VALUE ANALYSIS OR ENGINEERING – DETERMINATION OF THE ECONOMIC DIMENSION AND THE SYSTEMIC FUNCTION ANALYSIS

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Abstract: *Value Analysis / Value Engineering, by its nature, is an interdisciplinary issue that focuses on the improvement of the value of the functions required to achieve the goal in question. Its purpose is the systemic application of the recognized techniques used to identify the functions of the product and also the value of these functions and to provide only those functions that are necessary to perform the required performance at the lowest total cost. The purpose of this paper is to present the fundamental importance of the correlation between the consumption of a certain category of resources and the value it creates when formulating solutions to reduce one or another of the cost elements. The results of the study point out that a simple cost reduction does not necessarily mean an increase of the resource consumption efficiency due to the complex relationship of the different categories of resources with the value created by them.*

Keywords: *Value Analysis / Value Engineering, function, importance level of functions, economic dimension of functions*

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1. Introduction

The concept of Value Analysis begins in 1930 when F. Porsche, using the monocriteria analysis, considers as a single criterion the correlation between

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the value of the functions of a product/process/service and the associated costs as necessary and sufficient. However, Value Analysis was first applied in 1947 withinthe General Electric Company in the USA.

Harry Erliecher, director of General Electric's purchasing department, wishing to redesign products in the new post-World War II economic environment, commissioned Lawrence D. Miles, director of the Baltimore branch, to develop an implementation system of constructive alternatives at a systematically lower price.

Starting from Miles's statement, 'if I cannot get the product, I have to get its functions', he is in the literature known as the founder of a new managerial method called Value Analysis and Engineering.

Practically, both Value Analysis and Value Engineering aim to achieve the functions of an object in such a way as to ensure proportionality between the performance or utility of each function and the consumption of the resources needed to achieve it, resulting in maximizing the utility-cost ratio.

Alain Fernandez (2014), referring to the Value Analysis, states that it is based on the fundamental principle that Value Analysis should study the value of each function in consensus with the customer, and compare the cost of making the technology or the components before establishing the so-called functions and the required technical functions.

In our opinion, apart from the fundamental principle stated by A. Fernandez, there arealso other principles whose forms differ from one author to another and which may be technical, economic, cultural, managerial, and organizational.

According to the principles of the AV method, the first stage consists in describing the technical and economic characteristics of the PVC low voltage cable and determining its production cost. Correctly establishing a function nomenclature of a product is the most important methodological issue of the Value Analysis. This step of the Value Analysis / Value Engineering method was dealt with in a paper published in a previous issue of the *Review of General Management* (2017). However, the most laborious work is the economic dimensioning and the systemic functionanalysis, starting from the finding that the cost of any object reflects what has been consumed, but not what has been achieved, aspect which is complemented by the Value Analysis / Engineering which, using the function cost, links the economic effort to the economic effect.

2. Determination of the economic dimension and the systemic function analysis

The economic dimension of functions is the expression of their cost of production, and the action determining the cost of production at their level is called the economic dimensioning of functions.

The economic dimensioning of each function results from the summing up of the costs of the component elements that materialize that function, namely the cost of the structures that make the functions of the product.

For any product viewed as a physical object, its cost is economically justifiable if it is viewed only in terms of the constructive complexity and the quality of the materials used. Under thesecircumstances, the cost of any item reflects what has been consumed, but not what has been achieved, aspect which is complemented by Value Analysis / Engineering which, by resorting to the cost of functions, links the economic effort to the economic effect.

From the practical point of view, the economic dimension of the functions can be determined either globally or analytically on each structure of the production cost, through the following steps:

- establishing the weightings with which each structural component participates in the accomplishment of the functions, respectively of each technological operation;
- the allocation of the material and labor costs of the components to each function;
- calculation of costs and weightings of the functions in the total cost of the product.

The global method of economic dimensioning of functions involves the use of the global cost values (Cj) of the objects without the need for detailing the three structural components of costs (materials, wages and indirect manufacturing costs), aspect which the analytical method implies.

In the scientific approach we undertook, we opted for a mixed variant, namely by detailing the material components and taking the other components of the cost globally. We mention that the share each structural component of the cost participates in the achievement of the function is a problem related to the technical, engineering, apparatus, and is done by appreciation, following a rigorous analysis that answers the questions how much? and in what proportion? as shown in table no.1.

<u>Table no.1</u>

Calculation of function cost of VLPY low voltage electrical cable

Component	Value lei/km	Functions of product						
		F1	F2	F3	F4	F5	F6	F7
Conductor	923,16	184,63	276,95	138,47	73,85	92,32	46,16	110,78
Estimated cost share	100%	20%	30%	15%	8%	10%	5%	12%
Insulator	1.437,85	359,46	431,36	287,57	143,79	100,65	71,89	43,14
Estimated cost share	100%	25%	30%	20%	10%	7%	5%	3%
Labor + indirect manufacturing costs	2.589,04	569,59	1035,62	517,81	77,67	155,34	51,78	181,23
Estimated cost share	100%	22%	40%	20%	3%	6%	2%	7%
Ideal total production cost (Ctpi)	4950,05	1113,68	1743,93	943,85	295,31	348,31	169,83	335,15
Cost function share %	100%	22,5	35,23	19,07	5,97	7,04	3,43	6,77

In order to determine the economic size, we will graphically determine the correlation between costs and the share of the functions, i.e. establish the ideal costs by comparing the share of each function in the global function of the product with the share of the cost of each function in the production or manufacturing cost of the product.

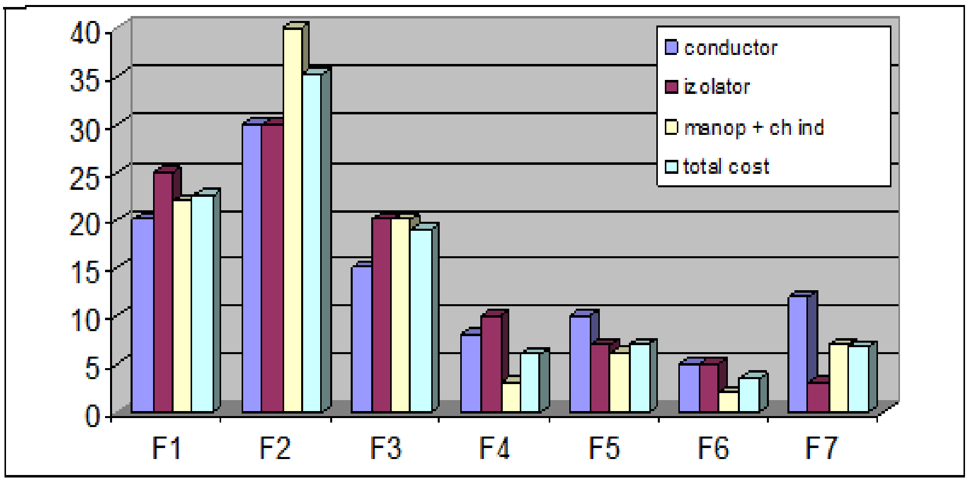

Figure no.1. Economic dimension of functions

We can notice that F4 and F6 are given less importance than it would be required.

Considering that the mathematical model of value is given by the function / cost relationship, we can assume that making decisions based on this relationship assures us that no element will improve on account of the decrease of another. Value Analysis studies usually improve several elements of the value simultaneously.

Cost minimization processes without a Value Analysis study often lead to the risk of compromising the performance of the function, altering the proper functioning of the product and the delivery characteristics required by the customer.

On the basis of the mathematical model of the value, one can notice the conditions in which the value can be increased, namely:

- function increases, the cost keeps constant;
- the function remains unchanged, but the cost decreases;
- function increases, simultaneously with a decreases of the cost;
- function increases in a higher proportion than the increase of the cost.

The option of decreasing the cost to a higher proportion than reducing the function is possible mathematically, but it is not acceptable in the Value Analysis methodology.

In order to express a certain option on the possibility of improving the economic dimension of the functions of the VLPY low voltage electrical cable, we carried out acomparative study between the actual costs of the functions and the ideal costs found on the last line of Table 2.

The actual cost of functions (Crf) is determined on the basis of:

$$Crf_j = \frac{if_j}{\sum_{j=1}^{7} if_j} \times 100 \times Ctp \qquad 1)$$

Table no.2.
Comparative Cost Functions Analysis

Function	if	Σif	pf %	Ctp	Real Cost Crf	Ideal Cost Ctpi	Δ Crf - Ctpi
F1	5	28	17,86	4950,05	883,94	1113,68	-229,74
F2	7		25,00		1237,51	1743,93	-506,42
F3	6		21,43		1060,73	943,85	116,88
F4	2		7,14		353,58	295,31	58,27
F5	4		14,29		707,15	348,31	358,84
F6	1		3,57		176,79	169,83	6,96
F7	3		10,71		530,36	335,15	195,21

According to the Values Analysis / Engineering principles, it is necessary to act on those functions that show the greatest difference between the real cost and the ideal cost, that means that for our product it is necessary to look at function F5 that aims at easy handling of the VLPY low voltage electrical cable.

Since the weight of the cable is given by the mass of the conductor (copper), it results that the solution would be to replace the copper conductor with a conductor that has an aluminum-copper alloy composition and which, at the same time, attracts an 18% reduction of the material cost.

By improving the constructive solutions, other values regarding the importance of the functions increase, according to the data in table no. 3, with the indication that the notations used initially are retained.

Table no.3.
Matrix of functions resulting from the improvement of the constructive solution

	F1	F2	F3	F4	F5	F6	F7
F1	1	1	1	0	0	0	0
F2	0	1	0	1	0	0	0
F3	1	1	1	0	0	0	0
F4	1	1	1	1	0	0	1
F5	1	1	1	0	1	0	1
F6	1	1	1	1	1	1	1
F7	1	1	0	0	0	0	1
if	6	7	5	3	2	1	4
pf	0,21	0,25	0,18	0,11	0,07	0,04	0,14

Based on the matrix of importance of functions, engineers established a new share of costs per function, according to the data in table no. 4.

<u>Table no. 4.</u>
Calculation of the cost of functions of electrical cable following the implementation of the solutions of constructive improvement

Component	Value lei/km	Functions of product						
		F1	F2	F3	F4	F5	F6	F7
Conductor	756,99	174,11	181,68	143,83	113,55	22,71	30,28	90,84
Estimated cost share	100%	23%	24%	19%	15%	3%	4%	12%
Insulator	1.437,85	359,46	460,11	287,57	143,79	129,41	0,00	57,51
Estimated cost share	100%	25%	32%	20%	10%	9%	0%	4%
Labor + indirect manufacturing costs	2.589,04	517,81	906,16	440,41	258,90	155,34	51,78	258,90
Estimated cost share	100%	20%	35%	17%	10%	6%	2%	10%
Ideal total production cost (Ctpi)	4783,88	1051,38	1547,95	871,54	516,24	307,46	82,06	407,25
Cost function share %	100%	21,98	32,36	18,22	10,79	6,43	1,72	8,51

The comparative cost analysis, presented in table no. 5 highlights the fact that further analyzes are needed to balance the cost of all functions, given that the value of the F7 function is significantly different from the real cost.

<u>Table no. 5.</u>
Comparative cost analysis of functions after the implementation of the solutions of constructive improvement

Function	if	Σif	pf %	Ctp	Real Cost Crf	Ideal Cost Ctpi	Δ Crf - Ctpi
F1	6	28	0,2142	4783,88	1025,12	1051,38	-26,26
F2	7		0,2500		1195,97	1547,95	-351,98
F3	5		0,1785		854,27	871,54	-17,27
F4	3		0,1071		512,56	516,24	-3,68
F5	2		0,0714		341,71	307,46	34,25
F6	1		0,0357		170,85	82,06	88,79
F7	4		0,1428		683,41	407,25	276,16

Conclusions

Without claiming to have reached the optimum solution, comparing graphically the share of costs per function calculated in tables no. 1 and no. 4, we notice that the slope of the straight line bends, following the improvement solution that we have considered, towards the graph of the ideal product knowing that in such a case the function line must make an angle of 45^0 with the OX axis.

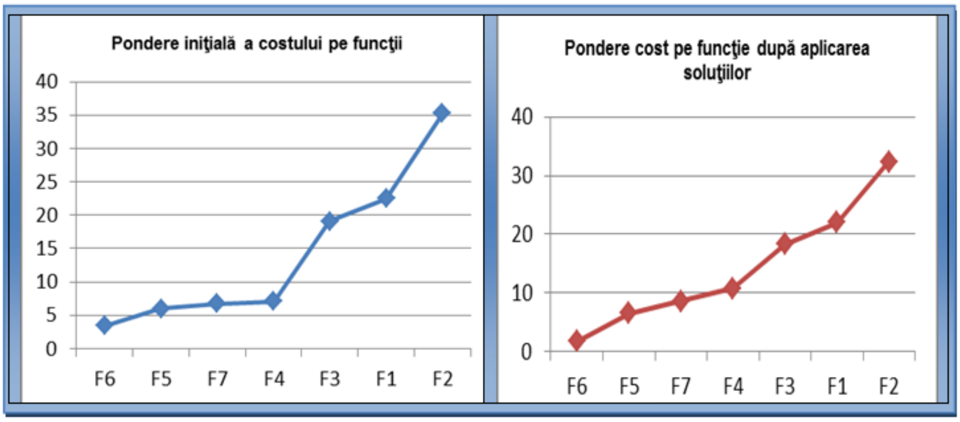

Figure no. 2. The comparative evolution of cost by function

In our opinion, the solution is to perform the Value Analysis on each structural cost component, as reducing material costs by using cheaper and lighter conductors can also entail changes in real labor costs by reducing labor times.

On the other hand, other solutions to improve the constructive solutions can also be found, such as:

- choosing another insulating material for the conductor;
- making the conductor of aluminum only;

For each of the possible solutions the analyzes presented in the case of replacing the copper conductor with an aluminum-copper alloy conductor should be made and by comparing the solutions the optimum solution to match all the functions of the product should be chosen.

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