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## IMPORTANCE OF VALUE ANALYSIS IN DOMESTIC AND INTERNATIONAL OUTLOOK

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### ABSTRACT

The value analysis is a well-known and widely used multi-criteria group decision-making procedure that not only looks for the cheapest, or not only the better, but also satisfies the desired and necessary needs at the lowest cost. Covering all important details of the project (product, service, procedure, process), the so-called multidisciplinary team of internal and/or external experts works together with the consultant. Value analysis identifies project functions and focuses on the most impactful intervention points. It then explores alternative solutions and creates optimal solutions for functions to cost-effectively satisfy and/or increase performance. Value analysis is now used by almost every large company in the world and is widespread in all industries. According to expert estimates, around 50,000 value analysis projects are carried out in Europe every year. Based on the provisions of the EN 12.973:2000 Value Management Standard in Hungary, the Public Procurement Act recommends the contracting authority require the tenderer to apply the method. This review paper reviews the process of the formation and development of value analysis, its fields of application in international comparison, the main methodological frameworks, its current challenges, and new opportunities.

**Keywords:** *value analysis, functions, costs, multicriteria decision, multidisciplinary team, methodology, options*

### 1. Introduction

Value analysis is an organized problem-solving system that maps all the functions that we perform with a process, product, system, or organization. It creates the conditions necessary to satisfy customer needs at a high quality level by creating an optimal function-cost relationship. The subject of value analysis is the analysis of all products (product, technology, service, investment, organization) that have functions and costs. Its purpose is a regular, well-founded examination of the functions and costs and the complete fulfillment of the functions at the lowest possible cost level.

By applying the value analysis method, all areas of company work can be improved quickly and efficiently. Value analysis is a system-based procedure that prompts the company to think effectively in technical and economic terms, enabling economic actors to quickly, efficiently and cost-optimally adapt to changes in a globalized, constantly changing business and economic environment containing numerous uncertainties and risk factors. Value analysis, as a systemic, strategic organizational development and management method, must definitely be integrated into the strategic decision-making and operational processes of companies. For this reason, the importance of value analysis is increasing both domestically and internationally, and it is becoming an increasingly researched field.

This review paper provides a comprehensive theoretical overview, supported by practical examples, of the development of the field of value analysis, its methodological toolkit, and its possibilities. They can be equally useful to all the actors involved in both the corporate and public sectors.

## **2. Methodology**

The domestic and international review relies on secondary or "desk research" research methods (reviewing existing relevant documents such as publications, studies, and online websites, then organizing, selecting, and analysing the data collected in this way).

The conclusions, findings, and suggestions made during the analysis of the data presented in this article reflect the private professional opinion of the authors.

## **3. The theoretical background of value analysis**

### **3.1. History and application of the value analysis**

The history of value analysis dates back to the late 1940s; similar to several other economic contexts and methods, it started in America. In 1947, General Electric executives commissioned L. D. Miles, an engineer and materials procurer at General Electric's Baltimore division, to develop a generally applicable process that would result in a reduction in material costs while ensuring the performance of the function.

Over the course of four years, Miles and his team developed a new procedure based on cost reduction and other solutions successfully applied in other areas, which Miles called Value Analysis (VA). Value analysis first spread in the country of its development, the USA. The US Department of Defense (DoD) played a major role in its wide application. As early as 1954, the American Maritime Administration included a value analysis clause in its procurement contracts, according to which the two parties, the supplier and the customer, shared the savings achieved equally.

The American Department of Defense (DoD) announced a cost reduction program in 1962, and value analysis played a key role in its realization. The defense budget in the USA between 1960 and 1965 was 46–53 billion USD annually; in 1972 it was already 75 billion USD. Thus, it is understandable why the DoD clauses were so significant in the spread of value analysis in the USA. As necessary, the state provided the amount necessary for the implementation of the project in advance, but in this case it withdrew 50–70% of the savings. The rapid spread of value analysis is typical of the fact that, in 1959, there were already 120 full-time value analysts working in Miles' department at General Electric.

Value analysis is now used by almost all large companies in the world and is widespread in all industries, integrated into strategic decision-making processes and development activities (Ibusuki and Kaminski 2007; Mousakhani et al. 2017; Tang and Bittner 2014).

The method has been known for more than 60 years. Its reliability is clearly demonstrated by the fact that in the United States of America, the Federal Acquisition Regulation (FAR) obliges ministries, state offices, agencies, and municipalities to use the method when spending public funds—a specified value limit, usually over USD 2 million. An annual report is prepared for the Congress on the results achieved. According to American sources, the use of value analysis currently saves the budget about 20 billion USD/year.<sup>5</sup> Since 1996, according to the Federal Acquisition Regulation (FAR), all executive organizations must have value analysis procedures and programs in order to use the budget more efficiently (Fodor 2010; Vickers and Mandelbaum 2009).

Of course, value analysis has not only spread to such an extent in America. In Japan, the value analysis, during the design phase, covers nearly 90% of the product, and in the later stages of the product's life curve, during further development, the value analysis is repeated, thereby extending the product's life cycle. According to American experts, one of Japan's most important weapons in ensuring its competitiveness is value analysis. The Transport for London company carries out 150–180 projects a year. A practical example from Europe is the Jubilee Line metro line in London, which was created with the help of value analysis. The interesting thing about this is that the shape of the assembly also approximates the circular section, i.e., the shape of the tunnel. This significantly reduced the amount of earthwork and thus resulted in a cost reduction, so that the function of the metro remained intact.

The Society of American Value Analysts (SAVE) was founded in 1959 and transformed into an international company (SAVE International) in 1997. Today, this company includes the national value analysis companies of several countries, including the Society of Hungarian Value Analysts; it has members from around 40 countries. According to estimates, around 50,000 value analysis projects are carried out in Europe every year. The EN 12.973:2000 Value Management standard regulates the application. The standard can be obtained from the Hungarian Standards Board (<https://shva.hu/ertekelemzes-a-nagyvilagban/>).

In Hungary, the Public Procurement Act recommends the contracting authority require the tenderer to apply the method. Based on successful application experiences, the Road Technical Regulations require the use of value analysis in the field of road investments as of January 1, 2004. During the revision of road construction investment plans, in the course of 85 completed value analysis works (further development of road investment plans) between 1999 and 2010, the total savings shown from the estimated gross investment cost of HUF 816 billion were close to HUF 110 billion (13%). The surplus content and the additional expenditure due to quality improvement were HUF 11 billion (1%). As a result of the proposals, the investor, the Hungarian state, is expected to be able to carry out these investments for HUF 98 billion (12%) less and with better quality.

In our country, the procedure is not yet very widespread in the company circle, but among the state-owned companies, value analysis is regularly used at the Hungarian State Railways and the Paks Nuclear Power Plant. (Balogh 2008; Fodor 2010).

At the Paks Nuclear Power Plant, the first value analysis project was implemented at the end of 2005, and an independent value analysis group (3 people) has been operating since November 2009. The total value of the projects reviewed between 2006 and 2009 is HUF 24,088 million, the savings are HUF 7,898 million, and the proposed additional expenditure is HUF 1,438 million, i.e., the net cost savings of the projects is HUF 6,461 million, i.e., 26.8%.<sup>9</sup> The diversity of the value analysis and the presentation of the possible areas of application are included in the study by Kardos (2009), in which the results of the implemented projects were gathered, and through the description of these, it draws attention to the advantages of the methodology and its potential.

The range of data and analyses used in measuring the usefulness of the value analysis work is relatively narrow; an exceptional area—where the application of value analysis is mandatory based on legal requirements—is road investments. During the review of 80 investment projects over the past 10 years, the teams pointed to the possibility of cost reductions of about HUF 71 billion (12%) out of HUF 604 billion in gross estimated costs, and with the aim of increasing quality, they proposed HUF 11 billion (2%) of additional spending. The net savings can thus be put at about HUF 60 billion and the total cost shift is HUF 82 billion. Approximately 100 road professionals participated in the review of road investments using the value analysis methodology.

The average team size was around five people. The interventions basically took place at the level of the planning permission plan; six times the study plan was further developed, and 11 times the implementation plan (combined plan). The teams raised a total of about 3,500 ideas, and more than 700 of these proposals were developed in detail. Based on the correlation between the order of magnitude of the costs of the investments and the order of magnitude of the savings achieved, it can be concluded, that the higher-value investments are worth reviewing, since larger savings in volume are likely for these projects. When selecting the topic, the expected estimated benefit of the methodology, i.e., the cost savings, must be compared with the cost of applying the methodology. During the projects, the most frequently occurring proposal types were the following: junctions, works of art, track structure, and track modification. The type of proposal with the most results and cost savings was route modification (Balogh 2008; Fodor 2010).

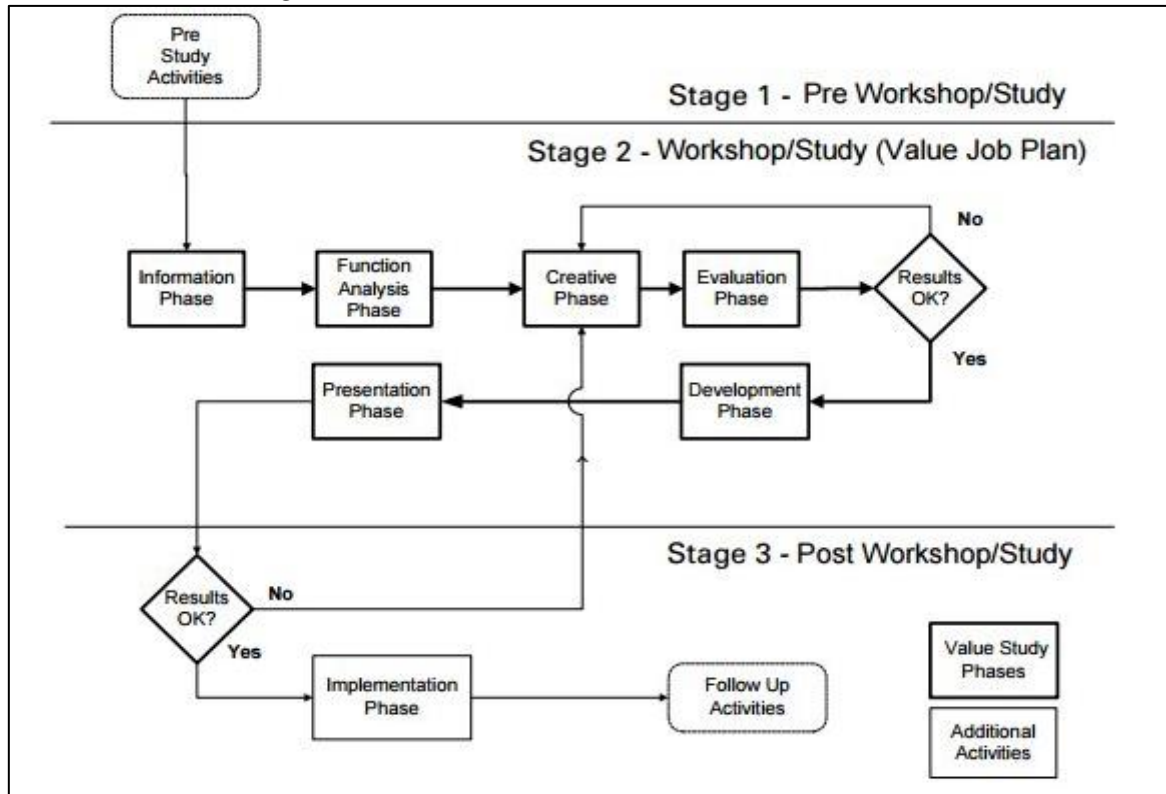
### **3.2. Approach to Value Analysis**

The value analysis is a decision-making procedure that not only looks for the cheapest, or not only the better, but also satisfies the desired and necessary needs at the lowest cost. The value analysis embodies the conscious application of the natural way of thinking and decision-making mechanism, according to which we consider the available advantage (quality) and the sacrifice made for it (cost) at a moment in time. It goes without saying why this useful technique should be applied at each stage of the normal day-to-day development to every product, process and organisation. According to the theoretical approach, everything that has a function and a cost can be the subject of value analysis.

Value analysis is a group decision-making procedure. Covering all important details of the project (product, service, procedure, process), the so-called multidisciplinary team of internal and/or external experts work together with the consultant. The methodology focuses on information and possible approaches. Value analysis means the implementation of a systematic series of development steps, during which analytical and creative sub-techniques appropriate to the nature of the problem are applied. Value analysis identifies project functions and focuses

on intervention points with the greatest impact, then explores alternative solutions and creates optimal solutions for functions to cost-effectively satisfy and/or increase performance (Ho et al., 2000; 2004; Fodor, 2010; Sharma and Belokar 2012). It can be read from Figure 1, which shows the logical sequence of steps of the value analysis method, that in his view, value is the satisfaction of the required function at a minimum cost level.

Figure 1. SAVE International Value Standard (2015)



Source: VMS (2015) and Wao (2018)

During the logical correlation system of the value analysis, the designer always starts from the expectations of the customer, consumer, user, and service user, determines the performance capacity, tasks, and functions required in terms of demand satisfaction. In this context, it has to examine what the functions are like in terms of properties, parameters, or whether they can be fulfilled at a cost, and looks for the smallest possible solution for these functions at a cost.

The expenses associated with the value are basically characterized according to the material sacrifices, so any unit of measurement in the world can be converted to a monetary value. It is important to mention, however, that the value is not unconditionally time-independent.

The value is the quotient of the function and the cost of the function, thereby defining a value independent of time and space. The cost of the expenditure must include not only the one-time point investment costs but also the aggregate lifetime cost, which corresponds to the function cost. By expectations, we must understand the change of needs over time, where the development of technology and society, changes in society's needs, and changes in the environment can and has to be taken into account. Here, the environment is not only natural but also businesslike, population-related. The environment is also understood. In practice, this defines the third-dimension axis and can sometimes be interpreted as time (Wolf, 2008).



In order to use value analysis as a decision-making method, a value analysis group is required, in which experts selected from the necessary fields of expertise take part in order to achieve the goals of the economic organization. In addition to the value analysis group, a management group is also necessary, which is a group of managers whose members ensure the conditions for carrying out the value analysis work.

### 3.3. The process of Value Analysis

In the process of value analysis work, each stage independently supports the knowledge and understanding necessary for the successful implementation of the next stage.

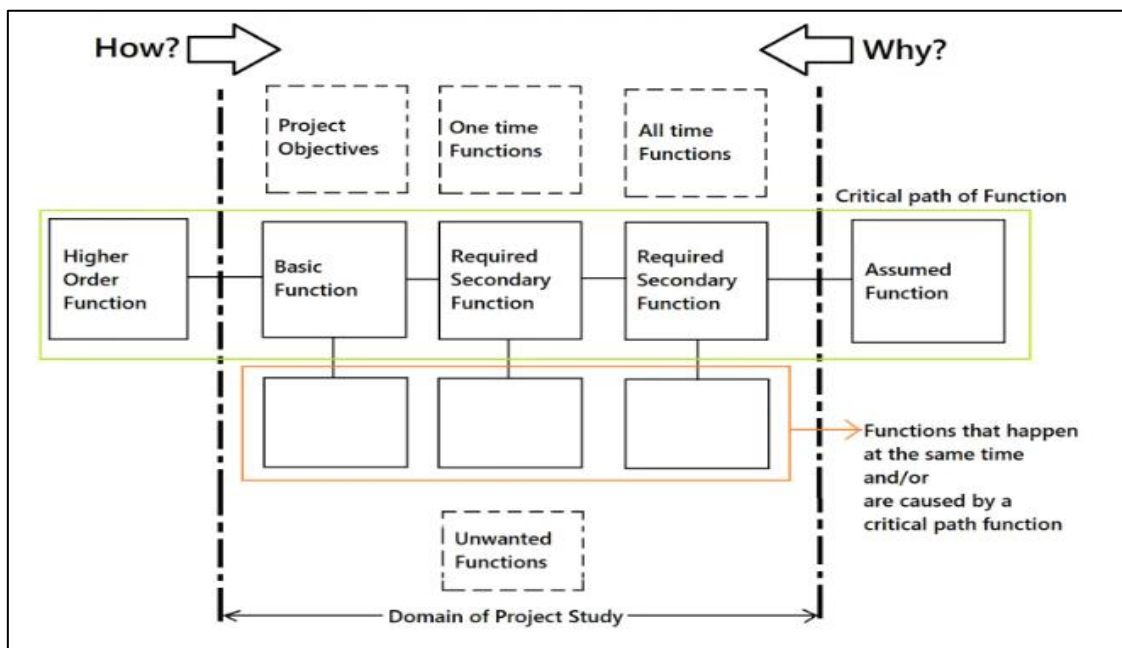
In the preparatory phase:

- to select the topic and develop the topic boundaries;
- to record the objectives by the management in a form defined by parameters;
- to appoint the members of the value analysis group by the head of the organization;
- to create a work plan containing the time schedule of the work steps.

In the information stage, the information defining the subject, limits, and external and internal requirements of the value analysis is collected. Within the information, priority should be given to the discovery of needs and the definition and arrangement of functions.

The function is the purposeful task, operation, performance, or possibly property of the object of the value analysis. Hierarchical, cause-and-effect, logical, or other relationships and interactions between functions are represented by the function scheme, which can be an ordered function list, a function family tree, or a FAST diagram. The Function Analysis and System Technique (FAST) is used to define, analyze, and understand product functions, how the functions relate to one another, and which functions require attention to increase product value. It is used to indicate different functions in a logical sequence, prioritize them, and test their dependency, as you can see in the below Figure 2.

Figure 2. Different functions in FAST



Source: Sundar (2020)

In the course of application of the FAST diagram, the first step should be to organise brainstorm to get deeper insight whether all the functions the product will serve from the aspects of the customer. A function is everything that the customer expects and requires from the product (technical functions, quality, service life, reliability, ease of maintenance, transparency, attractiveness, simplicity, other special features). The function should be defined as broadly and generically as possible. You can see the main types of functions in Table 1 below.

*Table 1. Classifications of the functions*

Name of the function	Description
Basic functions	They are the overall product function. For example, the basic function of a car seat belt is to restrain a person in a car seat
Secondary functions	These are essential to the performance of the basic function and they are direct cause to the basic function. Secondary functions can be categorized into 3 types: a) Required; b) Aesthetic; c) Unwanted by product
Other Functions	All Time Functions are functions that are pervasive to the product. Listed on the right of the diagram. One Time Functions are functions are listed at the centre of the diagram.

*Source: Own edition based on H. R. Fartookzadeh and M. Fartookzadeh (2018); Sundar (2020)*

The calculation of function costs, the determination of how much it costs to perform a given function, is represented by the function-cost matrix. Its sections are as follows (SAVE International Value Standard, 2007).

In the creative phase, ideas for weak points are collected, and all possible ideas are explored in order to eliminate weak points.

In the proposal phase, proposals for possible solutions are collected in a decision-preparation study.

During the decision process, one of the offered alternatives is selected.

The proposals will be introduced in the implementation phase. In this phase, the value analysis group cooperates only to the extent necessary.

In the control and evaluation phase, the managers recognize the implementation of the proposals and the results derived from them, according to the developed interest system and the work of the participants.

### **3.4. Value-based methods of Value Analysis**

As value analysis spread throughout the countries of the world, so did its trends (Miles 2015).

Value analysis has remained in the United States, while value management is used in Europe. According to some opinions, there is no difference between these two trends, while according to other approaches, there is. Looking ahead, it can be said that value management places value analysis in the management toolbox and treats it as one of its tools.

In the United States of America, value analysis activities are brought together by the Society of American Value Engineers (SAVE), founded in 1957, which was transformed into an international company (SAVE International) in 1997. About 40 countries are members of this company, including Hungary.

In Europe, value analysis and value management are represented by the European Value Analysts Society (EGB; European Governing Board) (SAVE International website; European Governing Board website).

#### *Society of American Value Engineers*

International deals with the development and support of the value analysis method and is a leading advocate of function-based value-adding methods. His duties include teaching value analysis, preparing publications, and organizing conferences.

The members of the company are present from the public and private sectors and from quite diverse fields, such as the construction industry, product design and manufacturing, transportation, health care, and environmental protection. SAVE International's Value Standard and its knowledge material, published in June 2007, are both a manual and a code of conduct.

The objectives of the Standard are as follows:

- Defines the steps and components that make up a reasonable value test.
- Provides information on general methodology, terminology, and practical application to guide value analysts and managers in the effective use of value analysis.
- Provides guidance to value analysts and managers as they determine the points at which value methodology is applied to maximize the benefit of the team's innovation skills and implement alternatives that increase project value.

The value methodology can be used both in product production and in connection with service provision, business systems, and processes, as well as in the value analysis of an organization.

The standard states that value methodology is a systematic procedure that is carried out by a mixed team in order to increase the value of the project through the analysis of the project's function.

Function analysis is the basis of value methodology; it is the key activity, and this knowledge sets it apart from other problem-solving or practical development methods (SAVE International website).

#### *European Governing Board*

The European trend of value analysis, or value management (hereafter VM), is a management style committed to motivating people, promoting skills and synergies, and innovating with the aim of maximizing the performance of the organization. It is a structured, team-based, analytical, and creative process for finding innovative solutions to complex problems. Its goal is sustainable, value-based solutions that reflect the needs of the organization and key stakeholders.

VM is based on principles that define measurable value and focus on functions that promote innovation.



Developing and integrating a unified value management system into the processes of an organization is a big task. The unified system starts from customer and market expectations and covers product development, including preliminary value analysis (Kmetty and Hegedűs 2001).

The European standard, hereinafter standard, can be applied flexibly in different circumstances. The essence of a VM is to provide a framework for applications. It presents a lot of useful tools, encouraging you to choose the most suitable method to achieve the desired result. The standard can be used in the design and development of new products, equipment, and processes, as well as in the revision of existing products, equipment, and processes.

The objectives of the European standard are:

- Create a foundation for management in the implementation and application of VM.
- Help team leaders and team members apply the method.
- Provides guidance for all managers who implement and use VM and for all members who want to understand it.

The most important principle of VM is value. The complete management work is built around this. The most important management goal is to maximize the value of the various activities carried out by the company, which is compatible with satisfying the needs of consumers, management, and other stakeholders.

Managerial work requires professional preparation, leadership skills, good communication, and teamwork. The organization's environment has to take into consideration when developing management activities. An organization has an internal and external environment. The external environment includes customers, suppliers, legal regulations, and economic factors. The internal environment also includes internal politics, organizational rules, organizational culture, and employees. These must all be taken into account, and the appropriate tools must be selected for this (the European Governing Board website).

#### *Comparison of the two trends*

SAVE International and the Society of European Value Analysts operate two rating systems, but everyone in the world understands the same thing by value analysis. The focus is on value. During the value analysis, the value is derived from the needs of the consumers, and the object of the value analysis is either a new product designed in teamwork, an existing product that is value analysed, a product that is re-analysed, or, where appropriate, a product whose value is checked.

The standard published by SAVE International provides detailed guidance on this. It defines steps that can be used as a work plan. The work plan presents the individual sections comprehensively. For the stages, it assigns the goals, basic questions, main activities, the methods and tools necessary for them, and, at the end, even the expected result.

On the other hand, value management is a management style that can be particularly recommended for motivating people, developing capabilities, and promoting synergies and innovations with the aim of maximizing the performance of an organization. The Value Management Standard published by EGB not only deals with the conduct of value analysis but also creates a basis for management and the entire organization to be able to carry it out successfully. Organizational culture and organizational strategy are extremely important. Value management organizes management tasks around value. Its purpose is to maximize the value

of the activities carried out by the organization, which arise from the needs of consumers, management, and other stakeholders.

The tools and methods used for value analysis are the same for both European and American standards; there is no significant difference between them.

#### **4. New challenges and solutions**

There are many different tools, methods, and perspectives that help with the development and improvement of value analysis methodology. Information and communication technology (ICT) is present in the operation of businesses. Today's economic life and consumer society are characterized by ever shorter product life cycles, the power of community spaces, the need for continuous innovation, constant cost reduction (thereby increasing efficiency), the need for sustainable development, and complex thinking. Value analysis is also helped by using all possible techniques whose way of thinking and logic are suitable for optimizing and increasing the aforementioned value. In my opinion, these can be used regardless of industry and are even necessary.

##### **4.1. Scientifically based cost reduction (Disruptive Cost Workout)**

Disruptiveness means that a new product is produced with a technology or method radically different from the previous one; a constant element of this is continuous innovation. A challenge that also creates an opportunity for growth.

Disruptive cost reduction can be briefly defined as creating more with less, i.e., with a smaller budget. The question is what can be the minimum functionality of a product that suits the consumer? This procedure actually means step-by-step cost optimization. In order for this to work, a "cost-out" team has to create within the company, whose only task is this. With a value analysis methodology, they look at the product through "functional glasses" and leave only those functions that the customer really requires. (The additional value is not paid by the customer anyway, so it is smaller value product is created due to higher costs). First, they focus on which are the most value-adding functions, which are definitely necessary, and then which are the second biggest value-adding functions. The reduction of costs is approached from the perspective of the necessary functions, the task is to reduce production costs by 5%. The continuation of the method is that if this is successful, in the next step the product will be "taken out" again, and I will try to reduce its cost by another 5%. They do all this very meticulously, breaking down cost reduction opportunities into small steps along the entire length of the value chain. The team often changes its point of view during the cost optimization. First, they look at the production of the given product and its costs with an engineering eye, then they also look at it from financial and marketing points of view, and then they examine again with an engineering point of view, is it still possible to produce the product? This cost reduction should be integrated into the entire value proposition chain, i.e. it must be applied and visible in all elements of the value chain.

An important element of this project work is the necessary value analysis expertise and know-how, the employment of appropriate experts, who must know the process and the technology, but must also be aware of the cost implications. These teams must impartially and strictly "cut down" the cost, the justification must be done on a professional basis, and the course of this must be systematic. The targeted area - elements, parts - or the factors that make up the largest part of the costs, ~50% (Pareto approach). In addition to cost reduction, the goal is also short-

term feasibility, so the step, solution proposal, which can be implemented in a short time comes to the fore. According to the steps of the value analysis work plan, they proceed from the information phase (understanding the customer's needs) through the function analysis and evaluation phase, and then in the development phase they present their proposals, which may or may not be acceptable ("go/no go"). If the steps as a whole do not result in a 5% cost reduction, then the steps and suggestions become necessary ("must") (Mainardi 2015).

It is advisable to use this methodology primarily in areas where expensive, innovative technology is used and where there is a large volume of production. Today, a testing and introduction phase cannot last for months, there is no time for that, the competition is fierce, and technologies can quickly become obsolete. The product can be completely disassembled and transformed according to changing needs, just think about the enormous development and transformation of mobile phones, even just in the last 5-10 years.

This is helped by disruptive innovation, during which new technology is not developed at enormous cost, but existing technologies are applied to the new product. It involves high risk, contains surprising and unexpected decisions and actions, and can turn the market upside down. This picture is complicated by the appearance of new business models, the appreciation of the role of social media and conscious consumers, and the lean approach of (Fintech) startup companies. Typical examples are the ever cheaper 3D printing, the use of intelligent software (AI) (self-driving vehicles), the Internet of Things (IoT), smart factories (Smart Factory), the appearance and expansion of mobile internet (banking), renewable energies application, but even genetic research can be mentioned. All of these are closely related to digitization, Big Data (data mining), and Industry 4.0.

#### **4.2. Quality Function Deployment and Target Costing**

Quality Function Deployment (QFD) is not a new concept; it was already incorporated into the value analysis methodology in the early 1980s. It is a quality planning method according to which customer satisfaction is the only measure of quality. Steps: understand the customer; collect customer opinions (in order of importance); understand and transform these for the value analysis team as a goal to be achieved; develop a matrix to select concepts and identify specifications; finally, these specifications must be connected and brought into line with the production possibilities. The main tool of the analysis is the "House of Quality", which associates a value with each function and the necessary parameters so that they can be measured and compared and looks for correlations between the functions and properties (Bolton et al. 2008; Cariaga et al. 2007).

Thus, it is a quality function evaluation analysis that creates a communication channel between professionals (engineers, logisticians, financiers, marketers, etc.). It clarifies what the desired quality is, what the customer wants and is willing to pay for, the order of importance of the customer's expectations, what is competitive, and what is really feasible.

What makes it considered modern and suitable for today's challenges is that it provides an answer to the problem that cost, quality, and functionality are not in balance; the established goal has become cost reduction. This model does not rule out effective cost reduction either, but it also considers it important to increase the added-value of the product for the customer. After the development of QFD, the next step is target costing, which is the "targeting" of the allowable cost level: target price minus expected profit. This target price depends on the industry and competitors as to whether it can be determined by the company or is a given, but

the logic is the same in all cases. Costs have to be minimized already in the planning stage, since the most and least painful interventions and changes can be implemented at this stage, and with continuous cost reduction, taking into account consumer price flexibility, volume, and depreciation costs. This is where value planning comes into play when we try to minimize the costs that have not yet been incurred. For this, the cost factors have to be find, evaluated, and changed, if necessary. If the allowable cost is lower than the planned cost, then it is necessary to go through the function carriers in order to reduce their cost, applying the function evaluation matrix. The next step is to incorporate the Kaizen philosophy into this process, according to which development does not stop, is not occasional, but consists of continuous and small steps, and every small improvement or cost reduction is valuable, so the risk can be reduced. We create permanent insufficiency, think in terms of processes, involve employees, and look for unnecessary time and costs (Schandl 2014).

### 4.3. Limitations of the Value Analysis at the business organisation

Besides the many benefits related to applying the Value Analysis and its methodological framework, there are many difficulties that companies might face in adopting and implementing value analysis. These challenges can be the followings (Sharma and Belokar 2012; Sharma 2022):

*Difficulty in obtaining accurate and comprehensive data for analysis.* The possible reasons can be beyond this one lack of information, usually caused by a shortage of time, furthermore many decisions used to be based on feelings rather than evidence-based facts. The complexity of the necessary information can be illustrated in the Value Analysis Questionnaire in Table 2.

Table 2. Main questions of Value Analysis

Subject	Question	Analysis
Function	What function can be performed?	Can it be eliminate? What alternative methods are available?
Material	What should be the material specification? What quality and quantity of material should be applied?	Can alternative material used? Can the specification amended? Is the size or weight of material excessive? Can the quality reduced? Will a cheaper material serve the same purpose? Is the cutting done economically without waste?
Labour	What are the direct labour costs?	Is it possible to reduce labour costs? Can lesser skilled workers be employed?
Process	Is the best available process or technology used?	Are all the operation necessary? Can be the alternative operation or business running process cheaper? Can assembly operations be modified and how?
Standardization	Are the materials, components or modules standard?	Can the materials and the processes be standardised? Can the product use standard parts?

Source: Own edition based on Nikhila (2022)

Analysis is crucial in the context of creative, cross-functional team work to determine the desirable feature of each product in terms of customer’s requirements.

*Resistance to change from employees.* The attitudes can be rooted in personality traits (habitual thinking distorting or hindering the objective problem perception) or rigid application of standards, customs, and tradition without consideration of changing function, technology or value. In addition, negative attitudes, failure to recognize creativity or innovativeness arising from poor human relations, lack of good communication, misunderstanding, jealousy, and normal friction between people are usually a source of unnecessary cost, resulting sometimes be duplicated and redundant functions (depending the company culture, values, structure and the applied leadership style).

*Challenges in integrating value analysis with other management tools or processes.* It means misbeliefs, insensitivity to public needs or unfortunate experience with products or processes used in unrelated prior applications. Over specifying, costs increase as close tolerances and finer finishes are specified. Reluctance to seek advice, failure to admit ignorance of certain specialized aspects of project development.

### Summary

Due to its functional approach, value analysis is one of the most effective and easy-to-learn problem-solving frameworks that can be used in any sector and in any company, regardless of its business portfolio, structure, size, and ownership structure. In addition, value analysis is an effective decision preparation procedure that can be used not only in projects initiated with the aim of cost reduction and whose defining characteristic is function analysis (Leung 2009; Shen and Liu 2003). The types of value analysis illustrated in Table 3 support its versatile application.

*Table 3. Types of Value Analysis*

<b>Designation</b>	<b>Description</b>
Value Analysis	Value analysis of an existing product, value improvement
Value Engineering	New product value analysis and value planning
Value Control	Value verification and verification of the implementation of proposals
Value Investition	Value Planning for Investments
Value Management	Value analysis of management processes (Value management: general corporate application of value analysis)
Value Purchasing	Material procurement with value analysis: procurement of materials and components
Value Research	Value Analysis of Experimental and Laboratory Work
Value Improvement	Value analysis of development programs

*Source: Own edition based on Nádasy (2014)*

The applications of value analysis can have many positive returns: cost savings (between 10 and 30 percent in volume); improvement of product quality; reduction of lead time; improvement of competitiveness and productivity; better utilization of available capacities; and more effective collaborations both inside and outside the company. Some concrete, real world everyday examples how to apply the different types of Value Analysis in different organisations.

Aadarsh Instruments, located in Ambala, for analysis, which runs the export business of medical microscopes, focused on the adjustment knob of the microscope, and with the critical evaluation of it, you were able to increase the value of the product by substituting another material in place of the one that is currently in use (Sharma and Belokar 2012).

Value generation in the traditional housing design process (in different countries, with different scopes and profiles) Value analysis was applied to determine desired value (DVI) and potential value (PVI) indices that represent the minimum and maximum value needed to meet the client's expectations. The stakeholder who gets the least value in the process is the builder, while in the product, it is the designer. On the other hand, the end-users obtain the most value from both the process and the product. Builders receive little value due to their low involvement in the design process, as they are traditionally incorporated into the construction-related stages. The value losses resulting from the different customer visions (default value losses) are low and are present in the process rather than in the product. Therefore, the main value losses related to the project's performance and not due to conflicts of perspectives between different customers (Giménez et al., 2022).

JCI's Applied HVAC Equipment division previously used organization-based tools like Sharepoint and emailed static files for VA/VE projects, taking weeks to deliver the ideas. This process is similar to many companies and industries that conduct these analyses routinely. JCI wanted to step up its collaboration by implementing CoLab. The initial implementation enrolled eight users in a single location; this access has since extended to more than 180 in four countries. JCI uses CoLab to cover VE processes, e.g., drawing reviews to achieve cost avoidance, and it employs the software for manufacturing process steps and existing products for VA. In addition, they now use CoLab in virtual real-time for efficient collaboration in value engineering and analysis (Kimmel 2022).

Numerous projects focus on sustainable development as a burning issue, which includes significantly more recycled material contents, requiring less energy or water usage, reducing construction waste, increasing natural lighting, and providing tangible contributions to an optimal facility. The value engineering methodology can provide for the identification of alternatives, making comparisons among the alternatives, or identifying the best value alternative. This is accomplished using life-cycle costing along with first-cost estimates. Life-cycle costing will be able to precisely predict the first-cost and full-life-cycle cost differentials of each alternative (Sharma and Belokar 2012).

Linked to industry 4.0-based technologies and digitization, value analysis contains many unexploited opportunities, for example in the field of business intelligence (BI). These are technological solutions that, in addition to company management systems, help companies make informed decisions in the following areas:



- Multidimensional database management
- Business planning (planning), forecasting (forecasting), and consolidating applications
- Reporting applications
- Dashboards and Scorecard systems
- Tools for performance monitoring (Key Performance Indicators - KPI)
- Data, Text and Voice Mining
- Data visualization

To build a BI system, we usually need several pieces of software. Typically, we need a database manager where we will store the data required for the analysis, a data loader with which we can upload a business intelligence system, and a display interface through which we can query the data of the BI system and modify its models. Value analysis can also provide effective help in this area by analysing the functions and costs of different software. Another future-oriented area of value analysis in software function analysis can be corporate architecture. It is a conceptual model that describes the company's business processes, organization, goals, and products and the relationship of these components with the supporting IT services and infrastructure, as well as modelling the organizational logic of the IT infrastructure, its components, and their connection system.

In certain cases, there are potential limitations to value analysis in the context of rapidly evolving technologies and business models. With the rise of Industry 4.0, the functional approach of value analysis may be less relevant in those environments where products are rapidly changing and customer needs are evolving at a fast pace.

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