USE OF "VALUE ANALYSIS" METHOD FOR AN ENERGY EFFICIENT AUTOMOTIVE PRODUCT

Oana VLADUT[1], Iulian-Claudiu DUTU[2], Petruta MIHAI[3], Mihaela-Florentina DUTU[2] and Maria-Valia MIHAI[4]

[1]Department of Economy, University POLITEHNICA of Bucharest
[2]Department of Biotechnical Systems, University POLITEHNICA of Bucharest
[3]Department of Entrepreneurship and Management, University POLITEHNICA of Bucharest
[4]Department of Business Administration, Petroleum-Gas University of Ploiesti

Abstract: *Given the pandemic situation that humanity has been facing for over a year, the car industry has become more important because many people have avoided crowds and tried to have their own machines. The purpose of the paper herein lies in the identification of the technical characteristics of an automobile that need to be improved so that the disparity between perceptions and expectations of the customers is reduced. To achieve this purpose, we used the "Value Analysis" method. We asked the customers of this industry about improving the quality of the product expressed by its characteristics and we wanted to find an appropriate relationship between the use value of a product and production costs. Following the research, it was found that the area of improvement is in the area of technology and technological performance, requiring the improvement of the assistance system, which is in a direct correlation with the autopilot.*

Keywords: *quality; research; automotive industry; quality management; value analysis; product*

INTRODUCTION

From a *technical* perspective, quality stands for the level of conformity of a product with the technical requirements in the production norms; otherwise, any change in such norms leads to a distortion of the product, made to save raw materials and decrease costs, which turns into a counterfeit product. In terms of *economy,* it expresses the optimum ratio between the level of revenue and expenditure for the producer and the consumer.

S*ocially*, quality is defined as the level of satisfaction of the consumers' requirements (expressed and implicit).[1] To generally improve the quality characteristics of a product, the following methods can be used: Technical level, "Quality house" method and "Value analysis" method.

Value analysis is a method of increasing production by reducing manufacturing costs. In order to implement the "Value Analysis" method, the description of the product and its importance for the economy must be presented, as well as its classification and the characteristics that define the products and differentiate them from services. All products have characteristics that are: typological, qualitative and insignificant.

Typological characteristics, as a rule, are common to some product classes that largely describe the main functions of the products and are defined by the value in use. These features are usually used to compare products.

Qualitative characteristics are created in the design and construction stage and are usable in the marketing and use stage. They aim to differentiate products of the same class by describing their particularities. They are dependent on the technical level of the equipment used, the wear of the equipment, the degree of organization of production and technology, but they are not dependent on the productivity of employees and the cost of production.

Improving quality aims to minimize non-compliant products. The improvements have the effect of increasing the company's profit and revenue. Value analysis is applicable to both products and technological processes, services, activities, information systems, organizational structures and projects.

The main objectives of the method are:

- Reduction of expenses both on the entire technological process, as well as on raw materials and labor;
- Improving the quality of the analyzed elements;
- Increased reliability;
- Creating STAS solutions for similar elements made by the company.

I believe that a strategy of promoting the entrepreneurship services will have the desired effect if we have in the center of our focus clear and well defined objectives.

EXPERIMENTAL

The method of “Value analysis” evaluates a product having the purpose to increase its use and to reduce the costs. This method attempts to raise profits and lower costs by means of an efficient, use of the resources and eliminate the unjustified expenses.

The goal of the “Value Analysis” improvement method is as follows:[2]

- Increase in the product quality, expressed by means of its characteristics;
- Deriving a MAXIMUM ratio between the usage value of a product and its production costs.

The value analysis can be conducted following the stages given below:

1. Determination of the functions;
2. Determination of the importance levels for the above functions (STEM method);
3. Determination of the relations between the references performing functions and the functions themselves;
4. Determination of the cost for functions;
5. Determination of the theoretical cost;
6. Determination of the theoretical calculation.

A standard was developed in Romania, as an attempt to clarify and explain a series of concepts used by specialists in the value analysis. The value analysis is thus defined as a “method of research, systemic and creative design which, by means of a functional approach, intents for the functions of the object under study be devised and accomplished with minimum expenses, under quality conditions that will satisfy the users’ social necessities.”[3]

The definition above, accepted for this paper, highlights a number of basic concepts (elements) used in the value analysis, such as:

- Social necessity;
- Value;
- Function.

Functions are represented as elementary use values, homogeneous in content, quantifiable or not, which ensure the achievement of the social necessity of an object. Therefore, an object (product, service, technological process, etc.) comprises a set of elementary use values, also known as functions, which together make up its total use value.

Functions feature several characteristics:

- represent essential attributes of the object under study, in relations with the environment and the user;
- are the results of the attributes, properties and characteristics of the object under study and are achieved with the support of one or more structural elements (components);
- are derived from the social necessity that the respective object needs to satisfy.

Case study on improving the characteristics of a product

The main goal of the “Value Analysis” method is to derive a Maximum ratio between the use value of a product and its production costs.

$$V = V \text{ use} / V \text{ production} = \text{Utility} / \text{Price}, \qquad (1)$$

where V = value

1. Determination of the functions for a product

Table 1 show the main technical characteristics of the automotive product under study, based on which functions are determined.

Table 1: Determining the functions of the product

Feature name	Function name	Symbol	U.M.
1. Driving assistance system	F1: Provides a safe travel for the driver	S.A.C	pieces
2. Cruise control	F2: Provides a comfort degree to the driver	P.A	level
3. Parking sensors	F3: Provides an easier car maneuvering during parking	Pa	pieces
4. Fuel consumption	F4: Provides fuel economy	C.C	L/100km
5. Tank capacity	F5: Provides the required amount of fuel	Cap.	L
6. Engine power	F6: Ensures engine operation at different speeds	P	kw

7. Number of cylinders	F7: Provides the engine operation	Cyl	pieces
8. Weight	F8: Provides lower consumption	G	kg
9. Wheelbase	F9: Provides agility/dynamics to the automobile	Amp	mm

While the first column is listing the 9 main technical characteristics in an automotive product, the second column indicates the functions and the other two columns give the symbols used and their measurement units.

2. Determination of the importance levels for the functions (according to STEM)

Table 2 shows the correlation between each of the 9 functions and the other ones listed above in Table 1, by giving a score as follows:[1]

- 0, on the main diagonal and for the least important characteristic;
- 1, in case the characteristic is equally important;
- 2, if the characteristic is more important;
- 4, if the characteristic is the most important.

Further on, the total amount is calculated on the table line and the score derived from each of the 9 functions will be added. The amount will be divided with the totals, which are 66 in the studied case. After that, the result will be multiplied by 100, which gives the importance weight of each of the characteristics.

Table 2: Levels of importance of functions

	SAC	**PA**	**Pa**	**C.C**	**Cap**	**P**	**Cyl**	**G**	**Amp**	∑	**X**	**%**
F1-SAC	+	1	2	1	2	1	1	4	1	13	0,196	19,6
F2-PA	1	+	2	2	4	1	1	2	1	14	0,212	21,2
F3-Pa	0	0	+	1	1	0	1	1	0	4	0,06	6
F4-C.C	0	0	1	+	1	1	1	2	1	7	0,106	10,6
F5-Cap	0	0	1	1	+	0	0	1	0	3	0,045	4,5
F6-P	0	0	2	1	2	+	1	2	0	8	0,121	12,1
F7-Cyl	1	1	1	1	2	0	+	1	0	7	0,106	10,6
F8-G	0	0	0	1	1	0	0	+	0	2	0,0303	3,03
F9-Amp	1	1	1	1	1	0	1	2	+	8	0,121	12,1
										∑=66		

The purpose of the table above is to identify this importance weight, where the derived result shows that the cruise control (F2-PA) is the most important, followed by the driving assistance system (F1-SAC), the engine power (F6-P) and the wheelbase (F9-Amp), which have an equal level of importance.

3. Determination of the relations between the references and the functions performed by such references

Table 3 shows the references, i.e. the main product components, along with their cost, given in the second column, while the third column shows the 9 selected functions. Depending on the connections between these and the product components, *Xs* have been noted down for affirmative answers.

Since all components have at least two functions from the selected number, and those components that are correlated with two functions exhibit lower prices, unjustified expenses are not identified.

4. Determination of the relations between the references and the functions performed by such references

Against the correlations, noted with *Xs*, Table 3 shows the weights of *X* calculated in Table 2. The costs of each function will be determined in the next table, taking into account those weights. The only reference performing a single function is the "*car seats*", which means it is the least significant of all the references.

Table 3: The relationships between the landmarks and the functions performed by them

Highlights	**Cost**	**Functions**								
Automotive product	Lei	F1	F2	F3	F4	F5	F6	F7	F8	F9
Driving assistance system	19.305	X 0,196	X 0,212	X 0,06			X 0,121			
Cruise control	5.600	X 0,196	X 0,212	X 0,06					X 0,03	

Body	6.500	X 0,196								X 0,121
Car seats	8.560		X 0,212							
Command center	10.000	X 0,196	X 0,212					X 0,106		
Parking sensors	6.000	X 0,196	X 0,212	X 0,06						
Engine	24.000				X 0,106			X 0,106		X 0,121
Cylinders	4.500						X 0,121			X 0,121
TOTAL	84.465									

5. Determination of the costs for functions

The main goal of the Table 4 is to establish the weight of the costs for each of the 9 functions, in relation with the costs of the automobile's components and the total of expenses.

Thus, for the "*Driving Assistance System*" component, given as an example, the functions involved are F1, F2, F3 and F6, having the weights given in Table 3. These are being added and after that each of the weights is divided by the addition result. Furthermore, the final result will be multiplied by the component's value.

Table 4: Establishing the costs of functions

Highlights	**Cost**	**Functions**								
Automotive product	LEI	F1	F2	F3	F4	F5	F6	F7	F8	F9
Driving assistance system	19.305	X 0,196 6230	X 0,212 6948	X 0,06 1965			X 0,121 3965			
Cruise control	5.600	X 0,196 2204	X 0,212 2384	X 0,06 674					X 0,03 337	
Body	6.500	X 0,196 4018								X 0,121 2481
Car seats	8.560		X 0,212 8560							
Command center	10.000	X 0,196 3813	X 0,212 4124					X 0,106 2062		
Parking sensors	6.000	X 0,196 2513	X 0,212 2717	X 0,06 769						
Engine	24.000				X 0,106 11206			X 0,106 11206		X 0,121 12792
Cylinders	4.500						X 0,121 2250			X 0,121 2250
TOTAL	84.465	18778	24733	3408	11206	0	6215	13268	337	17523
	Y	0,2223	0,2928	0,0403	0,1326	0	0,0735	0,1570	0,0039	0,2074

After performing the calculations above for each function, column addition will be made in order to determinate the weights of each function, in respect to the total of value. Function F2 is noticed to have a weight of 29.28%.

6. Determination of the theoretical cost

Table 5: Establishing the theoretical cost

E. calculation	F1	F2	F3	F4	F5	F6	F7	F8	F9	Total
xi	19,6	21,2	6	10,6	4,5	12,1	10,6	3.03	12,1	100
yi	22,23	29,28	4,03	13,26	0	7,35	15,70	0,39	20,74	100
$(xi)^2$	384,16	449,44	36	112,36	20,25	146,41	112,36	9,18	146,41	1417
xi*yi	436	621	24	141	0	89	166	1,18	251	1730

Table 5 shows both the weighting of coefficients *x* and *y*, in respect to the total value. The third line of the table shows the calculation of the square of the *xi* coefficients, while the fourth one is showing the product between *xi* and *yi* coefficients.

In accordance with the method of least squares, the coefficient of the angle will be calculated in order to adjust the coefficients of the approximation function, by using the results given in Table 5, using the formula below:

$$\mathbf{a} = \frac{\sum_{i=1}^{N} xi*yi}{\sum_{i=1}^{N} xi^2}, \qquad (2)$$

where *a* is the angle coefficient, having a calculated value of *a* = 1730 / 1417 = 1.22

Angle α is given by: α = arctan *a* = 50.65º.

7. Determination of the theoretical calculation

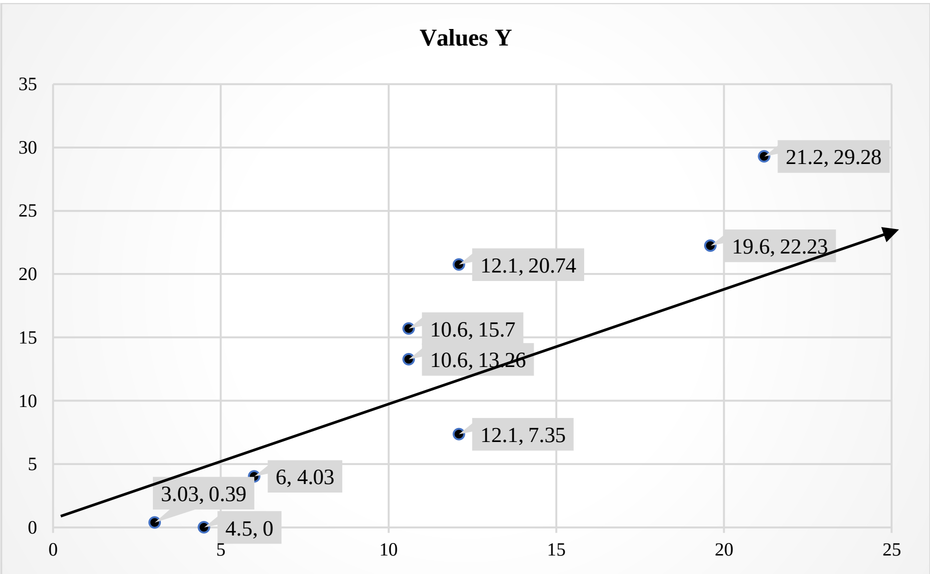

Figure 1: Functions positioning

Figure 1 shows the position of the functions relative to the inclined line at angle α = 50.65°. If the analyzed functions will appear on the positioning diagram or these functions will be situated closer one to the other, it will represent very good value for money.

As a conclusion, the diagram shown in figure 1 validates the hypothesis that the functions situated closer to the GRAPH are F3, F8, F4 and F7, while the farthest situated functions are F1, F2 and F9. Analyzing these results, it can be concluded that the functions situated farther from the graph need to be improved.

RESULTS, DISCUSSIONS

Following the results obtained with the method of improving the quality of some products in the automotive industry, it is necessary to improve the driver assistance system. According to the results of the quality improvement method, it is necessary to adjust the degree of technology and autonomy, in order to reach the level of importance desired by customers.

Given that the driver assistance system had the highest values for the absolute factor and the relative factor, this system needs to be improved or replaced with a more efficient system that also has a level of 4 for the autopilot. At level 4, the driver can completely delegate the task of driving to the automotive, in certain driving scenarios, it being able to use alone the steering system, acceleration and brake, turn signal lights or lane change, wipers, headlights. At this stage, the driver is no longer needed, neither to monitor the automotive, nor for back-up, as long as he remains in the driving scenario that the autonomous automotive can cope with.

For the future, improving the automotive driver assistance system will lead to increased sales, as the targeted improvement aims to provide customers with a greater degree of comfort and safety, this system being available in the standard features of the automotive and therefore not additional costs are required from the customer to benefit from this system.

The driver assistance system is a system that offers a higher degree of autonomy, compared to an intelligent control system found on all automotive, including the ability to let the automotive go without the driver getting his hands on the steering wheel, the automatic transmission lanes, without the consent of the driver, when conditions allow.

In order for new features to be introduced to the existing assistance system, engineers need to improve existing sensors and software so that working algorithms can safely track vehicles coming from behind. The system will hold the automotive in place until there is enough space to change lanes. The system is more intuitive, more efficient and more accessible for customers. In addition to the automatic lane change feature, improvements will be made to the user interface and hands-free driving dynamics.

CONCLUSIONS

Regarding the results that derive from the "Value Analysis" method, the improvement area is in close connection with the fields of technology and technological performance, thus requiring the development of a driving assistance system that is in a direct correlation with the cruise control system, that has to reach at least the level 3 of autonomy, in order to approach closest possible to the performance of the reference product.

The closest functions on the diagram are F3 – Provides an easier car maneuvering during parking; F8 – Provides lower consumption; F4 – Provides fuel economy; F7 – Provides the engine operation, which means there is a good quality – price ratio and no improvement is required.

The farthest functions on the diagram are F1 – Provides a safe travel for the driver; F2 – Provides a comfort degree to the driver and F9 – Provides agility/dynamics to the automobile. These are the functions that need for improvement, due to their poor positioning on the diagram.

The analysis of the products in the automotive field led to the formation of a detailed image on the car trends, on the digital innovation and on the current positions on the Romanian car market. All this shows that companies in the automotive field are innovative, constantly growing and developing, constantly contributing to increasing the level of performance and increasing the customer portfolio. The growth of the client portfolio is achieved by promoting a customer-oriented attitude and satisfying his desires.

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Corresponding author:
Vladut Oana, Associate professor
Department of Economy, Faculty of Entrepreneurship, Business Engineering and Management, University POLITEHNICA of Bucharest, Splaiul Independentei, no.313, BN 221, 060042 Bucharest, Romania

oana.david@upb.ro