{2t=4}$</td><td>U_{2g}</td></tr>
</table>

a. The balanced utilities ($U^{p}_{dij'}$) of the technical dimensions are firstly computed with relation 4:

$$u^{p}_{dij'} = k_{di} \cdot u_{dij'} \quad (4)$$

b. The balanced utilities $u^{p}_{dij'}$ of the functions j' which have more technical dimensions are then computed with relation 5 which is, in fact, the product between the importance coefficient of the respective function ($k_{j'}$) and the sum of the balanced utilities of the technical dimensions , relation 5:

$$u^{p}_{ij} = k_{j'} \cdot \sum_{d} u^{p}_{dij'} = k_{j'} \cdot \sum_{d} k_{di} \cdot u_{dij'} \quad (5)$$

c. The balanced utilities (j'') which have only one technical function are computed with relation 6:

$$u^{p}_{ij''} = k_{j''} \cdot u_{ij''} \quad (6)$$

d. The balanced utilities (U_{it}) of each group (t) of functions are computed with relation 7:

$$U_{it} = q_t \cdot \left(\sum_{j'} u^{p}_{ij'} + \sum_{j''} u^{p}_{ij''} \right) \quad (7)$$

e. The global utility (Ugi) for each action variant (Vi) will be given by the sum of the balanced utilities of the functions groups with relation 8:

$$U_{gi} = \sum_{t} U_{it} \quad (8)$$

f. The most performant action variant will be given by the maximum value of the global utility, with relation 9:

$$V_{opt} = MAX_{i} U_{gi} = MAX_{i} \sum U_{it} \quad (9)$$

3. CONCLUSIONS

As shown in the introduction, the algorithm suggested by the author represents an adjustment of the multicriterial decision method to the Value analysis and, at the same time, an improvement of the computation method of the total and global utilities. This algorithm can be applied only in the case when the products subjected to the multicriterial analysis have been studied beforehand with the Value analysis technique, occasion on which their functions classified list they have been established. The knowledge of the products functions and their usage as establishing criteria has facilitated the development of the second part of the algorithm, namely, the methodological improvement.

The advantages of this algorithm are great, being the decreasing of the subjectivism degree when establishing the importance coefficients and the increasing of the computation precision of the balanced, total and global utilities.

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