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FUNCTIONAL-COST ANALYSIS (FCA)

Georgi TODOROV **Andrijana BOCEVSKA** **Todor NESHKOV**

Abstract: *A functional cost analysis FCA (sometimes named Functional Value Analysis FVA) is a method that can be applied to examine the function costs of a product in relation to the value as perceived by the customer. The outcome of the analysis is to improve the value of the product while maintaining costs and/or reduce the costs of the product without reducing value. This paper is focused on the several steps and useful techniques for conducting a FCA such as FAST and Component Function Cost or Value Analysis Matrix, in the context of modern product development.*

Key words*: Functional cost analysis FCA, FAST, Function Cost Matrix, Value Analysis Matrix.*

1. INTRODUCTION

The functional cost analysis is a value engineering method that aims to increase the difference between the cost and the value of a product [1]. The cost is the amount that is incurred in the production and delivery of the product. This expense can include the price of parts, labor, overhead (e.g., building, power), packaging, shipping, and advertising, among others. What the product is worth in the eyes of the customer is considered the value. When completing a functional cost analysis, this definition of value is extremely important. The design team may not perceive a certain product feature to be valuable, however if it is important to the customer, then that feature must be regarded as valuable.

FAST is a powerful analytical process that enables people with different technical backgrounds to communicate and work together on problems that require an interdisciplinary approach [2].

FAST identifies those functions, which clearly serve a purpose in the goals of the system. It distinguishes between the functions that are necessary to the purposes of the system, and other activities that exist simply as a consequence of the way in which the purposeful functions are carried out. It also analyses functional interdependencies through a disciplined reasoning process that uses an inclusive logic methodology, which allows all stakeholders in the system to work together in its development, thus ensuring as wide a consensus as possible.

A Component Function Cost Matrix or Value Analysis Matrix is prepared to identify the cost of providing each function by associating the function with mechanism or component part of a product. Product functions with a high cost-function ratio are identified as opportunities for further investigation and improvement.

2. STEPS IN FCA

Function Cost Analysis is a team activity with from four to seven employees from different areas of the business such as design, engineering, management accounting, marketing, production and purchasing [3]. One of the great strengths of functional cost analysis is that it has a structured approach a specific objective to which all analysis is that it has a structured approach to achieve a specific objective to which all team members can contribute. Function Cost Analysis is carried out in the following steps:

2.1. Select product for FCA and decide specific objectives

For new products, the FCA can be integrated into the design process. For existing products the criteria when selecting products are very complex or very heavy or very bulky with relatively high cost. Other objectives could include the following:

- Increase the quality of the product without increasing the cost,
- Reduce the weight of the product without increasing the cost,

- Increase the function of the product without increasing the cost,
- Develop new patents.

2.2. Collect Information

The information collected would include the following:

- existing design;
- existing specifications for product;
- details of production process;
- material, labor and overhead cost data;
- scrap data;
- marketing data about the product.

2.3. List the separate components of the product, and identify the function served by each component

The first analytical step in the method is to strip a product down to its separate components - either literally and physically, or by producing an itemized parts list and drawings. However, parts lists and conventional engineering drawings are of limited value in understanding and visualizing the components, the ways in which they fit together in the product overall and how they are manufactured and assembled. So if an actual product, or a prototype version, is not available for dismantling, then something like exploded diagrams of the product are helpful in showing components in three-dimensional form and in their relative locations or assembly sequences.

It is important that the team thinks about the functions rather than the parts of the product. The function could be assigned by type as:

- Basic function - the primary purpose(s) for which the item or service was designed when it is operating in its normally prescribed manner. This function must be accomplished to meet the purpose of the product, structure, or service. A product or service may have more than one basic function.
- Secondary functions are ones that support the basic function (and, hence, are sometimes referred to as “support functions”). They result from a specific design approach to achieve the basic function. If the design changes, the need for existing secondary functions may be modified or even eliminated. To enhance the analytical an evaluation process some practitioners break secondary functions into a sub classification of “required” (by the current design), “aesthetic,” and “unwanted”.

The distinction between what is needed (basic functions that provide value) and what is not needed (secondary functions that have no value or even have a negative value) is vital to the successful functional cost study. Elimination of unnecessary cost is dependent upon it.

2.3.1. Creating a FAST model

For best results, a multidisciplinary team of experts should carry out the FAST process. Firstly, the team must agree the objectives and motivation for developing the system, or product, and then secondly, determine the functions that will be required to achieve these objectives. At this stage the team is concerned with analyzing the problem rather than developing solutions, and therefore it is important to distinguish between function and process.

A function is some necessary phenomenon that enables a particular purpose to be achieved, whereas a process may be just one possible way of performing that function. In the FAST process a function is described using an Active-Verb and a Measurable-Noun. The second stage of the FAST process leads to the production of a FAST diagram that describes the relationships between a purpose and the functions necessary to achieve it. In this diagram the relationship between functions are not time-constrained and can only be described using a HOW-WHY-WHEN Logic, as shown in Fig. 1.

2.4. Determine the cost of each component

It is not always easy for a company to determine the exact costs of components used in products. This explains why many companies employ specialists in cost estimating. It is not sufficient to merely determine the cost of the individual components and estimate the labor involved. A number of other factors must be considered and included. Some of these factors are:

- Cost of parts including the purchase price as well as any associated shipping costs.
- Cost of consumables that are used in the fabrication of the product (e.g., glue, cleaners).
- Labor costs for assembly as well as for any modification or finishing to parts.

- Equipment or tooling costs.
- Handling and inventory control.
- Packaging and shipping costs.

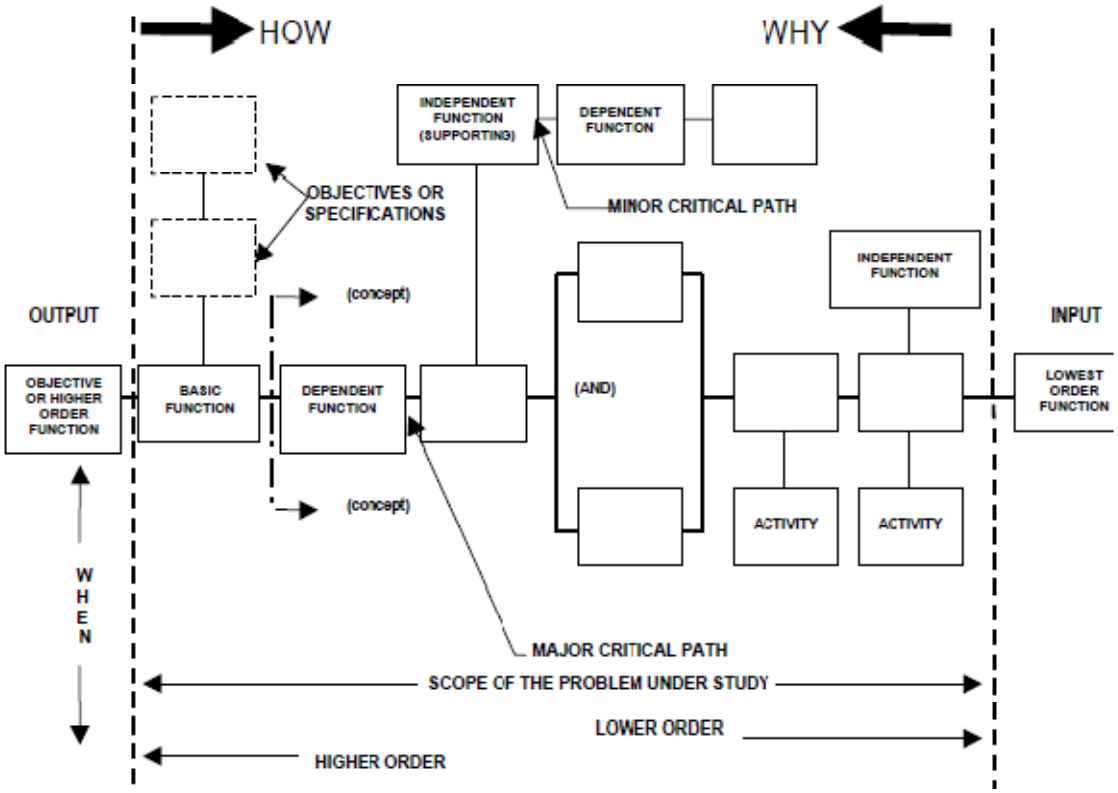

Fig. 1. Basic FAST model

Equipment or tooling costs are items that may require some calculation since there is not a one-to-one ratio between the unit of equipment and unit of product. Therefore, it may be necessary to calculate equipment costs based on projected volumes.

Very detailed cost calculations may also include indirect or overhead costs. These involve facility costs (e.g., heat, hydro, taxes), non-direct labor (e.g., finance, human resources, marketing), or any other cost that cannot be directly tied to a product. There are a number of different methods by which companies apply overhead costs to products.

It is important not to ignore low-cost components, particularly if they are used in large numbers (e.g. screws or other fasteners). Even a relatively small cost reduction per item can amount to a substantial overall saving when multiplied by the number of components used.

Once the costs have been determined for each component or sub-assembly in relation to the function(s) they support, the total cost of the component or sub-assembly is determined. The total product cost is calculated by summing the totals for all components. This total is then used to calculate the percentage of the total cost that each part represents.

2.5. Determine the cost of each function

Components often contribute to several different or related functions, and hence the cost of a particular function is often spread across several components. The kind of component/function cost matrix shown in Fig. 2 allows the designer to analyze in detail these often complex relationship.

This matrix displays the components of the product, and the cost of those components, along the left vertical side of the graph. The top horizontal legend contains the functions performed by those components. When a component contributes to more than one function, it may be difficult to break down its overall cost into precise part-cost per function. Approximate but well-informed estimates then have to be made.

The cost of each function can be calculated by adding all of the costs attributed to a specific function. As with the component costs, the percentage of the total cost that each function represents is calculated. If desirable, the cost sequence can be determined where the functions are numbered, with (1) representing the most costly function.

Component/Assembly	Support Functions							Cost of Component	
								Total	% of Total Cost
Cost of Function									
% of Total Cost									
Cost Sequence									
Value of Function									

Fig. 2. Component/function cost matrix

A powerful analysis method is created when FAST is used in conjunction with QFD (Quality Function Deployment) method [4]. QFD enables the uses of Value Analysis Matrix. It is powerful in two ways. First, it associates functions back to customer needs or requirements. In doing this, it carries forward an importance rating to associate with these functions based on the original customer needs or requirements. Functions are then related to components, the same as with the Function-Cost Matrix. Components are related to functions as either strongly, moderately or weakly supporting the given function. This relationship is noted with the standard QFD relationship symbols. The associated weighting factor is multiplied by customer or function importance and each columns value is added.

2.6. Consider the value of functions

This is a critical step and bring the customers views into the costing system, so the value of product functions must be those as perceived by customers, rather than by designers or manufacturers. Although values will be interpreted in different ways by different customers, its common characteristic is a high level of performance, capability, emotional appeal, style, etc. relative to its cost [4]. This can also be expressed as maximizing the function of the product relative to its cost:

$$\text{Value} = (\text{Performance} + \text{Capability})/\text{Cost} = \text{Function}/\text{Cost} \quad (1)$$

The goal would be to achieve a ratio of 1.

If a certain function is not perceived to be valuable to the customer and the function is determined not to be necessary for reasons such as performance or reliability, then perhaps that function should be simplified or eliminated. Having added functionality in a product that is not perceived valuable by the customer can actually hurt the sale of the product. The market prices of different products can sometimes provide indicators of the values that customers ascribe to various functions.

2.7. Generate alternatives of reducing cost without reducing value, or of adding value without adding cost

This is the really creative part of functional cost analysis where all the team member make suggestion for improvement. Attempts to reduce costs usually focus on components and on ways of simplifying their design, manufacture or assembly, but the functions performed by a product should also be looked at critically, because it may be possible to simplify them, reduce their range, or even eliminate them altogether if they are of limited value to the purchaser.

There are some general strategies which can be applied in order to direct the search for ways of reducing costs. The first is to concentrate on high-cost components, with a view to substituting lower-cost alternatives. The second is to review any components used in large numbers, since small individual savings may add up to a substantial overall saving. A third strategy is to identify components and functions which are matched as high-cost/high-value, or low-cost/low-value, since the aim is to achieve high-value functions with low-cost components.

Cost-reduction guidelines are:

Eliminate	Can any function, and therefore its components, be eliminated altogether? Are any components redundant?
Reduce	Can the number of components be reduced? Can several components be combined into one?
Simplify	Is there a simpler alternative? Is there an easier assembly sequence? Is there a simpler shape?

Modify	Is there a satisfactory cheaper material? Can the method of manufacture be improved?
Standardize	Can parts be standards rather than specials? Can dimensions be standardized or modularized? Can components be duplicated?

Other attributes which commonly contribute to the quality or value of a product are:

Utility	Performance on aspects such as capacity, power, speed, accuracy or versatility.
Reliability	Freedom from breakdown or malfunction, performance under varying environmental conditions.
Safety	Secure, hazard-free operation.
Maintenance	Simple, infrequent or no maintenance requirements.
Lifetime	Except for disposable products, a long lifetime which offers good value for the initial purchase price.
Pollution	Little or no unpleasant or unwanted by-products, including noise and heat.

There is a whole class of value attributes related to aesthetics. This includes not only the appearance of a product - colour, form, style, etc. - but also aspects such as surface finish and feel to the touch.

2.8. Evaluate alternatives and select improvements

The application of functional cost analysis should result in a number of alternative suggestions for changes to the product design. Some of these alternatives might well be incompatible with each other, and in fact all suggestions should be carefully evaluated before selecting those which can be shown to be genuine improvements.

2.9. Implement alternatives and audit results

It is obviously important to implement the chosen alternative and ensure that the predicated results are actually achieved in practice.

3. SYMMARY

Based on the considerations mentioned above the following conclusions can be formulated:

- Functional cost analysis is a structured, creative, team approach to development products, based on the increase values and reduce products cost;
- Equally applied in the development of existing, and in development of new products;
- Functional cost analysis is a focused customer concept which is compatible with QFD method for product development;
- Results from the analyzes are very important in the context of modern product development.

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CORRESPONDENCE

Assoc. Prof., Ph. D., Georgi TODOROV, Prof., Ph .D., Todor NESHKOV
Technical University - Sofia, 8 Kl. Ohridski Blvd. 1797 Sofia, Bulgaria
e-mail: gdt@tu-sofia.bg, tnesh@tu-sofia.bg

Assistant, M. Sc., Andrijana BOCEVSKA
Faculty of Technical Sciences, Ivo Lola Ribar n.n. 7000 Bitola , Macedonia
e-mail: abocevska@yahoo.com