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Application of functional analysis in a product of the furniture industry: bookcase

Abstract

The value analysis methodology uses a structured and methodical job plan contemplating several steps to assure the success in their application. The most known and distinctive phase is functional analysis, nowadays an autonomous tool of value analysis. In order to characterize the customer's needs in a clear language and to quantify the value of a product (a bookcase) of the furniture industry, a functional analysis study was developed. With this functional analysis it is intended to describe the functions that the product performs, provide a better knowledge of the product, to evaluate the degree of satisfaction of the product through its functional performance and facilitate the search for alternative solutions.

Keywords

Value analysis; Furniture industry; Functional analysis; Bookcase; Customer needs.

1. Introduction

The markets globalization and the continuous innovation, generated a redefinition of the value added chain. This value should be sustainable, seeking better resources application for the needs satisfaction and aiming not only to the economics but also to the environmental, social and other components. In this work, a functional analysis (value analysis phase) study was developed in order to identify the functions that the product performs, provide a better knowledge of the product, evaluate the degree of satisfaction of the product through its functional performance, facilitate the search for alternative solutions and quantify the value of a product (a bookcase) of the furniture industry.

This paper is organized in the following manner: in chapter two it is described in a briefly way the value analysis (VA) methodology and job plan, with particular focus in the functional analysis (FA) phase. In chapter three it is applied the FA study in a product of the furniture industry, more specifically a bookcase, with the description of the several steps of the FA application and its main results. In the conclusions there are emphasized the principal benefits of the tool application.

2. Value Analysis

The VA can be defined as an organized and creative methodology that uses a functional approach and aims to increase the value of a product/service (Ho, Cheng and Fong, 2000). The VA provides a means to link, align and maximize the efficiency of the value chain (Dove, 1996). VA is a well-known structured method to increase value and support the selection of the most valuable solution (Romano, Formentini, Bandera and Tomasella, 2010). Value is actually one of the keywords most referred in a

wide range of research and investigation topics as well in the day-by-day of the organizations. It becomes necessary then, to relate the organizations with value models and methodologies (Basso, 1991).

2.1. Value Analysis Methodology

The VA uses a structured and methodical job plan with several phases. The most known and distinctive phase is functional analysis, nowadays an autonomous tool of value analysis. In the extent of our work we use the following job plan (Pires, Putnik and Ávila, 2007).

Table 1. VA Job Plan

Phases	Management	VA Team	Operational Departments
Orientation	• X		○ X
Information Search		○ X	○ X
Functional Analysis		• X	○ X
Creativity		• X	○ X
Evaluation		• X	• X
Development		• X	○ X
Implementation	• X		• X

- X Responsibility
- X Participation

2.2. Value Analysis Job Plan Phases

In this section the phases of VA job plan will be described briefly, the FA steps will be more detailed in the next section.

Orientation: preparation of VA application; **Information Search:** obtain all the necessary information; **Functional Analysis:** identification, characterization, weighting, ranking and evaluation of the functions; **Creativity:** generation of alternative ideas; **Evaluation:** evaluation and selection of the alternative ideas; **Development:** development of the selected ideas; **Implementation:** implementation of VA project.

2.3. Functional Analysis

In order to characterize the customer's needs in a clear language and to quantify the value of a product (a bookcase) of the furniture industry, a FA study was developed. With this FA is intended to describe the functions that the product performs (identification), provide a better knowledge of the product (characterization), evaluate the degree of satisfaction of the product through its functional performance (weighting and ranking) and facilitate the search for alternative solutions (evaluation).

3. Application of Functional Analysis in a bookcase: case study

The product that was object of the FA application is shown in figure 1. It is a product of the furniture industry, a bookcase.

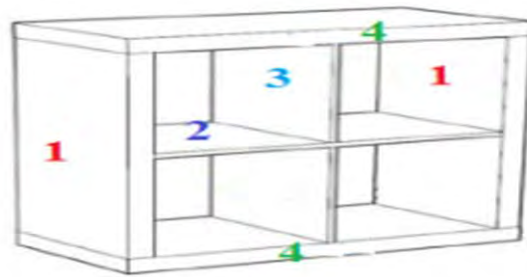


Figure 1. Bookcase

The components of the product are illustrated in the next figure (figure 2) and consists in two laterals, one shelf, one partition, a top and a bottom.

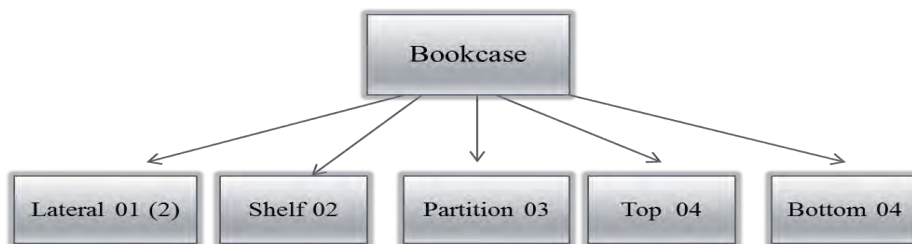


Figure 2. Components of the bookcase

The dimensions of the product are detailed by its components in table 2, in order to provide a better understanding of the product, a simple product but with a general utilization in different spaces, for different purposes and by different users.

Table 2. Dimensions of the bookcase

Component	Size (mm)		
	Lenght	Widht	Thickness
Partition	383	336	16
Shelf	688	386	16
Top/Bottom	765	392	37
Laterals	688	389	37

3.1. Functional Analysis Application

The steps of the FA study applied to the product (bookcase) will be detailed in this section, with a brief description of each step main objectives:

IDENTIFICATION: Description of the product functions. These functions are described by a verb and a noun according the VA methodology and are shown in the next table (table 3).

Table 3. Identification of the bookcase functions

Identification of the functions		
Verb	Noun	Function
Be	Functional	A
Be	Resistant	B
Present	Aesthetic	C

Be	Flexible	D
Adjust	Environment	E
Be	Compact	F
Be	Versatile	G

Below appears a description of the function needs for each function:

Be Functional: the product should be practical and useful, should allow the user easy access and its components should be removable.

Be Resistant: the product must have a strong structure to support heavy materials, shall be resistant to impact, moisture and sun.

Present Aesthetic: the product must have a pleasant color and design as well as a good and quality finishing.

Be Flexible: the product should be weightless, easy to carry and easy to assembly and disassembly

Adjust Environment: the product must be able to be used in different spaces (bedrooms, living rooms, kitchens, gardens).

Be Compact: the product should allow the user to save space allowing for a better use of space and should not obstruct the movement of persons.

Be Versatile: the product should enable the placement of storage boxes in the four partitions of the unit, each of which can assume different roles.

CHARACTERIZATION: Definition of satisfaction levels for each function, its flexibility and ranges. Spex defines the level of satisfaction of the existent product and Sma defines the level of satisfaction required by the product users.

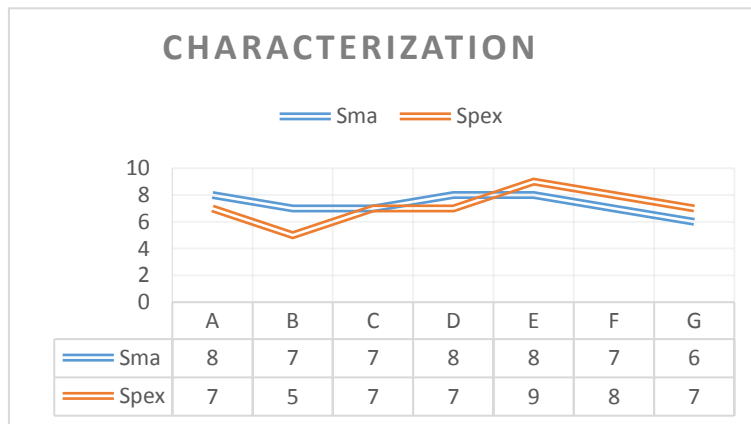


Figure 3. Matrix of the characterization of the bookcase functions

We can conclude from the results shown in the figure above that: Functions D (Be Flexible), and E (Adjust Environment) must be improved.

WEIGHTING: Weighting of the product functions by comparison of two functions for every combination. The weighting matrix is shown in figure 4.

RANKING: Ranking of the product functions, by order of importance obtained from the results of the weighting step.

Be Functional	Be Resistant	Pres. Aesthetic	Be Flexible	Adjust Environ.	Be Compact	Be Versatile	TOTAL	%	ORDER N°
	B	C	D	E	F	G			
A	A3	A1	D2	0	A2	0	8	23,5%	2
	B	C2	D3	E1	F2	B2	10	29,4%	1
		C	C2	C1	0	G2	5	14,7%	3
	D	E	D2	F1	D1	4	11,8%	4	
			E2	0	2	5,9%	6		
			F	F3	3	8,8%	5		
	G	G	2	5,9%	7				

Figure 4. Matrix of the weighting of the bookcase functions

EVALUATION: Evaluation of the product functions vs cost, relating the costs of each item (component) by the functions that performs or contributes for its performance. This is represented in table 6. In figure 5 we can see the comparison between the cost and the importance of each function of the bookcase, leading to the main conclusions of the FA study.

Table 6. Matrix cost-function

ITEMS	TOTAL COST	% TOTAL	F1	F2	F3	F4	F5	F6	F7	Total
	Euro		Be Resistant	Be Functional	Pr. Aesthetics	Be Flexible	Be Compact	Adjust Envir.	Be Versatile	
Top	1.595 €	17,9%	20%	25%	0%	25%	15%	0%	15%	100%
			0.319€	0.399€	0€	0.399€	0.239€	0€	0.239€	1.595€
Bottom	1.595 €	17,9%	45%	15%	0%	25%	15%	0%	0%	100%
			0.718€	0.239€	0 €	0.399€	0.239€	0€	0€	1.595€
Laterals	2.645 €	29,7%	20%	15%	25%	10%	15%	15%	0%	100%
			0.529€	0.397€	0.661 €	0.265€	0.397€	0.397€	0€	2.645€
Partition	1.582 €	17,8%	15%	25%	5%	25%	10%	5%	15%	100%
			0.237€	0.396€	0.079€	0.396€	0.158€	0.079€	0.237€	1.582€
Shelf	1.476 €	16,6%	50%	25%	5%	15%	0%	5%	0%	100%
			0.738€	0.369€	0.074€	0.221€	0€	0.074€	0€	1.476€
TOTAL	8,893 €	100,0%	2.541€	1.799€	0.814€	1.679€	1.033€	0.550€	0.477€	8.893€
			28,6%	20,2%	9,2%	18,9%	11,6%	6,2%	5,4%	100%

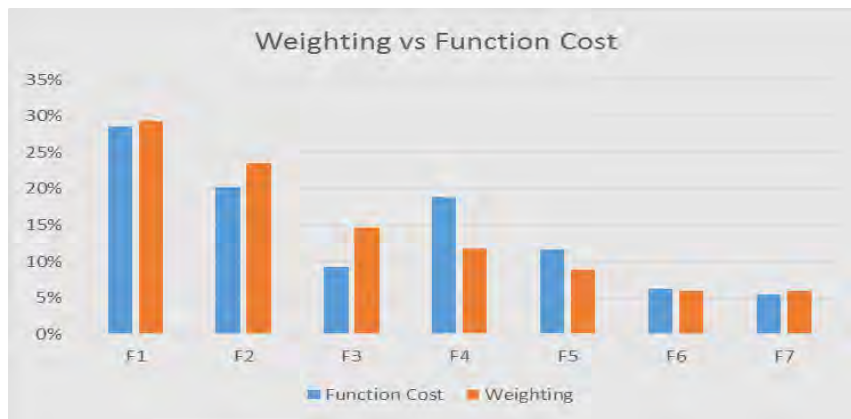


Figure 5. Comparison between the importance and the cost of the bookcase functions

3.2. Functional Analysis Results

Some of the main results of this study were yet illustrated in the application of the FA steps in the previous section, but we would like to emphasize, in this section, the analysis from the evaluation that permits to conclude that:

Functions F4 (Be Flexible), F5 (Be Compact) and F6 (Adjust Environment) shall be intervened because function cost is higher than its importance (weighting). Be Flexible and Adjust Environment are also functions in which its performance (Spex) is less that the users require (Sma), as seen in characterization step. By analysis of the matrix cost-function we can see that the laterals and the partition are the components that most affects these 3 functions, so these are the main items to generate alternatives. So, for future work, in the next phase of the generation of alternative ideas, it is intended to perform better the functions, stimulating creativity and innovation for the product (bookcase) in study, according to the results of the FA study.

4. Conclusions

The creation of a value culture in organizations should be effective in order to foment and increment their success. The analysis of results of FA application illustrates the potential of the VA that enables quantitative and qualitative benefits. The FA enables to characterize the customer's needs in functional terms of the product in study. We described the functions that the product performs, providing a better knowledge of the product. We also evaluate the degree of satisfaction of the product through its functional performance and facilitate the search for alternative solutions. The VA/FA can play an important role and establish itself as one support tool throughout the product reformulation, contributing with a sustainable and important improvement and an organizational change.

References

- Basso, J., 1991. Engenharia e Análise do Valor, IMAM.
- Dove, J., 1996. Being creative in VE Today, Value Engineering and Management Digest, 38 (6-7).
- Ho, D., Cheng, E., Fong, P., 2000. Integration of Value Analysis and Total Quality Management: the way ahead in the next millennium, Total Quality Management, 11 (2), 179-186.
- Romano, P., Formentini, M., Bandera, C., Tomasella, M., 2010. Value Analysis as a Decision Support Tool in Cruise Ship Design. International Journal of Production Research, 48 (23), 6939-6958.
- Pires, A., Putnik, G., Ávila, P., 2007. The Potentialities of the Application of Value Analysis. Proceedings of the 24th International Manufacturing Conference, Waterford, Ireland, 745-751.