**POLITECHNICA UNIVERSITY OF BUCHAREST**
**Faculty of Industrial Engineering and Robotics**
Doctoral School of Engineering and Management of Technological Systems

# PH.D. THESIS

## INTEGRATED MANAGEMENT SYSTEMS OF PRODUCTION COSTS

## SISTEME INTEGRATE DE MANAGEMENT AL COSTURILOR DE PRODUCŢIE

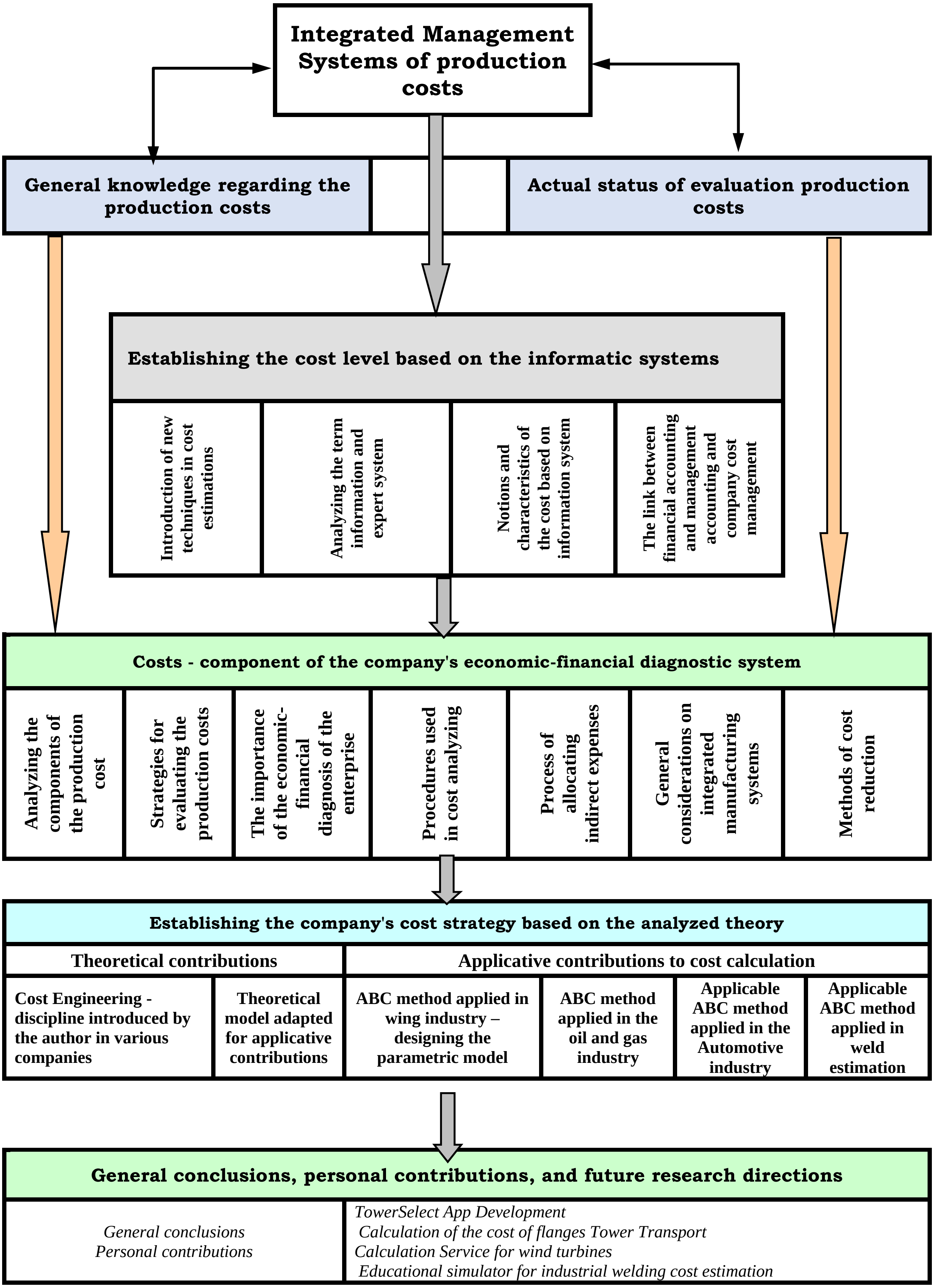
**Author: drd. ing. CAZANGIU B., Valentina-Eugenia (ZAHARIA),**
**Scientific Coordinator: Prof. Emerit dr. eng. Corneliu NEAGU**

**DOCTORAL COMMITTEE**

| | | | |
|---|---|---|---|
| President | Prof. univ. dr. eng. Nicolae Ionescu | from | Universitatea Politehnica București |
| Scientific coordinator | Prof. Emerit dr. eng. Corneliu Neagu | from | Universitatea Politehnica București |
| Scientific reviewer | Conf. dr. eng. Lucia Violeta Melnic | from | Universitatea Ovidius din Constanța |
| Scientific reviewer | Conf. dr. eng.Maria Magdalena Roșu | from | Universitatea Politehnica București |
| Scientific reviewer | Prof. univ. dr. eng.ec.Cosmin Octavian Dobrin | from | Academia de Studii Economice București |

Bucureşti 2022

## STRUCTURE OF THE THESIS



# INTEGRATED MANAGEMENT SYSTEMS OF PRODUCTION COSTS

# SUMMARY

# INTRODUCTION

The research analyzes trends in the evolution of management accounting using a new approach to cost engineering, which is in constant development. One of the most important objectives in the operation of an industrial engineering enterprise is the most accurate estimation of costs in the production area. Another objective is to analyze the recognized interaction between the final result and the interactive planning since each planning result will generate variable scenarios from case to case. To achieves these objectives **integrated production cost management** systems are the most appropriate technique of implement planning, collaboration and interactivity in the production process, and ABC method of cost estimation is the starting point for designing such systems and achieves *the coherence between* configuration and programming, in the administration of the data management system and of the communication protocols in a manufacturing process. At the same time, using of the software presented in the paper, we get lower production costs and time, saved throughout the entire production process operation cycle – from the initial planning and design phase to the operation and modernization phase, passing through all execution, control and management levels. In this way, great security is brought to the investment, through unique transparency and interoperability of the products and systems created.

**The reason** behind the choice of the present theme lies in the desire to come to the support of managers of enterprises in Romania (and not only) to solve their cost problems, sharing 12 years of experience in cost engineering at the companies NEVS – Sweden, TechnipFMC plc from Norway and Siemens Gamesa of Denmark.

Resource management in the industrial field in IT programs increases the productivity of a company and can be extended to a wider spectrum of organizations with various objects of activity. The efficiency of the integrated system in each production plant, through the installation of personalized and high-performance intelligent devices, leads to excellent results, depending on the requirements of the user and of the unit itself, increasing the efficiency of decisions at the managerial level. The present study **brings together the analysis of** the role of integrated systems in the design, estimation, and implementation of production costs, as well as the ways of leveraging modern technology, in order to come to the core of the creation and expansion of a **production environment architecture**, oriented to data collection - modeling – simulation – design – validation of intelligent manufacturing systems.

The thesis is structured in six chapters, spread over 182 pages of content, and contains 114 figures, 26 tables, 13 calculation relationships, 420 bibliographical sources, and 1 annex (2 pages), as follows: **the first chapter** of the thesis deals with the theme of definition, classification, and role costs from the production process. **The second chapter** ("The current stadium of cost evaluation procedures") represents the starting point of the current state of the various cost and value calculation methods. **Chapter 3**, " Establishing costs with the help of information systems ", makes the connection between the classical theory of costs and the influence of IT in the management of the maintenance resources. **Chapter 4,** " Costs - component of the company's economic-financial diagnostic system ", is focused on the topic of using the IT system in estimating costs, developing the economic-financial diagnosis of the maintenance, and achieving efficient management of the production process. The last chapters (more than 50% of the pages of the work) highlight the art of own contributions with the presentation of applied contributions, where, based on the theoretical concepts analyzed previously, a cost estimate is made by applying the **ABC (Activity Based Costing) method** from different industries. **Chapter 5** - **"Establishing the company's cost strategy based on the analyzed theory"** presents the research results and the original contributions in the studied field, choosing no less than five particular cases from three distinct types of industries (wind, oil, automotive), such as: making the parametric model in a wind company, calculating the costs in an application in the oil equipment industry, applying some software to estimate the costs for the production of a car seat, estimating the costs for a TaaS public transport service, and another application for estimating the cost of the welding operation. **Chapter 6** - General conclusions, personal contributions, and future research directions - highlights the summary of my theoretical and practical efforts in the doctoral thesis, the directions of future research development, as well as a synthesis of how to disseminate the results. The thesis ends with the presentation of the 450 bibliographic references resulting from the documentary study carried out during the elaboration and completion of the work, the lists of figures, tables, and Charts included in the work.

*The Activity-Based Costing method* introduced in costing software will especially help cost engineers. The method introduced by Johnson & Kaplan in 1987 later evolved into **TDABC** (Time-Driven Activity-Based Costing), Kaplan & Andersen, 2004-2007. This method is a form of modeling and distribution of expenses in costs calculated through different equations, in which the **time obtained,** and the **capacity of each resource** are the main factors (drivers) for estimating **the cost**. A cost driver is any element that causes a change in the cost of an activity. ABC is a modeling method that represents the distribution of expenses in calculated costs. Starting from the analysis of the profitability of each product, the method also extends to the analysis of distribution expenses, sales expenses and even those with the service provided for certain products. Through the ABC method, it is possible to identify the cost of each activity with profitable potential, the abandonment of unimportant activities or those that induce additional costs, the provision of Lean accounting by carrying out activities in parallel, in conclusion, many advantages that I highlighted together with Gary Cokins (one of the contemporary reformers of the ABC method) in an article written about the Service cost in the wind industry. The calculation model developed by me is useful for all industrial engineering projects related to wind companies. In different departments of the municipality, working groups were created and meetings were organized on various topics. In the project to develop a new wind farm, the functions of Industrialization and development of production, procurement and technological functions are involved.

**Keyword's:** ABC /***A**ctivity **B**ased **C**osting* Method, *Life Cycle Cost, and Energy Production, issued a parametric model in different industries (wind, oil, and gas, auto), mapping different activities. Indirect cost allocation based on the ABC, product estimation, costing software configuration: aPriori, Siemens TCPCM as an integrated system of decisional measure based on cost, TAAS (transport as a service), a tool for welding calculation cost. Cost Engineering.*

# DEL I – FUNDAMENTAL THEORIES OF COST CALCULATION

New concepts regarding the production process and techniques of cost calculations were developed with new terminology: integrate management of the costs, costs based on the activities and management based on activities, innovative concepts appeared in the last decade, to answer the global economy exigency.

Economic theory has developed tools to value the relationship between the cost evolutions and the multiple characteristics of a product. The most important of these tools are the price indicators, using the analysis of the data by looking to the previous cost of products, in a regressive way. The changes in recent years makes the management accounting practices to be adapted are the following: identifying of the costs associated with the business, through the activities carried out; the introduction of new technologies in which the costs of the labor force have decreased primordial, becoming the cost of flexible IT operating systems; Reduction of inventories of raw materials and finished products, as the subcontractor connected with suppliers and customers through an integrative ERP system - Enterprise Resource Planning. Traditional economics classifies the general process of social production into the following categories: production, distribution, exchange, and consumption. The direction in which the production structure is changed will be done according to the change in the time preference of the consumers. In a dynamic economy, innovation is not necessarily a technology or a product, but a concept of business. The idea of concept business innovation is to introduce strategic variety into an industry or commercial field. *Michael Porter* has advanced the idea that, in order to be commercially competitive, a company must approach a strategy of cost management, differentiation and focused. These strategic decisions are governed by the mix of strategic analysis, the choice of managerial strategy and, tactical nature of adopting of an established strategy. The implementation phase aims at realizing the strategy through actions. In terms of business development, the most important part of the process continues in the implementation phase. The actions taken in business development are essential for the company's strategic results. Choosing a strategy is based on making decisions that will determine the company's long-term market position. Decisions are chosen from a larger set of options, each leading to a specific scenario with a specific plan of action. Constraints are identified and options with unfavorable consequences are eliminated. This strategic analysis will establish the path that the decision makers will choose for the organization. Strategic implementation is the last stage of the strategic management process. It is about the practical unification of the decisions taken, in view of the application of the strategy.

## CHAPTER 1. General theoretical notions regarding manufacturing costs

### 1.1. Definition of the concept of cost and expenses

When creating and designing a production process, the company will try to estimate the costs that it will involve. Estimating the costs will provide a prediction of the final profit, to avoid the risks of risk or the entrepreneur losing the entire investment (or even worse, the entire business). The specificity of a production factor refers to the limitation of its utility to a narrow range of predefined scopes. Factors of production can be specific, depending on their degree of adaptations in production. Any production factor capable of producing goods or providing services is "embedded" with a certain duration of use.

*What is included in the category of capital goods?*

- All depreciable fixed tangible assets held for use in the production or delivery of goods or in the provision of services (for example, buildings, land, equipment)
- Transform/improvement operations of real estate/parts of real estate, respecting the condition that the value of each transformation/modernization is at least 20% of the value of the real estate/part of the real estate after transformation/modernization.

Depreciation[1] refers to the gradual, staggered recovery of all costs related to the purchase, construction, production, assembly, installation or improvement of depreciable fixed assets, also for the expenses

[1] **Mircea, Delia -** *Amortizarea fiscală vs. amortizarea contabilă,* https://blog.smartbill.ro/amortizarea/ (accesat ianuarie 2022)

related to an active: installation, assembly, non-refundable fees, etc. The depreciation methods used in practice are: linear depreciation; accelerated depreciation; declining balance.

***Expenses*** *are the costs that are incurred and consumed in total in the process of generating income within the company.*

***Manufacturing*** costs (factory overhead) will be treated as an active cost (therefore unexpired) and will be included in the cost of manufacturing the finished goods. The manufacturing costs will enter the inventory stocks of the finished products until they are sold, either in cash or in credits (Kent R., 2016:66). Once these finished goods inventories are sold, they become expensed costs or expenses and appear in the profit and loss account as "cost of goods sold" because it represents the cost of generating the sales revenue.

Unlike manufacturing costs, selling, ***distribution, and administrative costs*** are always considered expenses because they cannot be inventoried. Manufacturing costs are considered the added value of the goods produced. *Selling, distribution, and administrative expenses* do not contribute to the value addition of finished product stocks and are treated only as ab initio expenses. When combined, these expenses are deducted from income.

***The differential costs (incomes***) result from the difference between the costs (incomes) estimated in different scenarios. The unique costs correspond to a single scenario, and the differential cost already intervenes between two scenarios. The standard costing system used by manufacturing companies includes the cost of direct materials plus the labor involved plus factory production costs. **The standard cost** is estimated in close relation to the budgeted cost.

Loss is a term used in two distinct ways. On the one hand, the **loss** refers to the situation in which the expenses leave the income. On the other hand, when a certain asset is sold at a price lower than its cost price, the result is a net loss.

## 1.2. Cost classification

• ***Costs classified by function****: Production costs - Administration costs - Sales and distribution costs - Research-development-innovation costs.*

• ***Costs depending on the behavior:*** *Fixed costs - Variable costs - Semi-variable costs –*

• ***Costs according to nature or traceability:*** *Direct costs - Indirect costs.*

• ***The costs of making managerial decisions:*** *Cost of education/improvement quality - fixed costs - Cost of production, administration, sales, and distribution quality - Replacement cost - Opportunity costs - Differential costs - Marginal costs - Closure cost.*

• ***Costs according to time:*** *Historical costs*

• ***Costs classified according to normality****: Normal costs - Abnormal costs.*

• ***Costs depending on the quality of control:*** *Controllable costs - Uncontrollable costs.*

Determining the optimal cost of the product and evaluating the profit is fundamental and leads to making the best managerial decisions in the control of costs. In the sense of the three traditional types of classification of costs (fixed/variable, direct/indirect, product cost/period cost), the activity concept must be analyzed from an economic and legal point of view. The significance of the activity leads to the relevance of activity measurement in the classification and treatment of costs. Activities must necessarily be quantifiable (Sun, 2013). Any activity determines costs. The phrase "activity-based costing" appeared to understand whether or not management accounting is more efficient when it makes the connection between costs and business activities. The changes in recent years to which management accounting practices have been adapted are the following:

- the need to identify the costs associated with the business, through the activities carried out; - the introduction of new technologies in which the costs of the labor force have decreased, which affects the scheduling costs of the flexible scheduling systems based on the switch;

- stocks reductions of raw materials and finished products, because the division has connected with suppliers and customers through an integrative ERP system, (Enterprise Resource Planning) to ensure that the elements are delivered only at the time when they are - needed JIT (Just-in-time).

Observers of these new practices have identified new management accounting models that they have called: activity-based costing, costing in the management of new operations, just-in-time costing, quality costing, and costing that focuses on the total cost.

*Cost-volume-profit analysis* represents the systematic examination of the relationship between, sales, production volume, costs, expenses, and profits (Browning & Zupan, 2011). This analysis provides useful information for the managerial decisions of a company and can be used to establish sales costs, to select the product mix for sale, and decide on the choice of marketing strategies and consequences of the impact of changes in costs on profit. Therefore, the importance of the *cost-volume-profit* evolution continues to increase with time (Wight, 1932).

***The accounting of standard costs***. While traditional cost accounting focuses on ascertaining what it matters, activity-based costing records what it costs not to do or omit something, such as the cost of putting on hold a part of the production process.

**Lean accounting** has been adopted by several organizations that have in mind the reduction of time spent on unnecessary tasks (transportation, waiting times, stock production). This method is supported by the management of a company in order to ensure the performance of employees' work in the best conditions, customer satisfaction, and the success of each employee. In the book, *Practical Lean Accounting* (2011) written by Brian Maskell (242), the importance of considering the entire cost for the value stream is mentioned among others. If the cost of the product is not correctly calculated for each gig and scenario from an early stage of the platform development, then the risk of wrongly introducing some costs into the finished product will increase (Figure no. 3).

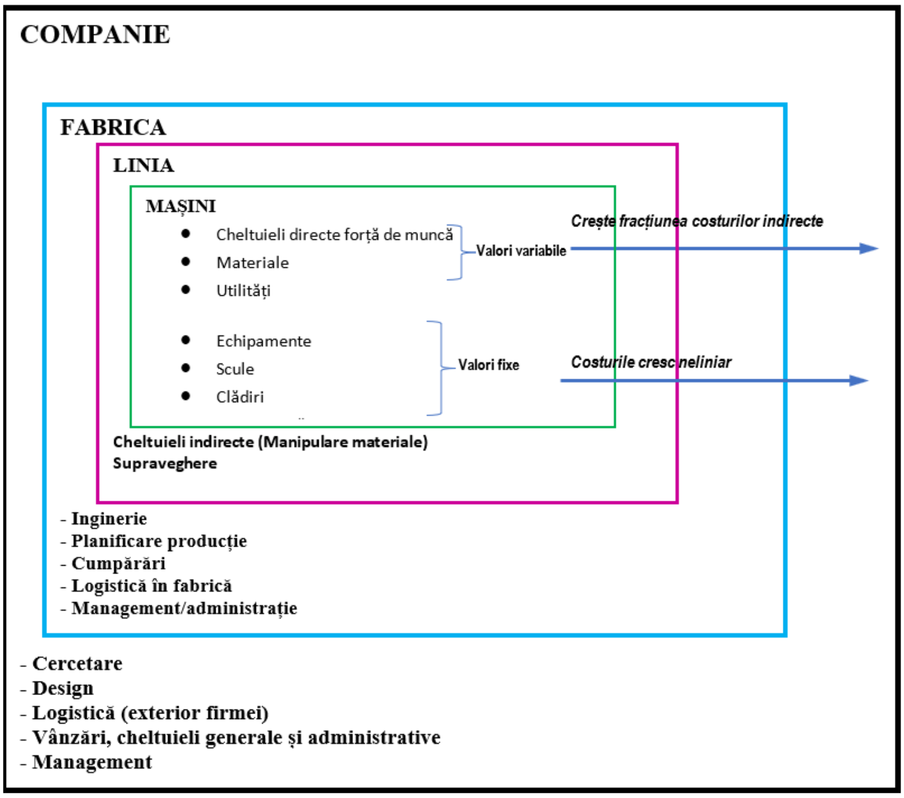



**Figure nr. 3. Different levels of the cost analysis Fixson (2002)**

***Resource consumption accounting*** (*RCA - Resource Consumption Accounting*) is a management theory that describes a dynamic, integrated, and holistic approach to management accounting, providing managers with information relevant to decision-making in order to optimize collaboration. RCA is a relatively new approach to management accounting, based largely on the Grenzplankostenrechnung approach (GPK - *Marginal Planned Cost Accounting* or *Flexible Analytical Cost Planning and Accounting*) of German management accounting and also allows the use of activity-based drivers[2].

Management accounting is an internal reporting tool composed of a set of techniques, procedures, and methods used by the organization to maximize shareholder returns. Accounting accuracy is the art of the management accounting toolset that ensures the overall effectiveness of the organization. The external books of a business differ from the accounting books prepared by accountants who follow the conception method.

[2] **Sursa:** *https://www.newmascotcostumessupply.com/ru-ro/wiki/Grenzplankostenrechnung*

***Performance's accounting*** aims to increase the speed or rate with which the production of products and services responds effectively to the constraints of an organization, regardless of its internal or external nature to the organization. The management accounting methodology that considers the constraints as factors that limit the reformation of organizations surely leads to accounting performance.

**The total cost of ownership** is a financial estimate intended to help buyers and owners determine the direct and indirect costs of a product or service. In the automotive industry, **TCO** (*Total Cost of Ownership*) means the cost of owning a vehicle at purchase, plus its maintenance and finally selling it as a used car. TCO is often quite different from TCA *(Total Cost of Acquisition)* and is much more relevant in determining the viability of any charitable investment than modern credit networks and financing. TCO is directly involved in the total cost of a project, absolutely all the projects and processes and, consequently, also in its profitability *(Tufan, 1998)*.

The **ecological accounting system** consists of a mix of conventional and ecological accounting. The ecologically differentiated sustainability measures in financial terms the effects of a community's natural environment, but also the influence that the community has on the environment and the impact of physical climate measurements, ecological accounting is a field that identifies resources usage, measure, and communicate the costs of the economic impact of a company on the environment ("*Cutting quality and inspection costs*", 1975), including the cost designated the cleaning or repairs the calamities areas, penalties received and taxes, costs of purchasing installation to protect the medium and cost for managing the residual materials.

To study the complex relationship between sales prices and profit margins, many companies use various **simulation** models. With their help, combined with other economic models, a study of the impact of individual decisions on production can be made, the most productive rationale for the global profitability of wheat can be found, as well as the most suitable mix of products to increase global profit, all coming to get rid of organizational inertia *(Şchiopu, 2007*). In addition, the simulation helps to estimate the results of the dynamic changes in the processes.

**Cost concepts and the Kaizen method**. Kaizen costing is a Japanese technique for managing costs from the design stages of a product. The objective of the Kaizen method is to reduce current costs through various improvement tools such as value engineering and functional analysis for each production facility. The objective of the Kaizen method is to reduce current costs through various improvement tools such as value engineering and functional analysis for each production facility. Cost reduction targets are set and enforced monthly. The Kaizen continuous improvement method is implemented over the course of a calendar year to achieve a target profit or to reduce the gap between the target profit and the estimated profit; thus, the analysis tracks the cost variance between the Kaizen target and actual costs. When proposing a new product for a Japanese company (such as Daihatsu), which uses the Kaizen method, a new product project is created. The costing system is implemented from the initial design stage. There are 6 design aspects involved in the manufacturing process of a product:

- Production, distribution, and sales plan.
- Projected costs for parts and materials
- Factory rationalization plan (anticipated reductions in variable manufacturing costs).
- Personnel plan (for direct labor and service department personnel).
- Facilities investment plan (capital budget and depreciation).
- Fixed expenses plan (for prototype design costs, maintenance costs, marketing expenses general, and administrative expenses).

*These six forecasts establish the annual profit budget or* ***"target profit".***

Cost reduction techniques also include the standard cost method. However, standard costing has limited applicability and may lead to undesirable results. For example, to minimize purchase price variance, a purchasing manager may purchase a cheaper, lower-quality, or second-hand item. As a result, product quality will be lower, and the company may incur higher overall costs in the form of repair or warranty issues (*Wheelwright, 1981*). In contrast, the costing proposed by the Kaizen method is carried out at the company level and it can be used in planning, design, and other processes. Kaizen costing activities do not reduce overall product quality; they ensure that the spending plan leads to obtaining an optimal value.

The Kanban **(Pull System**) is a Production Management technique that uses QR tags attached to components/containers to monitor the flow of materials in the factory. It is a visual production control system using reusable containers, cards, or empty spaces/places to facilitate the "pulling" of products from storage places, respectively suppliers to the production area. The main objective of using the

Kanban system is to guarantee 100% availability of materials and to permanently improve the stock level. The Japanese expertise in conserving energy and materials combined with the *ability of Japanese managers* to motivate a compliant workforce, as well as the careful policy of their own government, are often cited by American managers as major reasons why the Japanese auto industry grew between 1960-1980 from obscurity to the biggest in the world.

## 1.3. Production factors within consumption.

### 1.3.1. Natural resources, capital, and work

**The production factors** in an economy are:
- *The natural resources* that can be used in the production of goods and services.
- *Capital* is used in the production of goods and services. Example: Building offices, machines, instruments, equipment and tools, automated lines, etc.
- *The work or human* effort that can be attributed to the production of goods and services, including the employed persons, is considered the part of the labor force that can be distributed within the economy.

### 1.3.2. Cambridge capital controversy

**The Cambridge Capital Controversy** was a dispute between the 1950s and 1960s between proponents of two different theoretical and mathematical positions in economics. The debate concerned the nature and role of capital goods and a critique of the neoclassical view of aggregate production and distribution. To get rid of the deficiencies related to the linear conception of production developed by the Austrian economies and the general equilibrium approach adored by the neoclassical theorists, these two approaches were combined with input-output Leontief analysis. Among the productive activities, the standardized volume of production, the standard working time, the working time of a worker, and the level of non-productive costs are taken into consideration.

## 1.4. Analysis of the cost production relationship

**The income** *can be sent in the form of salary, rent from the property, dividends from shares, or through loans, pledges, or mortgages.* A consumer's purchasing behavior will be determined primarily by the income he would have earned after all deductions had been eliminated according to relationship 1:

$$Yd = Y - (Ty + Dy) \quad \textbf{(1)}$$

where: *Yd* = Disposable *Yield*
*Y* = *Incomes/yields from all sources*
*Ty* = *Taxes per yield*
*Dy* = *other deductions from the source*

## 1.5. The role of the cost of production in managing the enterprise

Markets are dictated by the interaction between demand and supply, and the system should work in the interest of the consumer, providing the product the public wants.

In a dynamic economy, innovation is not necessarily a technology or a product, but a business concept. The business concept and model interfere in the modality by which the concept is put into practice. The internal evaluation of the company refers to the determination of its assets, its strengths, and weaknesses. This provides an assessment of his resources, and ability to face the challenges he faces.

Michael Porter has advanced the idea that, to be competitive, the company must approach a strategy of cost management, differentiation or concentration. These strategic decisions are governed by the mix of strategic analysis, the choice of managerial strategy, and the tactical nature of adopting the proposed strategy. The implementation phase aims at realizing the strategy through actions. In terms of business development, the most important part of the process continues in the implementation phase. The actions taken in business development are essential for the company's strategic results. The analysis process will determine whether the company has a commercial advantage over its competitors in its relationships with suppliers and customers, especially in terms of resource strengths and the position it occupies in the field of competence. This information forms an image of the company and its working environment, allowing it to develop a certain strategy. The idea of business innovation is to introduce strategic variety in the industry or commercial field (Asaf, 2004). If this happens, then the value creation potential in the field will change substantially in favor of the innovator. Many companies enjoy similar strategies, but an innovator who enters the market with a new business model radically changes this situation, generating a sure increase in profits. Strategic implementation is the last stage of the strategic management process. It is about the practical unification of the decisions taken, in view of the application of the strategy. Implementation involves the creation of business plans, control and feedback systems, resourcing, budgeting, training, and reviewing of the organizational structure to ensure the achievement of the strategy. We classify accounting according to *stakeholders:* business owners (its shareholders), management, employees, suppliers and customers, creditors, and government agencies such as tax authorities and various regulatory bodies (Salman, 1999).

# CHAPTER 2.
# Actual stadium of the estimation of the process costs

In **Chapter 2**, the current **level of cost evaluation procedures** is presented, by describing a series of accounting techniques, but also some financial reform measures that support the strategic development of organizations - the monitoring of commercial performance, the evaluation of competition, the basis of the financial situation life cycle costing, costing, strategic costing. In order to provide the most accurate picture of the current state of cost estimation in a productive enterprise, **the use of classic methods in cost management (2.1),** ***the newest and evolved methods in the field of cost calculation (2.2.),*** and how the ***ABC (Activity Based Costing) – Method of costing based on activities (2.3.)*** – the main theme of the thesis – in the context of the others, using numerous examples from the author's experience. Management accounting methods and cost calculation methods should be classified, depending on the time of their occurrence, into *the classic method, and modern management accounting method.*

From the category of **classical methods**, we named: the global method, the order method, and the phase method. In the category of **advanced methods** are included: the method of standard / standard costs, the direct cost method, the **Georges Pérrin** method, and the **PERT** method, whereas in the **category of modern methods** we can often discuss: the **ABC** method, the ABM method (Activity Base), **TDABC** (Activity time-driven cost) and the target cost calculation method. The role of product cost estimation is to determine the global costs incurred during the product development and manufacturing phases. Some authors try to extend the estimation to the entire life cycle of the product, that is, including the costs of product service (service and maintenance).

Users of ***classical methods in cost management*** tend to focus on statistical figures and classical examples. The classical method highlights the use of larger and more complicated experiments, and the extended statistical analysis uses several iterations of a simpler experiment.

***The traditional accounting*** method (commonly refers to the cost allocation for the products made, indirect cost according to the volumes (number of units produce, direct working hours, or production hours of the machines.

## 2.1. Use of classic methods in cost management

Establishing a product cost requires knowledge of all costs associated with product development and manufacturing (eg, sales, supply, and administration). The ability to acquire this knowledge and estimate product costs accurately is essential for the survival of a business in the competitive market (Oprea & Cârstea, 2002).

Users of classical methods tend to orient themselves towards statistical figures, often statisticians towering to classic methods. The traditional cost accounting method refers to the allocation of general manufacturing costs to the products produced. The traditional method (*also known as the conventional method)* assigns or allocates indirect factory costs to manufactured items based on volume, such as the number of units produced, direct labor hours, or machine production hours (Oprea, 2001). The system used to check the expenses according to classic methods is not able to capture at the same time expenses and deviations determined through comparison between effective and final costs, this input comes very late and became useless for the management to balance the negative effect, only subsequent calculations can be used. The information received through classical methods does not allow each activity device, considered a single cost center, to clearly determine and objectively assess the results of the activity; implicitly, correct decisions and adequate measures will not be taken to make the work profitable and ultimately strengthen the budgetary objectives, to control deviations, to avoid and adjust errors. This is not only about deviations identified later, but about al deviations that lead to a drastic decrease in the value of information.

In our country, according to current legislations, cost calculations are done using the global methods, orders, sequences, direct cost or variables, or other methods by the companies (ex Minister Orders of Finance 1826/2003). Management accounting in any company is compulsory according to Accounting Law no 82/1991), what has stipulated in the accounting system in Romanian companies is composed of financial and management accounting.

### 2.1.1. Calculation of costs based on the global method

In any economy, by financial institution, we mean any institution that offers financial services to clients. Most of financial institutions are regulated by the government, hence the **usefulness of the global method**. The calculation considers all the other relevant elements, including the intangible and tangible advantages of a universal service provider, as well as the need for reasonable profit and cost efficiency incentives (for example: postal services, utilities, etc.).

It is important to avoid double accounting of the net cost calculation and, right from the receipt of the documentation, to review what common costs are. For this, the "Global Approach" is used (the terms systemic approach or **fully integrated approach** are also used), which provides coherent estimates of net costs, including clear knowledge of the common structure of the many existing tasks in a subcontract. The trade-offs between the obligations must be made as transparently as possible, through a global approach (so not separate), so that the decision-makers perceive the common impact and the net costs of the obligations (*Koller, Trinkner, 2009).*

### 2.1.2. Steps used to calculate

***The calculation of costs based on the global method (2.1.2.)*** starts from the principle that the majority of financial institutions are regulated by the government and takes into account all the other relevant elements, including the intangible advantages and those of a company providing a service. , as well as the right to a reasonable profit and cost efficiency incentive (example: postal services, utilities, etc.). *The "global approach" (systemic / fully integrated approach*) provides consistent estimates of net costs, including clear knowledge of the common impact of the many existing tasks in the company. The trade-offs between the bonds must be made as transparently as possible, through a global (so not separate) approach, so that the decision-makers perceive the common impact and net costs of the bonds.

Companies that use a standardized production process to produce a homogeneous and undifferentiated product use the ***process costing method***. Costing systems are designed to measure the cost of converting raw materials into a finished product as the product passes through each successive stage, in a predetermined period. Conversion costs are allocated to products, each time they go through a new successive stage of the process, the cascade allocation having as its objective the efficiency of the entire process. The costing system accumulates the costs in the process or through disassembly and assigns them to similar products that require the same services /processes. Companies that use a standardized production process to produce a homogeneous and undifferentiated product use the process costing method. The cost calculation systems are designed in such a way as to measure the cost of the conversion of raw materials into a finished product as the product passes through each successive age, in a predetermined period (Epuran, Băbiţă, Grosu, 1999). Conversion costs are allocated to products, each time they go through a new successive stage of the process, the cascade allocation having as its objective the efficiency of the entire process.

This way we can establish the cost reduction and we can assign the cost objective through 2 steps: *In the first step*: we analyze the database used to allocate overhead costs to production centers and services or tools and to establish total overhead costs. The second step involves the allocation of resources to strategic objectives. The correct system for calculating costs is different from one organization to another and should be determined based on costs and benefits (Sârbu, 2008). Simple costing systems are suitable for organizations whose indirect costs represent a small percentage of total costs and which have a range of standardized products, all consuming organizational resources in similar ways. In these conditions, simplistic costing systems rarely reduce costs enough to make decisions.

Enterprises that present a standardized production process within a homogeneous and undifferentiated product use the method of process costs through the following steps:

**Step 1 -** analysis of the cost of new buildings, labor, and other associated costs.
**Step 2 -** calculation of the potential benefit of the proposed solution, the advantages of routing include factors such as increasing productivity, simplifying work, reducing costs, and improving customer satisfaction. The benefit must be calculated over the entire life cycle of the product.

**Step 3 -** the analysis of the net profit, equal to the difference between the estimated and the stated profit. The method also known as the percentage-of-completion method, being similar to the way in which revenues are recognized from service contracts (Olariu, 1971).
**Step 4 -** reallocation of the costs that have been assigned to the service and production cost centers.

### 2.1.3. Calculation costs based on the order cost method

**The calculation of costs based on the order cost method (2.1.3.)** is based on the classification of costs and revenues according to their relevance to a certain decision. The unit cost is derived from the fixed and variable costs of a production process, divided by the number of units produced. To make decisions, costs and revenues should be classified according to their relevance to a certain decision. The **relevant** costs and revenues represent those future costs and revenues that will be modified by the decision, whereas the **irrelevant** costs and revenues are those that will not be affected by the decision. Fixed costs, such as rents in buildings, generally remain unchanged regardless of the number of units produced and even if this increases because of the need for additional demand (capacities) (Malciu, 2002).

**Order method**: The summation of direct and indirect costs is given by the relationship (4)

$$Ct = \sum_{d=1}^{K} Ch_{Dd} + \sum_{i=1}^{I} Ch_{Ii} \qquad (4)$$ where:

d - is the calculation item in the direct expenses
i - is the calculation item for indirect expenses
*hence the unit cost is not constant.*

### 2.1.4. Advantages and disadvantages of using the classical methods

By using the **classic method of standard direct cost calculation (2.1.4.),** the aim is, first, to calculate and analyze the total yield of the company. For each product, the contribution to the gross profit is calculated to find out to what extent the variable costs generated by production and sales have been adjusted and what contribution the adjustment of fixed costs brings to obtain a profit.

The advantages of the classical (standard) calculation methods consist in a simple way of calculation and long-term decision-making is supported, being a robust method of analysis and prognosis of the products manufactured by the company. **The disadvantages** of classical (standard) calculation methods come with the emergence of difficulties in establishing deviations from the standard cost, the method not allowing the correct calculation of fixed costs.

## 2.2. New methods in the cost calculation field

In subsection 2.2. some modern methods of estimating production costs are described, together with numerous practical examples and the opportunity to use them in different fields.

**The evolved methods of management accounting** were developed to eliminate the disadvantages of classical methods, being adapted to the new market conditions, providing much more useful information with reference to costs, so that the manager can take the optimal strategic decisions.

**The cost evaluation method PERT** (Program Evaluation and Review Technique) allows the accurate establishment of technological connections between activities, creates the possibility to permanently control the manufacturing process and standardize the cost of the scientific work involved, but it has a lot of scientific work involved

***Georges Perrin* 's method** creates the possibility to calculate the cost of the product unit and allows the realization of a strict analysis to ensure the control of the company's activity more accurately. But also, this method it requires a large amount of work, but is compromised by the use of the history of calculated periods (5-6 years).

**Conclusion:** the evolved methods used in management accounting have a series of advantages related to better analysis, control and forecasting of costs, but the main disadvantage is related to the large volume of work required to implement this act.

### 2.2.1. GP (Gross Profit) method

***Methode GP (Gross Profit)***

it is used when it is aimed to determine the cost of goods in stock in the conditions in which the company presents a value at a certain date and makes significant adjustments through reallocations to the annual physical inventory, to verify whether the rationed cost of the verifier is reasonable. In accounting, gross profit, gross margin, profit on sales, or credit sales represents the difference between revenue and the cost of making a product or providing a service, before deducting overhead, wages, salaries, and interest. This is different from operating profit (earnings before interest and taxes). *The gross profit method* provides a value estimate of the inventory, its usefulness depending on the accuracy of the profit rate, it is used for internal use, to analyze the interim financial statements and to establish the value of the registrant's debts (including those caused by the destruction of force majeure - fires, floods, or other catastrophes). The method is addressed to a company that perfectly knows its net sales, the cost of the goods available for sale and the profit, and subsequently to evaluate its gross profit for the desired period.

The gross profit method is as follows:

**Step 1**. It determines the merchandise that can be sold and its cost.

**Step 2**. The estimated gross profit is obtained by multiplying the net amount by the gross profit rate.

**Step 3**. Determines the estimated cost of goods sold by deducting the estimated gross profit from net sales

**Step 4**. Estimation of the final cost of the inventory, by deducting the estimated cost from the sale of stocks that cannot be divided into merchandise (Blackstone et al., 1893).

The gross profit method uses the available information from previous accounting periods and applies it to the current period. It is calculated by estimating the cost-to-retail ratio. The items in the ending inventory are measured in the same way as the separable goods for sale, and the ending inventory is combined from the different classes of goods. Costs will be worked out within the retail trade for each class of inventory (Thrun, 2003). Another advantage of the gross profit method is that it provides inventory values for preparing monthly statements and balances.

The deduction differences and their corresponding values resulting from net sales to net income are as follows: Net sales = gross sales – customer discounts + profitability + ratio (5)

Gross profit = net sales – cost of goods sold (6)

Net profit = operational profit - profit - interest (7)

$$\text{Net profit percentage } (\%) = \frac{\text{net sales} - \text{ goods sold}}{\text{net sales}} \cdot 100 \ (8)$$

The cost of goods sold is calculated differently in a merchandising business compared to a specific production one (Smith & De Swardt, 1967).

### 2.2.2. Normative Methode

**Normative Methode** it differs from other methods that use effective cost management, by establishing the normative cost for the transfer of products from one process to another. The normative cost method is based either on the absorption cost or the marginal cost and presents the following advantages: the transfer network does not hide inefficiencies, respectively the variation analysis can be used to control the real reformation. The distinction between the positive economy and the normative economy is straightforward, but it is not always easy to tell the difference between the two.

*Normative economics* is a branch of economics that expresses the value or normative judgment of economic correctness or what should be the result of the economy or the objectives of public policy. A clear understanding of the difference between positive and normative economics should lead to the development of better politics, if politics were based on virtue *(positive economics)*, not on goals *(normative economics)*. In addition, many policies dealing with issues ranging from international trade to welfare draw heavily on normative economics (Mongin, 2002).

### 2.2.3. Tariff – hour – machine (T.H.M.)

A very used method of determining a specific machine cost is to use the machine costing spreadsheet. This method is very useful for estimating the approximate hourly costs of a machine or for comparing the costs between two of them. The spreadsheet requires the input of machine cost base values that it uses to determine the fixed operational cost, operating cost, and labor cost associated with the machine. **The concept of productive time** (including time for break) was first used only in the processing industry, being then extended to other productive industrial fields. This concept can be used to calculate the duration from the start to the completion of a task, including the recovery hours required after intense physical work, as well as the required legally regulated times or those intended for other human interactions.

In comparison, the advantage of **concept human-hour** is that it can be used to estimate the effect of human changes on the time required for a task. This is done by dividing the number of working hours by the number of used workers. By combining information about system, environment, terrain, productivity, and cost information from numerous studies, it is possible to create a more complex input of available datas.

**The time-machine concept** can be grouped into a variety of distinct categories: planned schedule, non-functional schedule, etc. The productivity of the machine represents the time in which the machine is working effectively, and which excludes the time caused by delays of various types. Productive machine hours are obtained by the difference between operating hours, mechanical and non-mechanical delays. The calculation of THM contributes to the estimation of the productivity within the production rate of automobile components. The cost of the system and the estimated productivity will provide the production rate of the components, modules, subassemblies, etc. *The advantage* is that the THM method is "very" transparent, being easy to follow which values have been entered in the spreadsheet, making it possible to work in the team. *The downside* is that all values are just estimates. This is, in general, the case of repairs or orders made by expensive, automatic, or semi-automatic machines. When the human factor intervenes, it is more difficult to regulate the quality or quantity of their production. In such cases, **the hourly rate method** of the machines can be derived from the correct allocation of the general production costs to its different elements. To calculate the hour/ rate, the general expenses will be divided by the hourly operating hours of the car or the car fleet. In this method, manufacturing overhead is calculated based on the number of hours a machine or group of machines is used for work orders received. The similarity between the "machine hours" and "human hours" methods is that both are based on the time factor.

If the machine is the primary factor of production, the **Machine Hourly Rate Method** is the best method of estimating machinery operating costs. When the machine is idle, another cost is involved, called the "absorption cost". Otherwise, the hourly machine rate is usually a fixed rate. The individual rate for each machine may be calculated or, in the case of a series of similar machines working in a tandem, there may be a single rate for the entire group of machines. It is obvious that within a whole equipment, in addition to the costs mentioned above, there are other production costs found in maintenance, cleaning, lighting, rents, utilities, storage fees, consumables and shop, tool shops. and devices, maintenance etc. and which, therefore, are not required in any car or group of machines. In order not to leave out of the production costs such expenses, before calculating the rate of machine hours, an amount proportional to the expenses mentioned above should be included in it. To obtain the overall hourly machine work rate, some companies also include the wages paid to the machine operator, but it is still recommended that the operator's salary be included in direct wages.

### 2.2.4. Direct cost method

**The direct costing method** is used to extract relevant information from a variety of sources and collect information to make the best tactical decisions.

**The direct cost** is an excellent analytical tool for creating a model based on which only certain management activities will be performed, but it does not strengthen the role of a standard costing system that contributes to the current changes in the accounting records. Direct costing is particularly useful for short-term decisions, but it is more useful in the longer term, especially in situations where a company needs to generate enough margin to make massive expenditures. If the fixed cost changes significantly or if the indirect costs are too important for the managerial decision, then the information on the direct costs will not be sufficient, because they cannot be identified in a specific way to a product, nor can they be allocated to one equipment or another cost object. Direct costs can be related to labor, material, energy consumption and are directly attributable to the object. Usually only one cost object benefits from direct expenses. The calculation methodology consists in separating the following calculation terms:

- Variable cost elements refer to the product (the amount that defines the direct cost of the product).
- Fixed cost (production, administration, and sales) for a certain period (usually 1 year).
- The contribution per unit is defined as the difference between the net sales of a unit of product and the direct cost of a unit of the restricted product.
- Total contribution is defined within a certain period (usually annually) by: "Unit contribution" multiplied by "number of products sold" (Weber, 1966).

In the most advanced version of calculating direct costs, a distinction is made between fixed costs: thus, the direct fixed cost must be attributed to the cost of products, but the indirect fixed rates are considered at the global level. We seek from similitude what we obtain the precision.

**The traditional method** is based on the idea that all costs (fixed and variable) must be taken into account and integrated into a complex distribution mechanism, a fact that will have a double consequence: • the implementation of complicated processing procedures and re-classification calculations (or distribution sections), respectively • the cost indicators are only valid if the assumptions made in the initial cost estimate are in accordance with the subsequent realizations - very impossible in practice. In companies with a varied range of products, direct cost is a very useful tool for a good choice of the product range as well as for the motivation of operational rents, giving them a simple and individualized representation of their reforms (Garrett, 2008).

### 2.2.5. Value analyses

**Value analyses**

It involves a creative approach to finding and eliminating unnecessary costs in a product or service that are not necessary, do not improve its quality or efficiency, do not give it a better look, do not extend its life, or provide extra satisfaction the client. Value analysis is a methodical approach to assessing the efficiency and effectiveness of any process. Value analysis is the practice of breaking down a process into each individual component and considering ways to improve the value of that component as measured by cost and importance within the process. Value analysis is a creative approach to finding and eliminating unnecessary costs in a product or service that are not necessary, do not improve its quality or efficiency, do not give it better security, do not extend its life, or provide additional customer satisfaction. A properly implemented and adjusted value analysis allows the identification of items that are not worth the cost and that should be eliminated or replaced with alternatives. In this way, the process within the analyzed product or service is more refined, it is done with less expense. This becomes especially beneficial when a process has been done in the same way for a long period of time. The technique of systematically identifying wasteful costs and exploring improvement improvement channels was originally used in the field of engineering (which gave it the **name value engineering**) and later spread to other fields such as marketing, financing etc.

### 2.2.6. Standard cost method

***The method*** *of establishing* **"standard-cost"** is suitable if standard costs are relevant and is based on a standard net within a specified period, which is fixed within each class of goods. The difference between the actual cost and the standard cost is transferred to the purchase cost variance and highlights how much the actual cost differs from the standard cost in the catalog. This method is easy to use and provides stability in the cost calculation system.

The method helps to know the efficiency of acquisitions. If the actual total cost is lower than the standard net, there will be a favorable buying opportunity, and vice versa. The value of the stock does not necessarily have to show the real cost and must strictly respect the ascertainable criteria for stock valuation.

Other advantages:

- The starting cost approach compares current income with current cost and, therefore, is useful for the correct and precise measurement of a company's operational results.

- Using replacement cost highlights the difference between retained earnings and exploited earnings, and accountants will better understand the financial situation. If replacement costing is not used, the profit resulting from the exploitation of materials and inventory is wasted and therefore affects a firm's bottom line.

- If the departure price is used, it will reveal the efficiency of the company's Procurement department.

- The replacement cost approach helps establish a sales cost within the product that is commercial and realistic.

- If material stocks have decreased, the materials should be invoiced at the current replacement stock, and the resulting loss should be considered in the company's accounts (Cheatham & Cheathamo, 1993).

In a total costing system, the costs of the reported products will reflect the total cost of production. In a variable cost system, fixed costs are not allocated and the reduced costs will reflect the marginal cost of the firm (Bruns, et al., 2007). The marginal cost formula helps to calculate the amount of increase or decrease in the company's total cost of production during the period under review if there is a change in output by one additional unit and is calculated by dividing the change in costs by the change in quantity. Marginal cost is the change in total cost of production to a change in output, which is the change in quantity produced. Mathematically, it is expressed as a derivative of total cost with respect to quantity:

**Marginal Cost = Change in Total Cost / Change in Quantity (9)**

One of the economic theories emphasized the fact that these variable costs are more relevant in decisions about the product. Using increasingly complex models, it has been shown that setting marginal revenue equal to marginal cost will yield the highest profit. In practice, however, accountants continue to underestimate the company's total costs (Bruns, et al., 2007). The definition of the variable cost that is used in theory assumes that the decisions to be made have a time horizon limited to a month or a quarter. A cost is considered variable if it changes directly with the production volume (monthly or quarterly) and there is no other way to change the level of fixed costs simultaneously. An analysis carried out by Asiedu and Gu (1998) describes "Curba Freiman" from (Daschbach and Argar, 1988) presented in *Chart no. 1*, to emphasize the consequences of an underestimation or overestimation of costs.

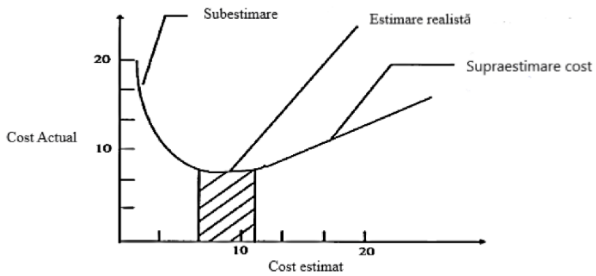



**Chart no. 1. Made by Author according to the Freiman curve**

**Chart no. 1** highlights the following:

1 Underestimation and overestimation lead to a lower real cost.

2. The realistic estimation area includes the most correct estimated cost of the project.

The traditional method of determining costs, including the global method used in determining and calculating costs, does not meet the current requirements aimed at the realization of a modern management and which implies the adherence and reference of such a method. Another disadvantage of the classic (traditional) methods is the large volume of labor, because it involves the realization of two series of calculations regarding the production cost: initially calculation and historical cost. Initial estimation are done before the production process start, with planning the budget, expenses at the unit level as well as with the budget for the unit cost of the product, in accordance with the resource to be obtained in accordance with the regulations in force and with the laws regarding consumption.

## 2.3. Method (Activity Based Costing)

An activity-based accounting system focuses on improving the efficiency of processes and activities. Measuring the effects of changes in activity efficiency can be an essential art of an activity-based management system. Following the analysis of the productivity of an activity, it is directly measured in which way the productivity changes using that activity. Similarly, the productivity of an entire process can be measured. Processes are collections of activities that have a common score, changes in the productivity of an activity must influence the productivity of the process.

We can show a series ot accounting techniques and an indicator for financial status used to support the strategic development of the companies.

Profit follow up, competition evaluation based on published financial statements, life cycle cost calculation, cost calculation, strategic cost calculation (Mancini, Vaassen, Dameri, 2013). In a business organization, **activity-based costing (ABC)** is a method of assigning the costs of resources in activities to the products and services provided to its customers. It is defined as a technique of assigning costs to cost units based on the benefits obtained from indirect activities, e.g., ordering, configuration, quality assurance. It relies on the management's focus on the total cost of producing a product or service, as a basis for full cost recovery. Activities within an organization can be classified as value-added activities and non-value-added activities. Value-added activities performed inefficiently cause excess costs and must be improved or eliminated altogether.

**Resource**: Economic element that is needed, used/used, consumed in carrying out the activities or that is the object of the costs. **A cost driver** is a factor that causes or refers to a change in the cost of an activity. The quantified sums of the costs are an excellent basis for allocating resource costs to activities and for allocating the cost of activities to the cost object. A cost driver is either a resource consumption driver or an activity consumption driver. Activity-based costing is a new practical managerial system of budgeting, costing, and accounting, providing the causal relationship between the activities that consume the company's resources and their results. The central idea behind the ABC analysis is that activities are the cause of costs, not individual results. By applying the ABC method, the management team could understand the organization's activity in the processes that take place within it and how these processes (or activities) are managed. Computerized support services are particularly suited to the activity-based method because they produce identifiable and measurable units of production. Activity-based costing encourages managers to identify value-added activities—those in which a mission is optimally accomplished, a service is provided, or a customer's request is satisfied. ABC improves operational efficiency and decision making with better and more relevant cost information.

ABC is used primarily to support strategic decisions such as networking, outsourcing, identifying, and measuring process improvement initiatives. The cost calculation based on the ABC method was developed to allocate the indirect general costs (or transactions) in the smaller parts in the price of the products made. In the requirements of the ABC method, the activities determine the general costs, constituting a more solid basis for cost allocation than the classical methods. Of course, ABC is not the solution to all overhead cost concerns, but it is a tool worthy of consideration in management decisions. ABC suffered in many countries due to poor implementation, and the success of the method was not universal. This knowledge of the underlying cost (and associated costs) provided by the ABC was previously hidden in accounts under a variety of headings and was conveniently ignored, ways of tracking down the actual cost of the cost they were hiding. This leads to activity-based management (ABM) in which information from the ABC process is used to influence company performance improvement activities. ABM is the truly useful outcome of ABC and allows us to focus on ensuring cost reductions as the process continues at TDABC.

**The advantages of the ABC method**: • More accurate than the other described methods • increased transparency, possibility of standardization and teamwork • A better understanding of the way of spending • a better management of activities • the company can identify at any time the resources used for different product lines and implicitly will not erroneously allocate additional resources and costs to those lines.

**Disadvantages**: • More expensive to implement • Data maintenance is time and effort consuming.

### 2.3.1. Product cost evaluations in the stages of ABC method

There are companies that offer complex and intense customer support (such as those active in the wind industry), and the appearance of "demanding" customers attracts a bushy chain of additional activities, reflected in the final cost of the product. (Ballings et al. 2018). The software associated with the ABC method reallocates in an optimized final form the expenditure of resources in relation to customers, products, distribution channels and the way they derive in the form of "cause-effect". The correct identification of expenses supports the improvement of managerial decisions on critical areas.

In figure no. 8 presents the *ABC/M-Activity Based Costing* / management method – The method based on the calculation of activities/their management (the cost distribution network in the final product). The cost assignment network resulting from modules linked together by the cost distribution module is highlighted. ABC software can automate cost traceability from source to destination (final product).

The development of a correct architecture of the ABC method is the basis of a performing calculation method in decision making. Both ABC accounts and traditional accounts allocate in the latter accounts the same existing accounts, but through different mathematical methods.

Therefore, the transition to ABC is usually determined by the need to better understand the "real costs" of individual products and services. Companies implement activity-based costing for:

- Identification of individual products that are not profitable.
- Improving the efficiency of the production process
- Establishing the cost level in a consistent way

with the help of correct information about the cost of the products.

- Finding unnecessary costs that should be eliminated

Organizations that use ABC consistently to achieve this activity-based ABC/M tactic goal. Activity-based costing (ABC) is a method of assigning costs to products, service projects, tasks or acquisitions based on the component activities and the resources consumed by each individual activity.

The ABC method allocates manufacturing overhead costs in a more logical manner than the traditional machine-hours approach, allocating costs first to the activities that determine the overheads and only then to the activities that make the products.

**Estimating the cost of the product is considered as part of a strategic system of production planning and control.**

## ABC/M Cost allocation network

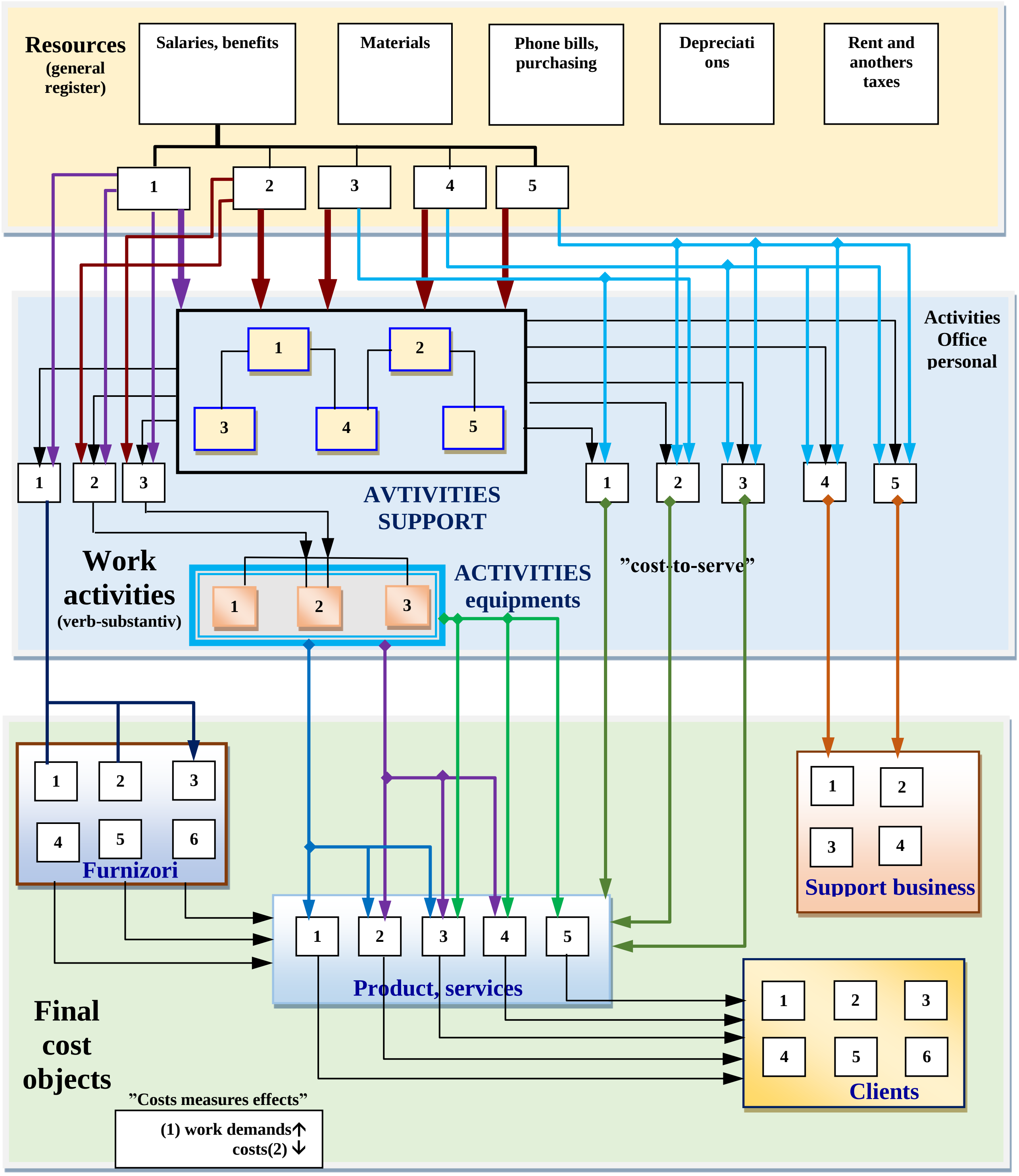



**Figure no. 8. The ABC/M-Activity Based Costing / management method – The method based on the calculation of activities / their management (the distribution network of the cost in the final product). Source: 6.2. Dissemination of results (*from this paper*) - DisRez 5**

# CHAPTER 3.
# Establishing costs with the help of information systems

Important aspects analyzed on all services and products that enter a value chain is based on what companies consider to be the most essential problems that they must solve: poverty and investments, the labor market, customs duties associated with commercialization, as well as problems related to redesign. For effective supplier selection, companies must have complete information about suppliers: list of available items - price, deliveries, reject rate and quality classification of goods or services, traditional purchase criteria (inputs) and output criteria (outputs), strategic and operational factors, transportation costs and on-time delivery. Among the models proposed in the specialized literature are fuzzy technologies.

Also, supplier management programs have placed a new emphasis on using *best value*, which means using broader criteria than lowest price to select contractors. Best value includes criteria such as quality and a firm's performance on previous contracts.

Within the presentation ***of new technologies*** **in cost estimation (3.1)**, the Concept of *Digital Twins (3.1.1.)* and *Innovation in artificial intelligence, standardization, software applications (3.1.2.) are analyzed in detail.*

In **Analyzing the term information and expert systems (3.2.)** the main notions of *information systems (3.2.1), expert systems (3.2.2.) and the main principles of cost estimation (3.2.3)* are given. In subsection 3.3. the main ***Notions and characteristics of the cost information system*** are reviewed and in 3.4. the ***Connection between financial accounting, management accounting*** **and company management costs** is highlighted, creating a parallel between *Financial Accounting and management accounting* (3.4.1.) and *Cost Accounting* (3.4.2.) is also addressed in this context.

## 3.1. Introduction of new technologies in cost estimation

### 3.1.1. The concept of digital twins (Digital Twins)

Prices are determined by the introduction of new technologies. Product engineers have long understood that CAD product models represent the physical product in the virtual world. It authorizes the form and function of virtual models, simulates and analyzes their transformations in a virtual environment, and plans and replicates their manufacturing processes in a virtual factory. This virtual/real concept has now progressed to a more intense digital twin concept. Siemens defines digital twins as a digital way that accurately represents a product, a manufacturing process, or a replacement of a product or manufacturing system in operation. A product's Digital Twins evolve and update continuously to reflect any change in its physical correspondence throughout the product's life cycle. **The term "digital twins"** is applied to industrial manufacturing and is a concept that combines artificial intelligence, computer learning and data-driven software to create real, viable digital models.

The terms of “digital twins" are constantly updated following the evolution of the physical prototypes and cover three requirements: 1) to match the appearance of the original object; 2) similar behavior of twins during testing; 3) information obtained from artificial intelligence to cover the "real advantages" of a real product.

Digital twins are a hybrid model (both physical and digital) created specifically for specific business purposes such as predicting failures, reducing maintenance costs, preventing unplanned outages. "Digital twins" and "integrated value networks" are two ongoing developments that will strengthen the requirements of technical feasibility, capability, and business viability. By simulating with the help of the digital model, the real model is provided with portability, accessibility, scalability of storage, without the need for investments in fixed assets. The **CIM** (*Computer Integrated Manufactury)* software solution provided by Siemens or Bentley Systems brings corrections to the feed back loop in any country where financial or manufacturing problems are detected. Product developers will benefit from the advantages of the Siemens and Bentley Systems partnership, focusing only on the "orchestration" of monitoring, design, and product manufacturing, modeled in the Siemens CAD solution.

"MindSphere" is a new Siemens application that facilitates the monitoring of machine tools on a global level, in smaller or larger production sites. Using these solutions, a manufacturing company can analyze large volumes of data from intelligence devices, yet from the project stage. In essence, the software solution is capable of not only monitoring the problem, but also solving it through a feedback loop in PLM (Product Lifecycle Management). The application demonstrates that in smart factory an existing or even future problem is/will be identified for the first time in the book of diagnostic information in real time or even before its appearance, and by resuming actions based on the knowledge gained from the **digital twin** reformation.

The combined Siemens-Bentley software solution optimizes knowledge-based product and facility management using **digital twin** technology. *CIM Data* Siemens-Bentley shows effectiveness of the digital twin solution and encourages them to continue the evolution of the concept to provide better quality and cost reduction to the users.

#### 3.1.2. Innovation in artificial intelligence, standardization, software applications

*The cloud* enables big-data analysis among small and medium-sized manufacturers, with minimal material efforts. As a result, both manufacturing data and their storage and analysis capabilities are increasing in scale, and information of the costs becomes more accessible. Meanwhile, the qualities of new technologies are growing rapidly, especially in the IT field. For example, innovation in artificial intelligence has rarely accelerated the evolution of computer cost estimation methods.

**Innovation in artificial intelligence, standardization, software applications**.

Innovation in artificial intelligence has accelerated the advancing of computer cost estimation methods. *Integrated software-hardware solutions, increasing the degree of interoperability open the way to innovation,* aiming at the exchange of data between different technologies. Standardization is a significant challenge of Industry 4.0 and standards play a key role in the rate of adoption of technology to enable intelligently connected products, machines, and goods to interact in a transparent way. This abandons the simple protocols of communication and involves the creation of semantics and standard mechanisms to allow intelligent speakers to "reinvent" and connect. For example, the OPC UA *(Open Platform Communications - Unified Architecture)* platform remains compatible with previous "classic" OPC devices.

### 3.2. Analyzing the information term and expert system

*Economics information* is a branch of microeconomic theory that studies how information systems influence the economy and economic decisions. Information has special characteristics. They are easy to create, but complex to manage. Information is easy to distribute but difficult to control and influences many decisions. These special characteristics (compared to other types of goods) complicate many standard economic theories. Given that the study of information systems belongs to an application domain, industry practitioners expect information systems research to generate immediately applicable solutions in practice, which is extremely difficult because information systems designers examine behavioral problems much more deeply than users expect (Ferrag & Ahmim, 2010), understanding the results of information systems research remains difficult and leads to criticism.

**3.2.1. Information system** is helping with specific reference to information and the complementary networks of hardware and software that people and organizations use to collect, store, filter, process, create and distribute data (Glanville, 2007), with particular emphasis on on hierarchy, protocols, access limits, users, processors, inputs, outputs and communication networks.

**Information systems (IS)** differs from information technology (IT) in that the former present an information technology component that interacts with all process components. Information systems interconnect with data systems, on the one hand, and activity systems, on the other, and can be considered as a semi-formal language that supports human decision-making and actions.

Information systems are the main focus of study for organizational informatics. Each department or functional area in an organization has its own collection of application programs or computer systems. These *Functional Area Information Systems (FAIS)* support the pillars for the overall IT system, namely business information subsystems and dashboards. The four IS components (hardware, software, database and network) come together in an IT platform (Liebowitz, 1988), which oversees security measures, risks and data management. These actions are known as *information technology services.*

### 3.2.2. Expert system

**The expert system** can be defined as a computer system (hardware and software) that simulates human activities, in a certain area of specialization, with decisions made by means of artificial intelligence. Today, a global information infrastructure connects users around the world on a large scale, relying on application-level protocols and services, such as new business management technologies such as cloud computing and virtualization. The problems that expert systems can face can be classified as follows: *mainly deterministic aspects* and *stochastic* problems.

### 3.2.3. Cost estimation

The cost value theory illustrated in figure no. 9 states that the price of an object is determined by the sum of the cost of the resources that led to its realization. The cost can include any of the factors of production: labor, capital, land. Production technology can be viewed as either a form of fixed capital or circulating capital (eg intermediate goods).

***Cost Estimation*** (3.2.3.) is usually carried out by experienced engineers and technical cost specialists and focuses mainly on improving techniques and methodologies, analyzing requirements and corresponding data and information sources, all to simplify procedures. The Digital Enterprise Suite solution enables manufacturing companies to optimize and digitize their entire business process. They can start at any point in their value chain: from product design to production planning and from production engineering to production execution and finally to service. Achieving the desired profit margin for each product to be sold is determined by pricing appropriately for the market and is largely dependent on knowing the product's costs. With *TeamCenter Product Cost Management* (TCPCM) software, a cost strategy can be implemented, from procurement to series production, integrated into the calculation process and represented in a common global system landscape. For a strategic sourcing initiative to be successful, procurement professionals must expand their potential supplier base globally. It must evaluate the cost savings along with the level of quality and service provided by all potential suppliers.

### 3.3. Notions and characteristics of the cost information system

A ***cost information system*** is an organized system for collecting, filtering, organizing, storing, processing and distributing all cost information in the internal environment of a company. Many developers use a *System Development Life Cycle (**SDLC**)* approach, which is a systematic procedure for developing an information system through successive stages in order to optimize costs. The development of the cost information system is done in stages that include recognizing and specifying problems, gathering information, specifying requirements for the new system, designing the system, building the system, implementing the system, reviewing and maintaining it. Information management concerns the practical and theoretical issues of gathering and analyzing information in an area of business functions, including enterprise productivity tools, application programming and implementation, e-commerce, digital media production, data, and decision support. Communications and networking deals with telecommunication **(TC)** technologies.

### 3.4. The connection between financial accounting, management accounting, and company management costs

#### 3.4.1. Financial accounting and management accounting

***Financial accounting, management accounting and company management costs*** are strongly interconnected within any manufacturing organization. The data provided by Financial, and Cost Accounting are further used to manage all processes associated with the acquisition and efficient use of financial resources in the short, medium and long term. Such a management process is known as *Financial Management.* The objective of financial management is to maximize shareholder wealth by making the most efficient investment, financing and dividend decisions.

*Cost accounting* was developed due to the limitations of financial accounting from the perspective of management control and internal reporting. *Financial accounting* performs the function of presenting in a correct and fair global picture of the results or activities carried out by an enterprise during a period (through the profit and loss statement) and its financial position at the end of the year (through the balance sheet). Also, based on financial accounting, effective control can be exercised over the property and assets of the enterprise to ensure that they are not misused or misappropriated. In this sense, financial accounting helps to assess the overall progress of a concern, its strength and weaknesses by providing the figures relating to several previous years. Analyzing financial accounting and management accounting in parallel, the trend towards the unification of financial and management accounting as new practices is deduced.

Management accounting provides the data on the costs and valuations of the used stocks that will be found in the *financial reporting*, being subordinate to it. Financial accounting is mainly used by those outside the company or organization. Financial reports are usually created for a set period of time, are indicative and have predictive value for those who want to make financial decisions or invest in a company. Management accounting is the branch of accounting that deals mostly with confidential *financial reports* for the exclusive use only of the organization's top management. These reports are prepared using scientific and statistical methods to arrive at certain financial values, as support in decision-making, and includes sales forecast reports; budget analysis and comparative analysis; feasibility studies; mergers and consolidation reports. Management reports are generated whenever needed and have a forecast value for those within the company.

In *financial accounting*, cost categories are based on the type of activities (e.g., wages, repairs, insurance, stores, etc.), meet criteria based mainly on functions, activities, products, processes, and internal planning, on the information needs of the organization, etc. Financial accounting is concerned with the presentation of "true and fair data" of records, profit and loss for a period and statement of financial position (in the form of profit and loss account and balance sheet) at a particular date. Unlike *financial accounting*, management accounting uses not only accounting techniques, but also statistical and mathematical techniques, provides information to internal users, although the basic data comes from financial accounting and cost accounting systems. The objective of management accounts is to provide real-time financial and statistical information for managers to make optimal decisions. Management accounting analyzes different variables, explains the reasons for profit variations compared to the previous period, but does not establish a standard format for this information, it is only an orientation guide, useful for management in making various decisions regarding the business for automatizing the entry entry, the accounting management table in Excel format can be imported into an information system such as ***aPriori software*** and/or **TCPCM.**

In conclusion, *management accounting* aims at calculating the cost of goods in a scientific manner, facilitating control, and reducing costs. Financial accounting reports the results and position of businesses to the government, creditors, investors and external users.

### 3.4.2. Cost accounting

**Cost accounting system** can be used without management accounting, while management accounting cannot be installed without a proper cost accounting system. Cost accounting is based on its historical approach and projects past results. Management accounting is predictive compared to cost accounting. Cost accounting is concerned with short-term planning. The management accountant must have a clear idea of the elements and types of costs necessary to analyze and solve specific business problems and the effect of these costs on alternative solutions. The last and very important "dividend decision" concerns the determination of the amount and frequency of cash that can be paid out of profits to shareholders. Management accounting refers to managerial processes and technologies that focus on adding value to organizations by achieving efficient use of resources in dynamic and competitive contexts. Therefore, management accounting is a distinct form of resource management that facilitates "decision making" by management by producing information for the managers of an organization. Cost accounting was developed because of the limitations of financial accounting from the perspective of management control and internal reporting. Financial accounting performs the function of presenting a true and fair global picture of the results or activities carried out by an enterprise during a period (through the profit and loss statement) and its financial position at the end of the year (through the balance sheet). Also, based on financial accounting, effective control can be exercised over the property and assets of the enterprise to ensure that they are not misused or misappropriated. In this sense, financial accounting helps to assess the overall progress of a concern, its strength and weaknesses by providing the figures relating to several previous years.

# CHAPTER 4.
# Costs - component of the company's economic-financial diagnostic system

Without any doubt, *Costs* are a component of the *company's economic-financial diagnostic system* and are the central theme of chapter 4.

## 4.1. Examining the components of production cost

In subchapter 4.1. *Examining the components of production cost*, defined as fixed costs and variable costs and the main components of total production cost.

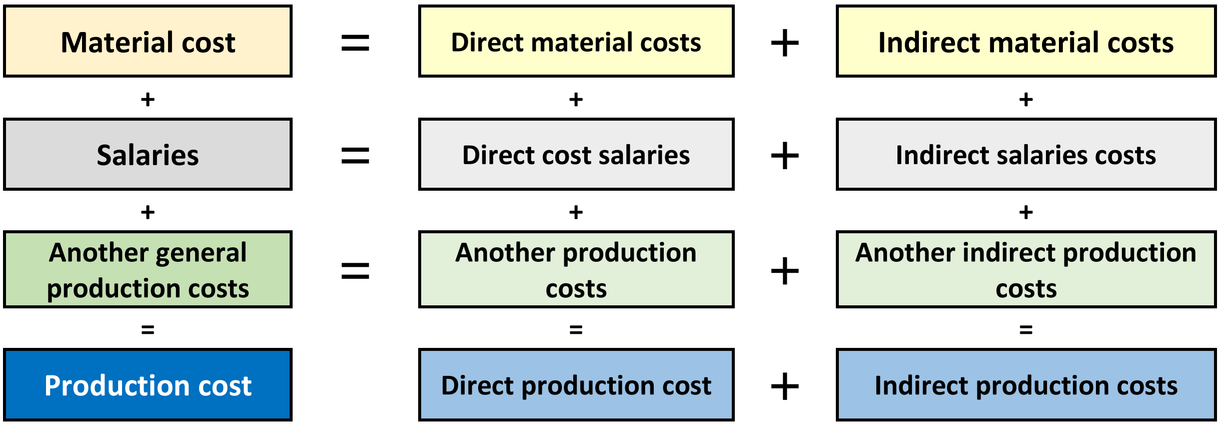



**Figure nr. 10. Cost component of the production costs**

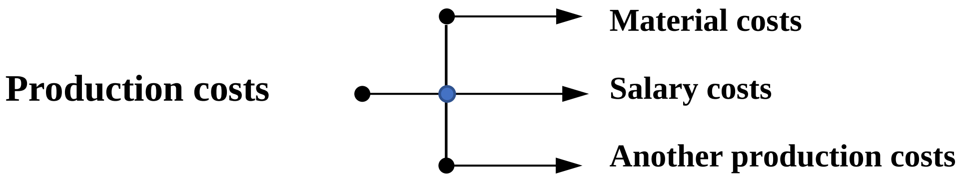



**Figure no. 11. Representation of production cost. Author processing after Managerial Accounting.**

**Source:**
**https://econ.ubbcluj.ro/documente2017/Contab%20Manageriala%20%20Suport%20de%20curs%20%20%20LICENTA%20CIG%202017.pdf**

The design stage is the first step in achieving the performance objectives and meeting the functional specifications associated with the technical aspects of the product design. From several options analyzed, the final design is accepted, the one that follows the concept of **LCOE** *(Life Cycle Cost and Energy Production)*. Many design decisions are made from the conceptual stage. Several models attempt to quantify the "manufacturability" of a design (the ability to manufacture a part with specific dimensional tolerances and deviations). To be competitive and profitable, a manufacturer must understand and control the three basic elements of manufacturing costs—direct materials, direct labor, and overhead. The first step in this effort is to conduct an operational assessment to identify strengths and weaknesses in the manufacturing process. All fixed and variable costs in the manufacturing process must be focused on reduction, elimination, modification, substitution, or innovation. It is recommended to check direct material purchases, freight, utilities, insurance, inventory carrying costs and other indirect manufacturing costs (Uddin, Shash, 2006).

## 4.2. Strategies for evaluating production costs

*The Chartered Institute of Accountants, London*, defines a **cost unit** *as "the unit of product or service against which costs are assessed".*

**Absorption costing** is a costing technique that includes all production costs in the form of direct materials, direct labor, and variable and fixed manufacturing overhead while determining the unit cost of a product. In the context of the cost of a salable good (product and/or service), *absorption costing* considers a portion of all costs incurred by a business for each of its goods. **The cost center** refers to one of the units conveniently chosen for costing, from the convenient division of the enterprise.

Each activity can be considered a separate cost center, and all costs related to a particular cost center can be identified separately. Although standards (procedures, rules, regulations) must be established for materials, labor, and overheads, only an **integrated approach** will bring the best results. The first step in developing a standard costing system is to establish a standard cost, that is, to predetermine standards for each cost element - direct material, direct labor, and overhead (Joseph, 1962).

***Production cost budget***: materials budget, (the time and amount of funds needed to make purchases are sized using the materials budget) + Labor budget (the monetary value of labor for each production job). Product costing practices interact with the benefits the product brings to the customer ***PSS (Product/Service-Systems).***

The limitations of this research are due to a non-statistical sampling, using online forms, significantly reducing the possibility to generalize the research results beyond the sample. This concept starts from the idea that a product always comes with a series of features that provide its user with a series of services or advantages (Setani, Tennent et al., 2015).

## 4.3. The importance of the economic-financial diagnosis of the enterprise

The financial diagnosis in the management of the enterprise is necessary to think ahead of time the necessary measures to prevent the negative effects of external and internal factors, to identify the causes that generate economic-financial problems of the activity of an enterprise and which must be quickly managed.

Diagnostic analysis is an organic part of strategic management. The management of the enterprise must adopt appropriate recovery strategies in a profitable situation, having objectives for each field of its activity. (Sutherland, 1999). The forecast of a company's progress cannot be made without knowing its current situation, which suggests the dependence of the application of valuation methods based on future cash flows or income specific to a pertinent diagnosis. The major objective of economic activity is profit and its measure is emphasized by ensuring the viability of the company and, most importantly, increasing the value of the enterprise. The activity of the diagnostic program has a complex character, including technical, commercial, organizational/management and financial aspects; it is recommended to create a recovery plan that contains measures for each area of activity (Crosby, 1979). The financial diagnosis can only offer a partial and specialized look at the financial situation and the company's performance, its approach being mainly aimed at studying the following: - the ability of an enterprise to support the level of immediate and short-term crediting, more specifically to avoid the risk of bankruptcy;

- the ability to perform sufficiently with the resources used for the development of the activity, i.e. exceeding the profitability threshold;
- the ability to refinance the activity, to have sufficient resources to face the financial risk (Maxim, 2004).

A company's strategy must be established to cope with all situations and scenarios, following a deep analysis of all the components that are in competition with the conduct of activities. An effective diagnosis requires passing through three interrelated stages, such as:

- identifying the dysfunctions that support the basis of the degradation process.
- establishing the necessary measures for their elimination.
- the adoption by the management of the necessary decisions for the application of the provided measures.

The indicators provided by the financial diagnosis are an essential tool for making financial or securities investment decisions, both for the company in question and for other investors on the money market; it also represents an evaluation diagnosis when contributes to the clarification of some elements necessary for establishing the value of a company, in the case of certain investment operations, consolidation or absorption, etc. The financial diagnosis could directly determine the value of the company's patrimony or could provide the necessary indicators to establish the value of the patrimonial results; it becomes *a crisis diagnosis*, when it intervenes to determine the difficulties of a company and aims to put it back in business (Nigam & Jain, 2017). In this case, the preliminary objective of the diagnosis is to determine whether a company can maintain or recover credit in the short term.

*The economic-financial analysis* can represent the first component of the overall diagnosis specific to a company, for example in terms of evaluating companies, business plans, etc.

*The financial profitability analysis* is the second part of the financial diagnosis and complements the economic-financial performance assessment indicators related to the enterprise, known as intermediate management assets or storage margins (Masaaki, 1997).

Liquidity analysis is the third component of the *financial diagnosis*. This analysis is carried out by means of the liquidity ratios used in business studies, carried out by commercial banks, on loan applicants. These ratios also indicate a qualitative content, as they capture synthetic aspects of money flows and economic activity, respectively. Their quality also consists in the possibility of characterizing the financial situation of the enterprise and, respectively, the financial balance, thus avoiding the risk of not paying current bonds or short-term debts. Carrying out the financial diagnosis will allow a good assessment of the economic situation and thus early recognition of critical points and can represent the starting point for obtaining a set of favorable measures and the realization of dynamic activities (Nigam & Jain, 2012). The diagnostic function is predominantly related to the conclusions of the economic and financial analysis, which summarizes the weak and strong points of the company's activity.

## 4.4. Procedures used in cost analysis

In this subchapter, the concepts of task, activity, process are defined.

*Task* is an elementary operation in the job description (Joseph, 2010). An activity is a set of tasks organized for a specific purpose that gives them coherence. The accounting activity tries to determine what each activity costs. The activities must be homogeneous and at the origin of the company's expenses.

*A process is composed of a series of activities that serve the same purpose* (internal or external, to the customer). A process covers, partially or fully, one or more functions of the company. Model-based activities are not fully reduced in the arbitrary allocation of indirect costs and can be very difficult to establish; however, ABC is a tool for analysis and reflection on the origins of costs (JawaharLal, 2010).

### 4.4.1. Direct material costs - structural analysis

Among the three cost elements, namely materials, labor and other expenses, materials account for 56-69% of the total product cost. Materials control is defined as "a systematic control over purchasing, storage and consumption of materials in order to maintain a regular and timely supply of them while avoiding excess stock". Costs of materials from different industries are exemplified: electrotechnics and electronics, shipbuilding industry, automobile industry (4.4.1.1.)

#### 4.4.1.1. Reflections on an example of material costs in the automotive industry

Steel materials represent 55% of the total weight of an average automobile. The use of plastics continues to expand in both interior and exterior automotive applications. In a recent "Plastics Automotive" report, Market Search, Inc., Toledo, OH, identified five areas where plastics suppliers will find strong opportunities over the next five years. A combination of steel and polymer can also be advantageous for automotive applications. From the design phase, it is recommended that the baseline scenario be analyzed and optimized before calculating the costs and benefits of the proposed project. Cost-benefit analysis is complex, time-consuming, and difficult to implement, especially when it comes to obtaining data on certain types of indicators; the constraints for obtaining good indicators become a particularly difficult problem for top management. Cost estimators may request a variety of information from the supplier, but validation of the information provided will only be done after careful verification.

Cost estimators were found to use resources to obtain two different types of information; cost information and information needed to deduct the cost.

#### 4.4.2. Salary expenses: analysis, control, and planning

In 4.4.2. payroll expenses are compared with income from a business. Payroll includes all labor costs - not just wages: the cost of bonuses, holiday pay plus facility maintenance costs (office space, utilities, cleaning, computers, etc.), the value of time lost because of using a user interface with which he is not familiar he is also familiar with the adaptation period in which some obvious sums are spent.

##### 4.4.2.1. Expenses of the workforce using the costing software

Managing the Expenses of the workforce using the costing software (4.4.2.1.) it is done according to a human resources management (HR) plan that includes: • The roles and responsibilities of the team members throughout the project; • Project organization charts; • Source of human resources (recommending agencies for employment); • Chronological planning of RU / skill sets; • The necessary training for the development of skills; • The way performance evaluations will be carried out; • Recognition and reward system.

Innovative software companies (names like Authoria, Docent, Saba, Softscape, SuccessFactors and others) have developed enterprise-class tools to automate staffing. These systems fell into the category of applicant tracking systems (ATS – Applicant Tracking System), performance management systems (PM) and learning management systems (LMS – *Learning Management System*). In those days, companies installed systems like PeopleSoft, SAP, others). Sophisticated LMSs allow managers to approve training, budgets, and calendars, calibrate and evaluate performance management. The self-service module allows employees to query their own performance measurement data and perform certain HR transactions through the system. Each employee's performance is then stored and can be accessed through the WorkDay module. The Employee Reassignment module is a recent additional functionality of HRMS. This module has the functions of transfer, promotion, payment review, re-designation, deposit, confirmation, change payment method and letter form.

##### 4.4.2.2. Computer process functions: cost software used

The human resource management function involves the recruitment, placement, evaluation, compensation, and development of an organization's employees (Kanter, 2000). To make a correct evaluation is critical element in strategic human capital management, which seeks to align HCM (Human Capital Management) more closely with the company's financial success. Beginning in the late 1990s, to make digital technology more accessible to small and remote teams, HR agencies began offering cloud-hosted *HR (Human Resources)* solutions. In the early 2000s, more and more systems handled specific tasks such as recruiting or benefits administration, including the best systems that replaced the one-size-fits-all ERP *(Enterprise Resource Planning*) + HR formula. Information systems and related software help companies to classify, arrange, systematize, and analyze information. The use of enterprise resource management systems (ERP), information management systems (MIS - *Management Information System)* and database systems allow companies to optimally manage business processes and functional areas, from an operational point of view. One of the primary goals of implementing large-scale IT systems, software, networks, and IT tools is to **achieve productivity** at all levels of an organization. Human resource information systems provide a means of acquiring, storing, analyzing and distributing information to various stakeholders. Software as a Service (SaaS) is a cloud-based software delivery model where the cloud service provider develops and maintains software for cloud applications, provides automatic software updates, and makes the software available to customers through the Internet, with pay-as-you-use. The public cloud provider manages all traditional hardware and software, including middleware, application software, and security. Thus, SaaS customers can massively reduce costs, deploy, scale and modernize business solutions faster than if they were maintaining systems and software on-premises, and predict total cost of ownership with greater accuracy.

### 4.5. Process allocation of indirect costs

#### 4.5.1. Cost allocation using IT

Cost allocation can be defined as a methodology whereby expenses (and burdens) that were not originally allocated or directly associated with a program activity (or with the results of operations) can be conveniently accumulated and distributed to those activities that benefited by the ABC method. The effective allocation of indirect costs is made based on actual costs incurred, through a fixed or calculated share of direct costs or only with standard cost allocations (Jorgensen, Emmitt, 2009). The fulfillment of four key imperatives defines a high-performance management: a) everything for the benefit of the client; b) the ability to react to changes and uncertainties; c) mobilization of resources and d) an internal environment conducive to face competition. Thus, the development of a collaborative strategy between departments aimed at the fulfillment of different steelmaking tasks (uncertain duration, information that varied dynamically, retrieved, and distributed to different process areas, etc.) led to the decision that the start of steel treatment operations be prior to downstream casting, through a standard operating procedure (SOP) (Matson et al., 1999). Prediction problems can be classified into two types: evolution and regression. Expert systems used in a classification problem estimate the result in one of several evolutionary or regressive categories. Data circulation algorithms were applied to the expert systems in the process of "self-learning", self-training, referring to rules taken from the examples of human operators. The impact of human-AI (artificial intelligence) collaboration is examined, by applying validation techniques and data extraction/processing to increase the performance of knowledge-based expert systems (data cross-validation techniques). Through an algorithm applied to the expert system, the scenarios in the training sample can be classified, after which the classification cost is estimated under a range of certainty factors and the most pessimistic result is determined. The effectiveness of the approach is evaluated by comparing the performance of the expert system with that of the original, primitive version. A receiver operating characteristic (ROC – Curve for expert system) Chart will be generated to visualize the performance of the expert system classifiers, adjusted using a series of decision thresholds. The evaluation provides promising results, expert system tuning results in significantly lower costs. Siemens **PTI-PSS®E** software package is widely recognized as the best performing and reliable expert system for analysis-planning-estimating-evaluation-stabilization. In addition to the standard models and analyzes provided directly by PSS®E, the user has the possibility to customize and develop the execution and results of the settings using the **Python** scripting language (*Machine Learning Tools)*. The dynamic simulation module of PSS®E is a versatile tool to investigate the system response to disturbances that cause large and sudden changes in the production system. It offers not only a vast library of tested models for modeling different types of equipment, but also the ability to create new user-defined models of any complexity. In using PSS®E, user models can be developed using a programming language or graphical construction mode (GMB) to develop and test control block diagrams and other compatible products. Accounting does not provide manufacturers with reliable information on costs, due to the inability to calculate the cost of intangible assets (trademarks, trademarks, licenses, concessions, exclusivity contracts, patents, etc.), inaccuracies in calculating expenses and failure to estimate life cycle costs of life.

### 4.5.2. aPriori costing software

*aPriori's cost expert* system allows designers to process a cost assessment of a model quickly and adequately without having extraordinary economic knowledge. Based on the knowledge of the input information, the processing rate of the economic evaluation depends only on the time required to set the input data. The system is designed as a macro file (file with "xls" extension). The reason for integrating Microsoft Excel into the expert system environment is the advantage of extending the capabilities of an already known application with a broad user base. The program belongs to the class of software known as expert systems, because it is able to select and apply an appropriate method of evaluating economic investments, allowing inexperienced users to work with it. In the aPriori software, calculating the total cost involves selecting values associated with each editable cost component. If we tick a certain checkbox, the corresponding cost value opens for editing. We can replace one or more values. Target costing is a technique that determines the price of an ideal product to maximize profit over the entire product life cycle. The ABC method is applied to products already in production. The design phase of a new product governs most of its life cycle costs. The mature phase refers to the period when the product is on the market and has maximum potential.

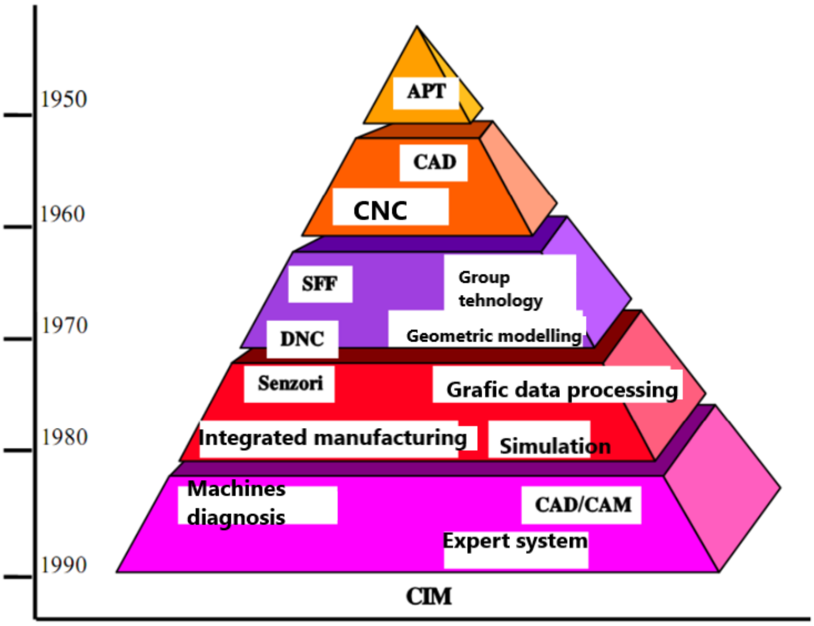
## 4.6. General considerations on systems integrated into production

In the market economy, economic evaluation provides the fundamental arguments for decisions to take an action

### 4.6.1. Types of integrated systems

The three major challenges for developing an integrated manufacturing system are the following:

• Integrating components from different suppliers; • Integrity of the data used; • Process control. As a manufacturing method, three components differentiate CIM (*Computer-Integrated Manufacturing - Integrated Production System*) from other manufacturing methodologies: a) techniques of of data storage, retrieval, manipulation, and presentation; b) mechanisms for detecting shutdowns, malfunctions and deviations from the normal state; c) algorithms for correlating the data processing component with the detection sensor.




**Structura Figure no. 12. The structure of the integrated production**

Source: http://cadredidactice.ub.ro/crinelraveica/files/2011/10/msptf.pdf

The term CIM is both a manufacturing method and a computerized system in which the production, marketing and support functions of a manufacturing enterprise are organized together. In a CIM system, functional areas such as design, analysis, planning, purchasing, cost accounting, inventory control, and distribution are centralized in a server along with factory functions. A conception of the expert system for the economic evaluation of investment projects is based on the possibility of linking economic evaluation methods with individual types of investment activities.

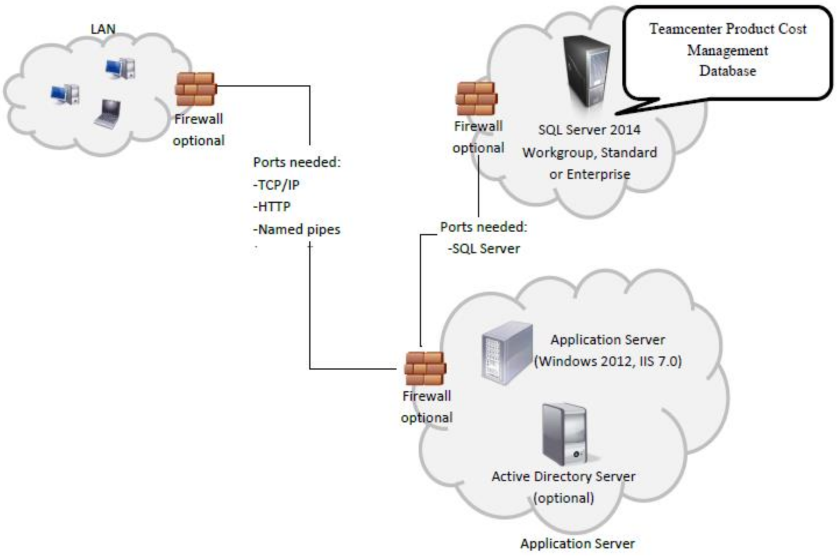



**Figure no. 13. Architecture of an integrated SIEMENS system. Source: SIEMENS Teamcenter Product Cost Management June 01, 2013**

A typical level enterprise installation scenario that includes an application server, a central database, and the offline capability of Teamcenter clients. Product cost management is represented in figure no. 13.

### 4.6.2. The benefits of integrated systems in cost planning

*The benefits* of using *integrated systems in cost planning (4.6.2.)* are as follows:
• facilities to view and extract data about potential and existing customers, resulting in a higher net sales figure. • significantly reducing the operational costs of a business related to procurement activities, inventory storage • accurately indicating existing needs and where to focus efforts and resources • estimating the cost for product design in different levels of technological maturity, as well as for avoiding the maintenance of all dispersed systems • information can be accessed instantly from almost anywhere, without wasting resources to extract and link data from different sources, and employees are better informed and can make accurate and faster decisions • Attract new customers and increase revenues are key pillars for the continuity and success of any company.

With an integrated software system, expansion to more locations and additional sales channels can be achieved much faster thanks to unified accounting and order management processes and data. *With so many applications, integrated systems save an enormous number of financial resources and time.*

In contrast, in the absence of an integrated system, based on inaccurate, incomplete and disjointed information, managers of organizations are faced with making critical decisions either too slowly (delayed) or hastily and risky.

To eliminate the deficiencies in the above context and to support these processes to be carried out in a unitary manner, the implementation of an integrated production system is required, the benefits of which are highlighted in **figure no. 14**

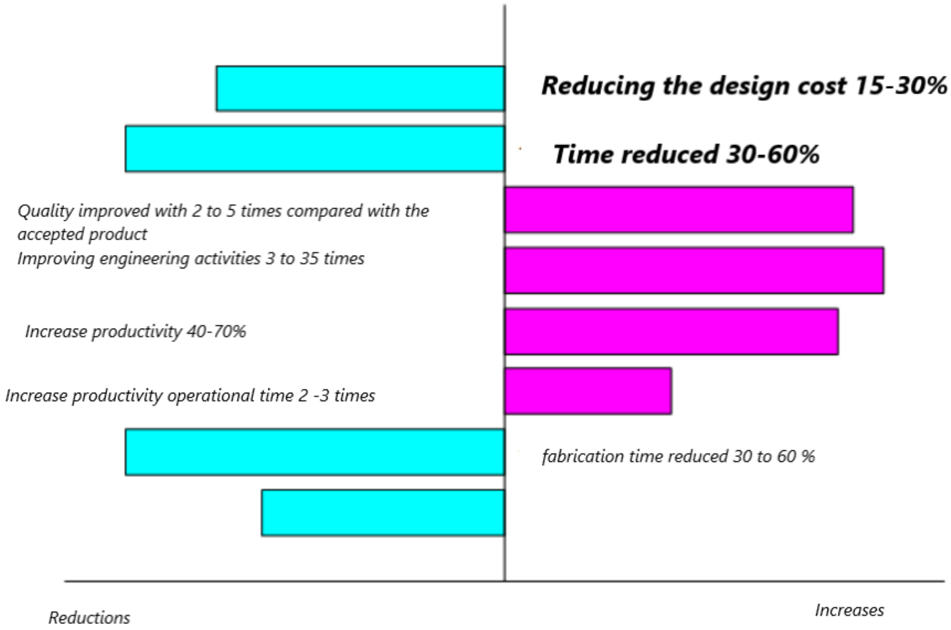



**Figure nr. 14. Beneficiile sistemului integrat în producție in production Source: http://cadredidactice.ub.ro/crinelraveica/files/2011/10/msptf.pdf**

## 4.7. Ways and methods for cost reduction

### 4.7.1. Concepts of value engineering

In cost management, the product development process in a company follows the correct approach to value engineering (*Value Engineering* - VE) and establishing the target cost (*target cost* - TC). Value engineering takes into account the following factors: Actual delivery performance according to the planned delivery schedule (defective deliveries are those that are not made on time, are in incorrect quantities) • People productivity (PO) is measured in the time required (person hours) to produce a good quality product. • Inventory Turnover (ST) • Overall Equipment Effectiveness (OEE) shows how well a company uses its equipment and personnel • Value Added Per Person (VAPP) shows how well people are used to turn raw materials into finished products. • Space utilization measures the sales revenue generated by one square meter of factory production space. In process improvement efforts, quality costs or cost of quality is a means of quantifying the total cost of quality efforts and deficiencies. A properly implemented quality procedure can reduce testing, scrap, repairs, etc. The quality costs of a good (product/service) can be controlled through a value analysis. Value analysis starts with reducing costs and optimizing a need with the means to achieve it. Cost reduction includes auditing and advice on the prevention and management of professional risks, optimization of social and fiscal contributions, obtaining European research credits, optimization of procurement and management of general expenses.

### 4.7.2. Cost reduction and quality cost evaluation

The comparative method of cost scenarios is used in situations of similarity and constitutes the main concept to reduce the cost and determine the quality costs (4.7.2.). Thus, a number of cases are chosen in order to create a common model (template), adjustable to any modification of the production lines or to any new scenario, implicitly time will be gained because "it will not start from scratch".

Apergis and Rezitis (2004) grouped expenses in a company's cost structure into labor cost, material cost, equipment cost, information cost, technology cost, resource cost, financial cost and management cost.

Cost reduction can be manifested in all factors: supply and distribution chains, procurement, materials and their handling, production, processes, manufacturing, methods, organization and personnel, market entry strategies. Moreover, investments in IT and modern technological equipment will increase the innovation capacity of the company and over time a reduction of costs in the production process will be observed.

Cost reduction is analyzed and reviewed critically to improve the efficiency and effectiveness of processes and the main directions of cost reduction would be, in brief, the following: • application of procedures for monitoring expenses and performances in relation to the progress of a project and operations manufacturing • implementing a cost-cutting strategy whenever the firm is facing difficult times or planning for future growth • eliminating non-essential, non-value-added activities • eliminating scrap • avoiding frequent transports and inventory blockages • the cost of controlling labor force work presents the greatest financial risk faced by companies, therefore workforce restructuring can be done by repeatedly reducing excessive and expensive work; establishing fair work standards with the workforce and periodically updating their work standards; monitoring worker performance in real time.

Other cost reduction methods: 1. Establishing a minimum cost reduction objective; 2. Budgeting evaluation with the proposed target; 3. Cost reduction in the broader business strategy; 4. Economic factors of costs; 5. Cost analysis on the value chain; 6. Carefully managing the change process; 7. Successful monitoring of results.

# DEL II – PERSONAL REVENDICATIONS

## CHAPTER 5. Establishing the company's cost strategy based on the theory analyzed

*Establishing the company's cost strategy* based on the analyzed theory is the main subject of chapter 5, which is also the chapter of own contributions. My research aimed to design a new cost evaluation system, coming up with my own solution for detailed identification and mitigating the effect of indirect costs using the "activity-based costing" method (ABC method), through which managers will improve their process cost assessment and will be able to achieve an optimized, efficient and profitable cost strategy.

**The scope of the doctoral** thesis: the creation of an adequate financial model to support the choice of the concepts from the early stages of the product development process, in order for the company to obtain maximum profitability.

**Objectives:** 1) identifying the type of data and information needed to estimate manufacturing costs for different industries (wind, oil, automotive); 2) building the relevant data infrastructure, as a basis for the development and operation of a web portal, as an interface of the information infrastructure; 3) demonstration of cases that highlight the benefits of the ABC method. The activities carried out in each phase of my doctoral thesis were the following: clarification of the research, creation of the theoretical framework of the thesis, creation of an original cost estimation model based on the ABC method, selection of examples applied in practice. From the studies carried out together with managers from several departments involved in the Siemens Gamesa wind company, we created a parametric cost calculation model using the ABC method, validated and tested, in the framework of management decisions in a product development project.

With the support of the companies, I collaborated with and collaborate with, combined with the efforts from my own experience, **I synthesized a selection of examples applied in practice** (the third stage). The study process was carried out in parallel with the thesis work, and from the correlations of theory and practice, I selected only the most important parts. At the end of the descriptive study phase, **we compared and discussed the experimental findings with the theoretical ones (fourth stage).** To evaluate the quality of the research works, we used the ***validity and reliability*** of the study as parameters. As a parenthesis, reliability highlights the consistency and reproducibility of the study, while /validity focuses more on how strong its result was, i.e. the similarity between the study's value and the actual value. [3].

### 5.1. Theoretical contributions

Implementation involves two important aspects: 1) availability of input data for the cost model and 2) how the model should be implemented.

To answer the first question, we reviewed various commercial data collection systems. The analysis imposes special requirements on the data and information collection systems: to be correct, realistic, to reflect the manufacturing process as faithfully and in detail as possible. The collected data is found in the manufacturing costing software precisely to cover all the requirements of visualization, data extraction and simulation of the requested results.

To answer the second question (to what extent do companies collect the necessary data?), two wind towers were examined to develop a manufacturing costing software application at one of the manufacturing companies participating in the study.

In the first stage, to clarify the research objectives, a first descriptive study was carried out, suggesting how the results can be used to improve detailed cost estimation in three different industrial fields (wind, oil and automotive). In the second stage, my research identified a data infrastructure in which I will explain the need for and how to use the data and where it is found. Next comes the logical structuring of this data in a database. A catalog of data and information is created for different industries, which can be used as a benchmark, if standardization is possible in the respective industrial fields, and that the catalogs are used by all companies as a reference point.

[3] Surse: https://ro.weblogographic.com/difference-between-reliability-and-validity-262700, https://ro.differencevs.com/6859201-difference-between-reliability-and-validity

Therefore, we have determined that ***information resources*** are classified under three major headings: *internal resources, supplier resources, and external environmental resources*.

By implementing these data collections in the software of the providers, many new functions will be added such as: copy functions, search facilities for terms, features, comments, etc., which will increase the sophistication of the data infrastructure and shorten the search time. Five dimensions of performance measures are distinguished: quality dimension, time dimension, flexibility dimension and cost dimension, delivery reliability.

The applications required the creation and implementation of costing techniques to support manufacturers to correctly associate them with production items.

Companies using existing software could integrate the infrastructure into an explicit cost estimation database (this is a web portal that was not developed in this research but can be considered in future research directions) which, further, would support the user in obtaining a refined rate of costs.

### 5.1.1. *Cost Engineering* – discipline introduced by the author in different companies

In 5.1.1. we detailed and show the difference between **"target cost" and "production cost"** . Within any company, it is requested to establish a product cost estimation team that will be involved in • Facilitating the *"Design to cost"* concept for the development of new products; • Knowledge and evaluation of any activity involving production costs. • Close collaboration with the product design department; practice showed a 10% improvement when the new design plan was applied. • Significant cost reduction of current projects. The cost estimating engineer will go through the following stages: Definition of hypotheses - Choosing the best manufacturing process in the market - best practice; Making the estimate using the TABC method - (dividing the manufacturing process by activities according to the presented method); Cost estimation following the information received during the visit; Negotiations with the supplier following the cost estimate. Before establishing the difference between the production cost and the target costing (target costing), the following questions will be answered: 1. How is the target cost established? 2. When do we start managing product cost? 3. What is the difference between target costing and production costing? The target cost is analyzed within the product development cycle. The target cost is the maximum amount that can be invested in a product. A cost should be an estimate that indicates to management whether the product provides a minimum acceptable profit.

### 5.1.2. Theoretical model adapted to applied contributions

In **figure no. 18** we can see a model that Toyota and its suppliers have implemented with great success, considering the five stages of the Lean product development process (Nolmdahl, 2010), which ***I have adjusted*** for 2 towers wind turbines:

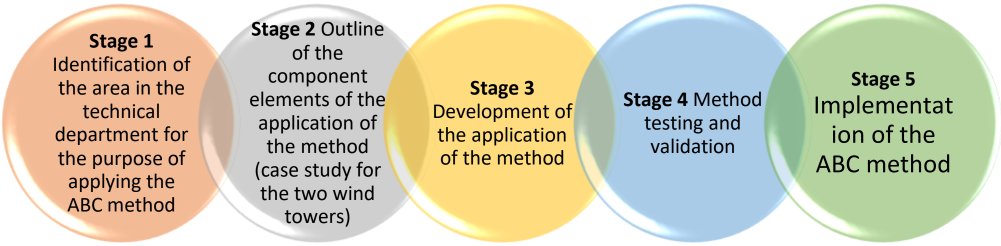



**Figure no. 18. The Stage-Gate process adapted by author according to the Five Stage Method (Cooper, 2001)**

The methodology approached within the work of this thesis was based on the research questionnaire (Yin, 2009). When we choose a wind tower company, a financial model suitable to the ABC method will be created to be used from the beginning of the product development process, in order to obtain the highest possible profit in the wind company. *By identifying the activities and estimating the cost of each activity, I was able to reduce the production costs of these towers.* Prior to this method, most cost estimating engineers used price per kg as the primary factor in determining total cost.

Applying the ABC model, the cost explanation led to relevant negotiations between the purchasing department and the tower suppliers.

*Analyzed questions:* 1) What are the most suitable business models today? 2) How should the allocation of overhead and fixed costs work in a product costing scenario today? 3) How do you support a financial model with the decisions of the people in the framework of a product development project?

*Delimitations*: To delimit the volume of work and to establish the limits of the system in this thesis, I have focused only on the factories for the execution of wind towers. The calculation model developed by me is useful for all industrial engineering projects related to wind companies. Working groups were created in different departments of the company and meetings were organized on various topics. In the development project of a new wind farm, the functions of Industrialization and development of production, procurement and technological functions are involved.

Today, the project is carried out on several conceptss of wind installations classified in several families. In this case, by family we mean the same technical solution. One of the scores of the project is to ease the design work by reducing the number of gigs and implicitly to gain time. The elimination of the concepts is realized through the coordination between all the involved departments. Today, the concepts are at different maturity levels (TLR). Reducing the number of conceptss to the desired level will save time and the transition phase to production will be carried out adequately. It is important to be clear about why a concept is being removed, so that later there is no misunderstanding in the project. Documentation is vital as a precaution so that a potentially successful concepts is not accidentally deleted in the run-up to the project. The project is huge and involves several functions. To ensure the sustainable profitability of the wind company, the cost of products was chosen as one of the most important criteria for the evaluation and selection of a product development project. In the framework of a product development project, a financial model that manages to meet all the necessary criteria becomes the guarantee of reaching its financial objectives.

## 5.2. Applicative Contributions

Subchapter ***5.2. Applied Contributions*** is entirely devoted to original practical contributions from my experience, describing no less than four examples from 3 different industrial fields: wind turbines, oil rigs and automotive.

### 5.2.1 Application of the ABC method. Contributions to the realization of the parametric model in a wind enterprise

Financially, a firm can maximize its savings by reducing storage costs, capital, lead time, delay costs, and lead times. The flow of materials in a manufacturing organization indicates how well the system is organized (Agneti et al., 1997).

The enterprise investigated for the purpose of applying the ABC method is a wind equipment manufacturing company. I will limit myself to applying the method only to wind towers of different sizes.

In **5.2.1.1.** product families were described - Turbine types 2X (2.9 kW), 3X (3.46 kW), 4X (5kW): Siemens Gamesa 2.X - SG 2.1-114, Siemens Gamesa SG 2.2-122, Onshore wind turbine, Siemens Gamesa SG 2.6-114, Onshore wind turbine, Siemens Gamesa SG 2.9-129 (built for the needs of the American market), Siemens Gamesa SG 3.4-132 the most profitable product in its market segment (parameters are shown in the appendix).

**Figure no. 19. Siemens Gamesa 2.X - SG 2.1-114**
**Source:** https://www.siemensgamesa.com/products-and-services/onshore/wind-turbine-sg-2-1-114

**Figure no. 20. SG 2.2-122, Onshore wind turbine, Source***:*
*https://www.siemensgamesa.com/products-and-services/onshore/wind-turbine-sg-2-2-122*

**Figure no. 21. SG 2.6-114, *Onshore wind turbine,* Source:** *https://www.siemensgamesa.com/products-and-services/onshore/wind-turbine-sg-2-6-114*

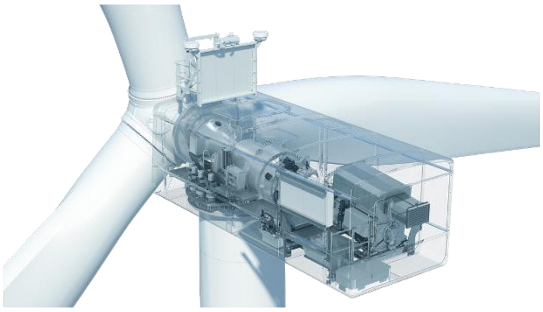


**Figure no. 22. SG 2.9-129 – Source:** *https://www.siemensgamesa.com/products-and-services/onshore/wind-turbine-sg-2-9-129*

**Figure no. 23. SG 3.4-132 – Source**: *https://www.siemensgamesa.com/products-and-services/onshore/wind-turbine-sg-3-4-132*

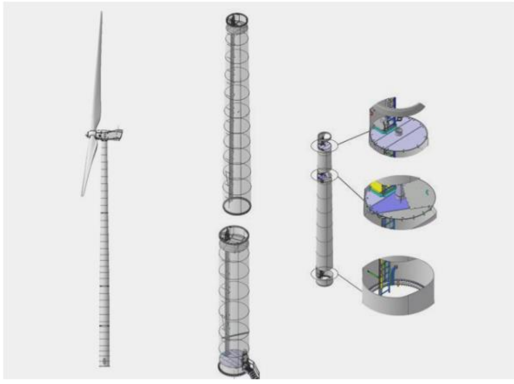


**Figure no. 24. Components of the wind tower together with its interior (Source: https://windar.impetudesign.com/torres-onshore/)**

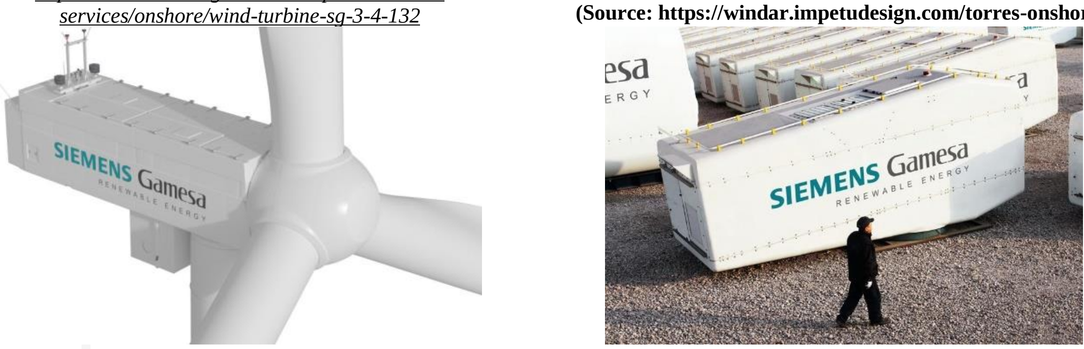
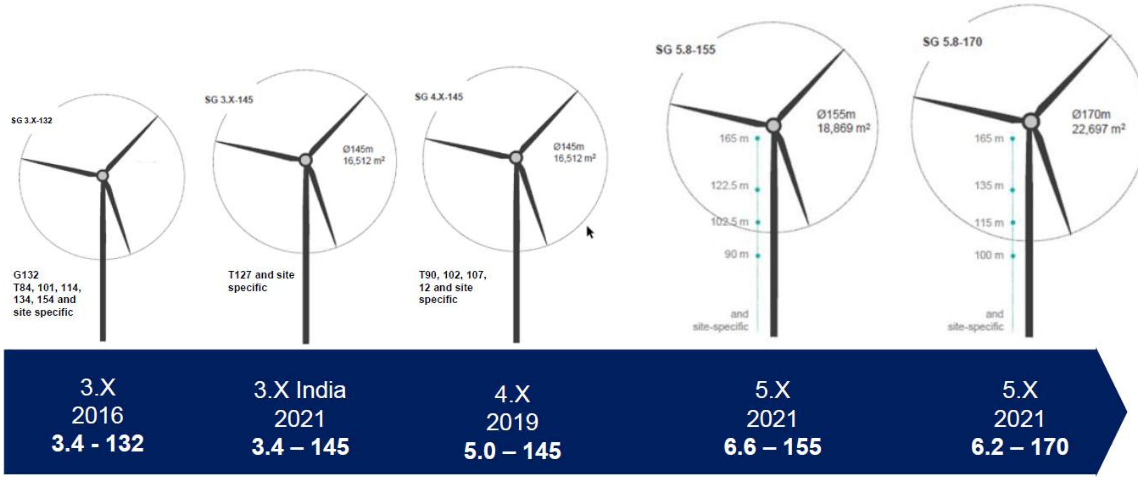



**Figure no. 25. Wind equipment as a whole (nacelle, tower, blade, transmission system. Source: (433)**

SGRE Company is working on the development of wind farms, and the complexity is progressive.




| Figure no. 26. | Concept A | Concept B | Concept C | Concept G | Concept F |
|---|---|---|---|---|---|
| Produsul 1 SG 3x-3.4-132 | Tower 184 m | Tower 101 m | Tower 114 m | Tower 134 m | Tower 154m |
| Produsul 2 SG 3x-3.4-145 | Tower 90 m | Tower 102 m | Tower 107 m | | |
| Produsul 2 SG 4X-5.0-145 | Tower 90 m | Tower 102 m | Tower 107 m | | |
| Produsul 3 SG 5X-6.6-155 | Tower 90 m | Tower 102.5 m | Tower 122.5 m | | |
| Produsul 4 SG 5X-6.2-170 | Tower 100 m | Tower 115 m | Tower 135 m/165 m | | |

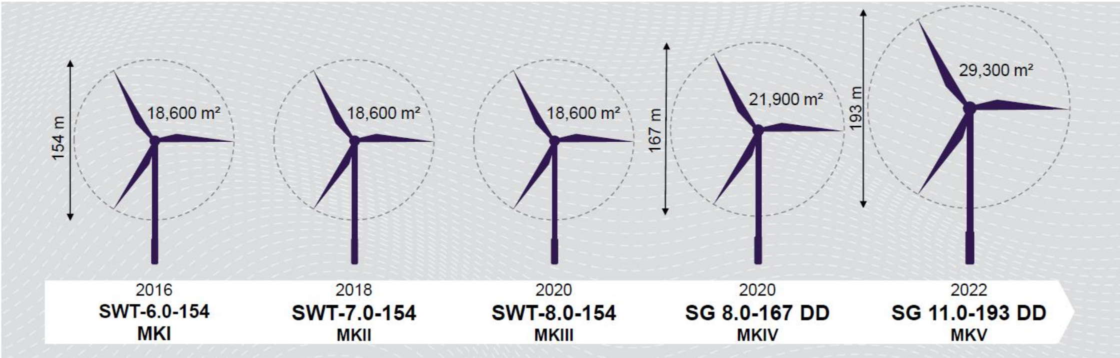
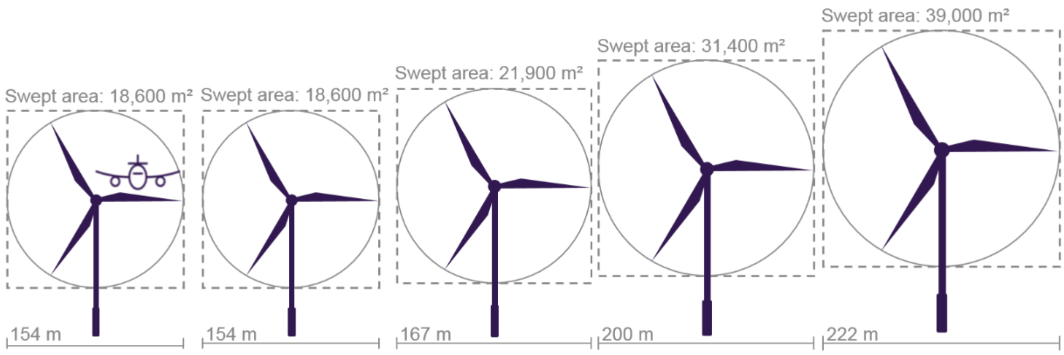



**Figure no. 27. Types of wind turbines located in the water area (offshore)**




| | SWT-6.0-154 | SWT-7.0-154 | SG 8.0-167 DD | SG 11.0-200 DD | SG 14-222 DD |
|---|---|---|---|---|---|
| IEC Class | I, S | I, S | I, S | I, S | I, S |
| Nominal Power | 6 MW | 7 MW | 8 MW | 11 MW | 14 MW |
| Blade length | 75 m | 75 m | 81.4 m | 97 m | 108 m |

**Figure no. 28. Evolving stages of large-scale wind turbines**

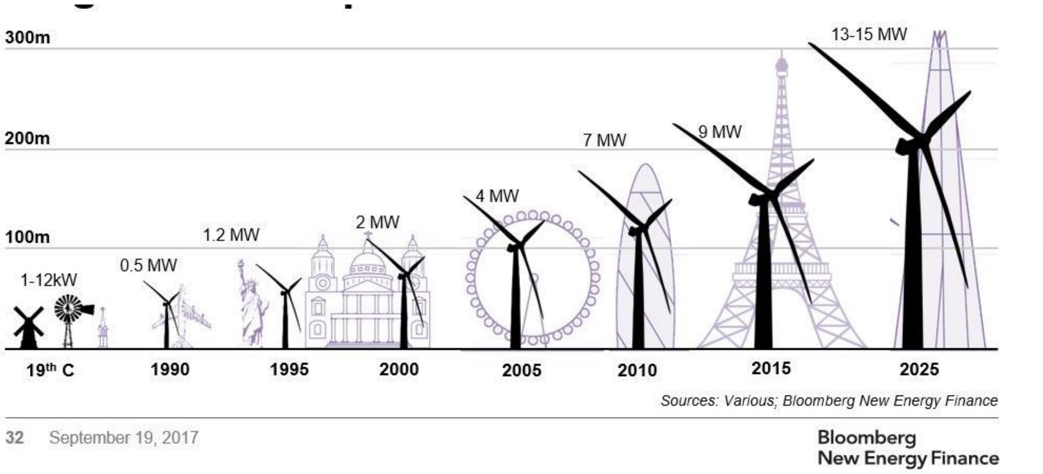



**Figure 29. Evolution of wind turbines in height and developed power**

### 5.2.1.2. Execuțion of parametric model ABC – cost model

A clear challenge for Siemens SGRE is to calculate a correct output cost at the scenario level for wind turbines, assuming that they are standardized in a common value stream and the costs must be modulated within the output platform. The theoretical concepts and my interviews with the team of cost engineers in the company led to the conclusion that identifying a correct method in the distribution of indirect costs is a vital tool to ensure the profitability of the company.

The usual method in product development is to divide the product families into different product platforms and try to redesign the different modules (patterns) and number of items to achieve higher production volumes and flows. to reach new segments of the river. The advantages of this approach will be distinguished during the entire life cycle of the product, from product development, to acquisition, production and after sales (service). Starting from some relevant situations in different research methods, the qualitative technique for calculating the cost of production based on what we created and described in the theoretical contributions chapter supports all 5X wind farm projects.

The allocation of fixed costs and general costs in the cost of products depended on the needs and requirements of the company, the resulting conclusion coming hard to study the theory of costs based on activities and reflected in the data collected from the interviews. An incorrect allocation complicates business decisions and affects the company's long-term profitability.

**In my doctoral thesis I only addressed the first stage: *Tower conversion (cost calculation for the construction of the wind tower),*** following the 3 stages of execution of the ABC parametric model - cost model: 1) The starting dates for two wind tower projects 2) Identifying project requirements 3) Achieving objectives and implementing the project.

A) What is available

- The existing structure of the tower with the initial estimates in excel format
- Understanding and deepening the manufacturing process in detail
- Existing database for the price of equipment semi-finished products

B) What are the project requirements

- Defined projects with accurate estimates and identification of potential cost reductions
- The company's need and willingness to apply this cost estimation model
- Support from all departments of necessary functions in the company: Purchases, Logistics, manufacturing design, product development;
- Access to drawings and specifications;
- Access to the real data of the manufacturers in order to compare and calibrate the results obtained;
- Application of the model to all types and sizes of towers.

C) Project expectations: •

- Validation of the cost model for the chosen projects and application of the model in future negotiations.
- Realization of a flexible parametric model for tower execution in the first stage
- Parametric model verification for use in design, Sales and Purchasing.

#### 5.2.1.3. Application of the standard cost method for a wind turbine

*Standard-cost method* will apply to the most important components of the wind farm: nacelle, hub, power unit, towers, and blades, and will be based on the historical cost of other platforms.
The improved solution of future cost estimation is to attach an activity-based cost model, through a *business intelligence* IT solution, with certain parameters established for a certain area of the product, in this case for "*towers*", the model to be extended also within the Service department.

The application contribution is called *Tower* and is a platform project for a family of products. The results from the technology department of this project lead to the creation of an improved solution which can be seen as the cost model of the product below.

The effect of the cost of capital invested in the project is found by adding a percentage increase, comparing the current situation and the value of the invested capital. Technological Department must identify the effect of product cost assurance when implementing the project of a new type of wind tower, of different sizes, depending on the loads and atmospheric conditions. In addition to the above actions, it will take into account the research of previous purchases that influence the effective production, inventory/stocks and debts on the balance sheet.

#### 5.2.1.4. Cost model for a wind tower, based on the ABC method

*The cost model* of the wind tower based on the ABC method (*Activity Based Costing*) starts from the definition of the main activities and the estimation of the initial investments. *Initial data:* • Development of the ABC method in the wind enterprise • Re-evaluation of the calculation of indirect costs • Change of the method of evaluation of the costs of wind platforms. *Current conditions:* • Services offered additionally after purchase and leading to increased costs, • Non-productive costs are cataloged as a percentage. *The final goal*: • To be a solid method of evaluating indirect costs • To increase the transparency of projects • The author's own classification regarding the ABC method **Activity Based Costing* • The execution of the steps towards the application of the ABC method.

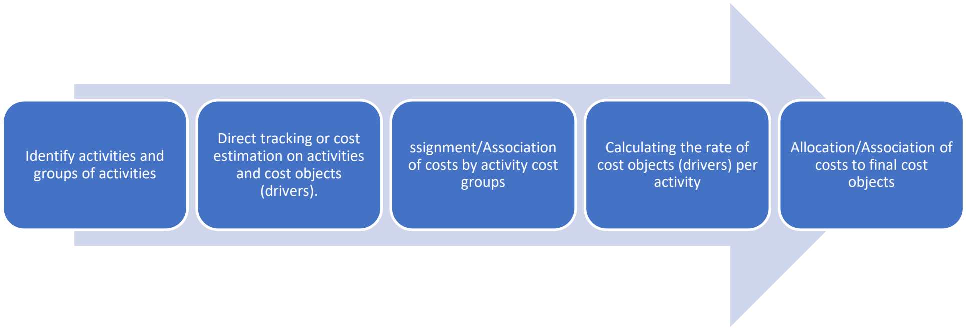



**Figure no. 32. Cost design flow diagram, drawn up based on the theoretical elements studied about the ABC**

### 5.2.1.5. Example of the execution of a wind tower within a wind company.

An Initiated project by the wind company had as its starting point the estimation of the cost of the execution of two wind towers of different sizes. To cover as wide a range of platforms as possible (2X, 3X, etc.), two towers of different sizes were analyzed, two lists of materials (plates) from which the gross cost estimates start, two projector solutions compared with standard costs of similar products on the market in different regions of the world. The study of the two wind towers taken "into account" starts from the standard model in which we highlighted all the activities included in the process.

To exemplify the necessity of setting up an interdisciplinary team, I recall a particular case encountered in the technological department of the wind equipment manufacturer Siemens, regarding a PSS (*Product/Service-Systems*) where the risk of inducing vibrations in the wind tower had to be eliminated by installing generators (see Figure no. 34). The technological, operational, *project-execution* department, production managers, service, turbine builders and logisticians, the administrative department for obtaining patents, licenses and certificates and of course the cost engineers contributed to this.

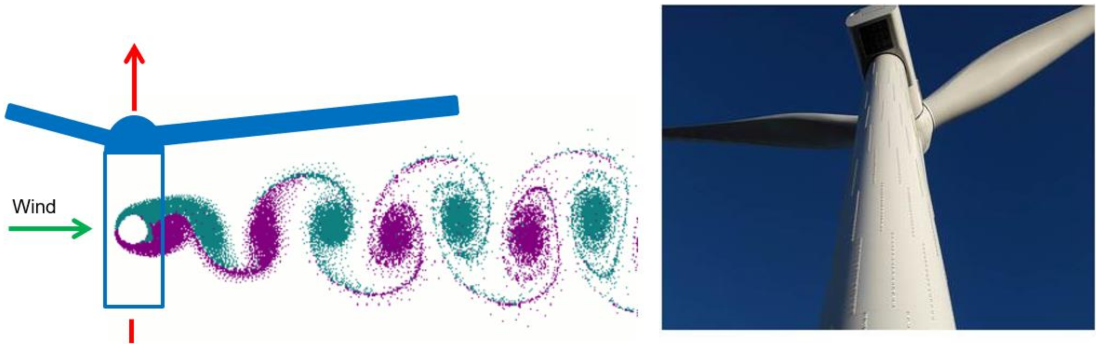



**Figure no. 34. Cost estimation in PSS (product/service systems) for a wind turbine manufacturer**

The example of the two wind towers taken "into account" starts from the standard model in which we highlighted all the activities included in the process. In the following figure, the orange frame includes the activities necessary for the execution of structural parts from sheet metal (**cutting, bending, longitudinal welding, assembly and circular welding, assembly of sectors and sectors with flanges**). The green frame includes the activities of **sandblasting, painting** and **assembling** the internal elements of the tower. The last part is the activities of **packing** and **shipping** the product (see Fig no 35)

### 5.2.1.6. Details on the parametric calculation. Stages defined by the author

To develop a parametric, flexible cost model for various types of towers (on-shore/"on land", respectively off-shore/aquatic ("on water"), a checklist of activities will be created. As a final result a cost quotation (result) will be obtained to be used in future negotiations with other manufacturers.

The final format of the parametric calculation model in which all activities were simulated for several representative wind towers and for all activities, starting from two representative onshore - water / offshore towers. They have been numbered in order of execution sequences by numbers. It is the most richly illustrated subchapter, the algorithms, the steps being captured (see Table no 7, next page)

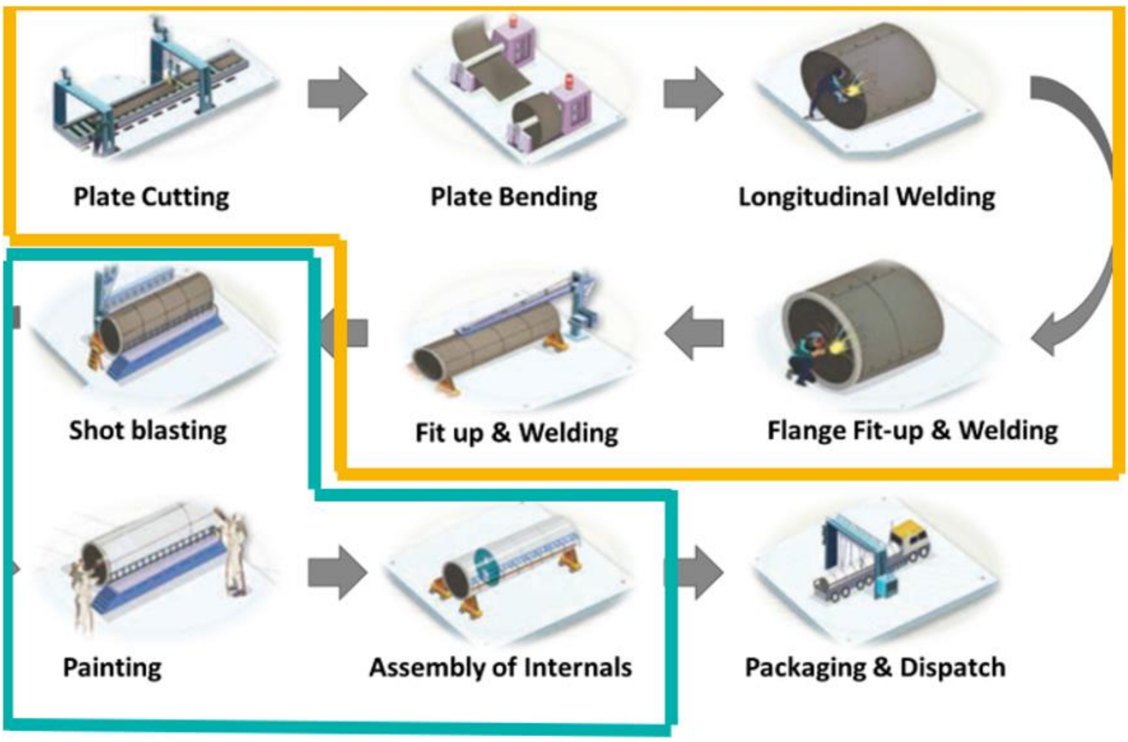



**Figure no. 35. Tower processing flow from the wind company (source: SGRE)**

**Table no. 7. Parametric model example**

| | |
|---|---|
| **0.Collect data from the organization** | |
| **1. Cost model adjustment** | Defining data entry * plates dimensions |
| | Create component list used in calculation |
| | Defining the net weight |
| | Defining fabrications steps |
| | Defining cycles times |
| | Defining the machines necessary to execute the process steps |
| | Defining the indirect expenses for each production step |
| | Designing the model together with software company |
| **2. Creating the parametric model** | Defining entering parameters exact dimensions |
| | Discussion regarding the two type of models for towers, water OF , land ON |
| | Defining software process classifying |
| | Defining a structure of general purpose components |
| | Creating or using *cycle time calculation calculators for various manufacturing processes |
| | Defining the weight for different materials |
| | Evaluation and definition of the correlation needed to define the parametric calculation of times |
| | Evaluation and definition of parametric correlation with the manufacturing system |
| | Evaluating and calculating indirect costs for various manufacturing processes |
| | Dataset creation in software |
| | Completing the parametric calculation in the software |
| | *Training*, maintenance, and documentation |
| **3.Cost model validation** | Identification of a manufacturer for model validation |
| | Detailed discussions with the supplier regarding the assumed assumptions |
| | Internal evaluation of the results with the involved Engineering departments. sale |
| **4.Using the model** | Identifying different types of towers |
| | Creation of cost models |
| | Carrying out negotiations supported by the created cost model |
| | Negotiations with the chosen supplier |

The elements inside the orange frame in figure no. 35 correspond to the list of activities from figure no. 42

| Black process - Shell production | | | |
|---|---|---|---|
| | Manufacturing step | calculated | Comment |
| 010 | Raw material reception | ☑ | |
| 020 | Incoming inspection | ☑ | |
| 030 | Handling | ☑ | |
| 040 | Preblasting | ☑ | |
| 050 | Handling | ☑ | |
| 060 | Cutting (and bevelling) | ☑ | |
| 070 | Handling | ☑ | |
| 080 | Beveling | ☑ | |
| 090 | Bevel Transition preperation | ☑ | |
| 100 | Inspection | ☑ | |
| 110 | Handling | ☑ | |
| 120 | Bending/Rolling | ☑ | |
| 130 | Tack welding of shells | ☑ | |
| 140 | Test Circumferentiality | ☐ | incl. in 130 |
| 150 | Handling | ☑ | |
| 160 | Longitudinal welding | ☑ | |
| 170 | Handling | ☐ | not incl. so far |
| 180 | Re-Rolling | ☐ | not incl. so far |
| 190 | Handling | ☑ | |

| Black process - Flange assembly | | |
|---|---|---|
| Manufacturing step | calculated | Comment |
| Positioning of the flange | ☑ | |
| Flange tack welding to shell | ☑ | |

| Black process - Tower assembly | | |
|---|---|---|
| Manufacturing step | calculated | Comment |
| Handling to growing line | ☑ | |
| Positioning of the cans | ☑ | |
| Section complete tack welding | ☑ | |
| Section Welding | ☑ | |
| CW Sec Shell and Shell outside | ☐ | incl. in 250 |
| CW Sec Shell and Shell inside | ☐ | incl. in 250 |
| NDT inspection | ☑ | |
| Handling | ☑ | |
| Flame cutting for hole of door | ☑ | |
| Welding door | ☑ | |
| Grinding around the door | ☑ | |
| NDT inspection | ☑ | |
| Positioning of bushings and brackets | ☑ | |
| Section Welding bushings and brackets | ☑ | |
| Grinding around the bushings (welding se | ☑ | |
| NDT inspection | ☑ | |

**Figure no. 42. Activity breakdown of the Wind Tower manufacturing process.**

Figure no. 43 indicates the steps towards the TDABC method, each activity including a mini database identified by the component elements: resources, capital, execution times, activity, and number of operators (correlated with Table no. 8. Final form of the parametric calculation, page 133). In order not to lose sight of any activity, I used Table no. 7 above. Parametric model example) how to make a checklist for this purpose.

USER INTERFACE - CALCULATION REMISES

| | # Shells |
|---|---|
| Top Section | 0 |
| Middle Section 1 | 0 |
| Middle Section 2 | 0 |
| Middle Section 3 | 0 |
| Bottom Section | 0 |
| Overall | 0 |

| Business | |
|---|---|
| OFF Shore | ☐ |
| ON Shore | ☑ |

| Region |
|---|
| Spain |

| Black process - Shell production | | | |
|---|---|---|---|
| | Manufacturing step | calculated | Comment |
| 10 | Raw material reception | ☑ | |
| 20 | Incoming inspection | ☑ | |
| 30 | Handling | ☑ | |
| 40 | Preblasting | ☑ | |
| 50 | Handling | ☑ | |
| 60 | Cutting (and bevelling) | ☑ | |
| 70 | Handling | ☑ | |
| 80 | Beveling | ☑ | |
| 90 | Bevel Transition preperatic | ☑ | |
| 00 | Inspection | ☑ | |
| 10 | Handling | ☑ | |
| 20 | Bending/Rolling | ☑ | |
| 30 | Tack welding of shells | ☑ | |
| 40 | Test Circumferentiality | ☐ | incl. in 130 |
| 50 | Handling | ☑ | |
| 60 | Longitudinal welding | ☑ | |
| 70 | Handling | ☐ | not incl. so far |
| 80 | Re-Rolling | ☐ | not incl. so far |
| 90 | Handling | ☑ | |

| Black process - Flange assembly | | | |
|---|---|---|---|
| | Manufacturing step | calculated | Comment |
| 00 | Positioning of the flange | ☑ | |

| Black process - Tower assembly | | | |
|---|---|---|---|
| | Manufacturing step | calculated | Comment |
| 220 | Handling to growing line | ☑ | |
| 230 | Positioning of the cans | ☑ | |
| 240 | Section complete tack welding | ☑ | |
| 250 | Section Welding | ☑ | |
| 260 | CW Sec Shell and Shell outside | ☐ | incl. in 250 |
| 270 | CW Sec Shell and Shell inside | ☐ | incl. in 250 |
| 280 | NDT inspection | ☑ | |
| 290 | Handling | ☑ | |
| 300 | Flame cutting for hole of door | ☑ | |
| 310 | Welding door | ☑ | |
| 320 | Grinding around the door | ☑ | |
| 330 | NDT inspection | ☑ | |
| 340 | Positioning of bushings and brack | ☑ | |
| 350 | Section Welding bushings and bra | ☑ | |
| 360 | Grinding around the bushings (wel | ☑ | |
| 370 | NDT inspection | ☑ | |

| Black process - Tower quality inspection | | | |
|---|---|---|---|
| | Manufacturing step | calculated | Comment |
| 380 | Inspection dimensional | ☐ | see next |
| 390 | Ovalization | ☑ | |
| 400 | Length | ☑ | |
| 410 | Paralelism | ☑ | |
| 420 | Flatness | ☑ | |
| 430 | Measurement of various (e.g. holes | ☑ | |

| White process - Tower | | | |
|---|---|---|---|
| | Manufacturing step | calculated | Comment |
| 440 | Handling | ☑ | |
| 450 | Washing | ☑ | |
| 460 | Handling | ☑ | |
| 470 | Blasting incl. Cleaning | ☑ | |
| 480 | Handling | ☑ | |
| 490 | Masking for metalization | ☑ | |
| 500 | Metalization incl cleaning | ☑ | |
| 510 | Handling | ☑ | |
| 520 | Preperation before painting (e.g. re | ☑ | |
| 530 | stripe coating (use a brush for not e | ☑ | |
| 540 | Painting and curing | ☑ | |
| 550 | Inspection painting | ☑ | |
| 560 | Handling | ☑ | |

| White process - Internals assembly | | | |
|---|---|---|---|
| | Manufacturing step | calculated | Comment |
| 570 | Bottom section installation | ☑ | |
| 580 | Middle section installation | ☑ | |
| 590 | Top section installation | ☑ | |
| 600 | Add on offshore: Damping system | ☑ | |
| 610 | Add on onshore: Lift installation | ☐ | missing |
| 620 | Paint repairs | ☐ | |

| White process - Final inspection | | |
|---|---|---|
| Manufacturing step | calculated | Comment |

| Logistics | | | |
|---|---|---|---|
| | Manufacturing step | calculated | Comment |
| 640 | Handling | ☑ | |
| 650 | (Storage) | ☐ | |
| 660 | Handling | ☑ | |
| 670 | Packing , dispatch. Fitting of transp | ☑ | |
| 680 | (Shipping) | ☑ | |

**Figure no. 43. The product cost model using the ABC method and its implementation in a parametric approach**

Tower Execution - Process Flow Mapping - is shown in Figures 44-45:

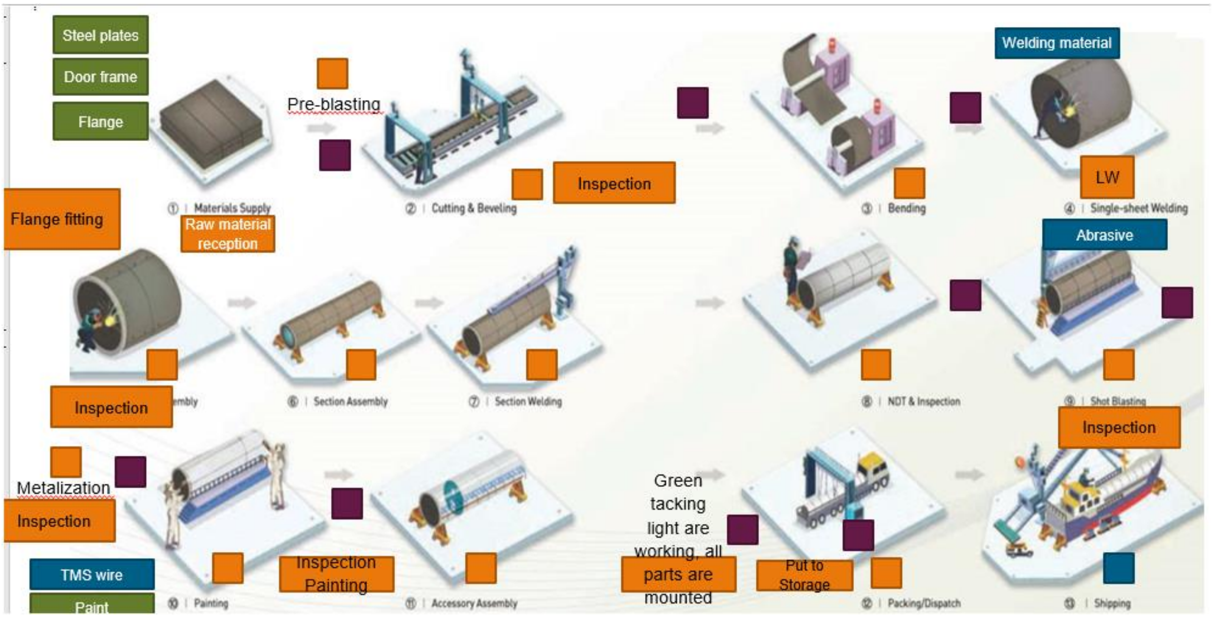



**Figure no. 44. Mapping of the technological process of the execution of wind towers, made by the author based on the research done in the suppliers facilities**

a) General structure of the parametric model

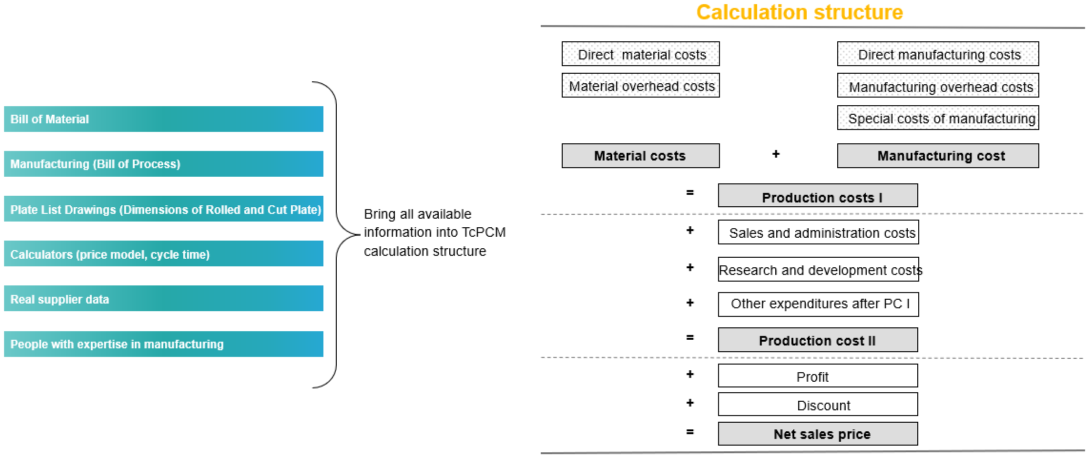



**Figure no. 48. The cost structure made by the author based on the acquired knowledge**

b) The structure of the tower sections in a calculation software (sections with related dimensions)

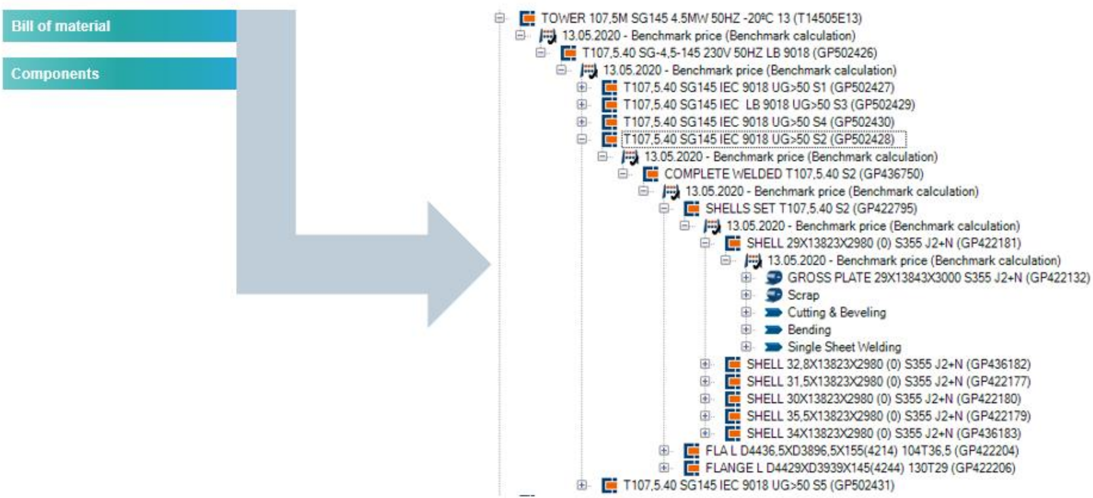


**Figure no. 49. Establishing in software the structure of the tower's components**

c) The starting data for parametric calculation from direct material costs and indirect production costs are shown in Figure no. 50:

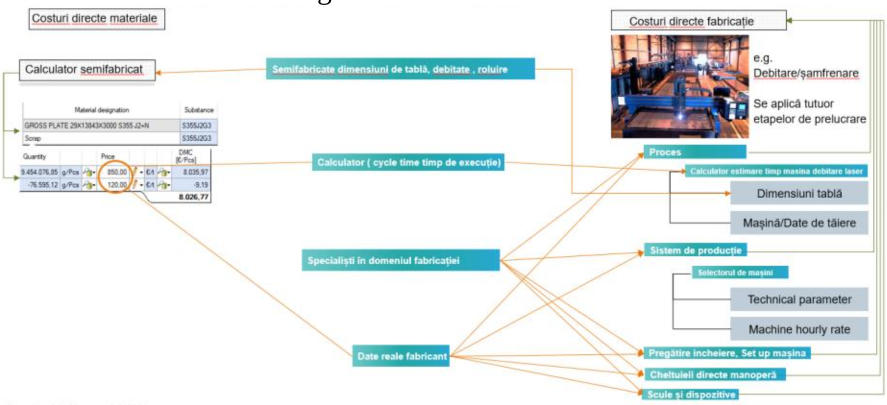



**Figure no. 50. Direct costs of materials**

The final format of the parametric calculation model:

All activities were simulated for several representative wind towers and for all activities, starting from two representative onshore - water / offshore towers. They have been numbered in order of execution sequences by numbers. The final form of the parametric calculation is presented in full in **Table no. 8.** from the thesis in the detailed form, and the indicated costs are distributed in the categories mentioned in figure no. 48 (General structure of the parametric model), with the numerical value associated with the calculated wind tower. All material costs used in the above operations are centralized in the Manufacturing Costs category. Materials costs include those for sheet metal, paint, welding wire + Direct materials and scrap costs + taxes applied to material stocks. Labor costs (hours used to carry out the execution operations multiplied by the hourly rate), **Manufacturing costs** machine cost (cost per machine hour to carry out the respective operation, preparation / finishing operations, maintenance, tools and work tools) + Indirect manufacturing costs applied as a defined percentage for each operation 10÷15%. **General and administrative expenses** as a percentage applied to manufacturing and work-in-progress expenses + R&D expenses as a percentage applied to total production costs + shipping + customs duties. The final form of the cost together with the cost of the material results according to table no. 9:

**Table no. 9. Estimate performed by the author within the Engineering department and value cost**

| No. | Item | Formula | EUR /unit | Procent |
|---|---|---|---|---|
| 1 | Direct material costs | | 19.301,00 | 22,3% |
| 2 | Material overhead | | 772,04 | 0,9% |
| 5 | Material costs | (1+2+3+4) | 20.122,34 | 23,3% |
| | | | | |
| 6 | Direct labor | | 211,22 | 48,1% |
| 7 | Machine cost/Manufacturing cost | | 0,00 | 5,4% |
| 8 | Manufacturing overhead | | 211,22 | 5,4% |
| 11 | Manufacturing costs | (6+7+8+9+10) | 626,29 | 58,9% |
| | | | | |
| **12** | **Production costs** | (5+11) | **20.748,63** | 82,2% |
| 13 | Sales and general expenses | | 8.518,06 | 9,9% |
| 14 | Expenses with development research | | 0,00 | 0,0% |
| 15 | Another costs | | 174,32 | 0,2% |
| 18 | Profit | | 6.089,80 | 7,0% |
| 19 | Payment conditions | | 631,85 | 0,7% |
| 20 | Transport, taxes | | 0,00 | 0,0% |
| **21** | **Estimated cost= (1)** | (17+18+19+20) | **86.397,90** | 100,0% |
| **22** | Specific Development cost allocated | | 0,00 | |
| 23 | Quotation (2) | (21+22) | **86.397,90** | |

The reliability of the research is ensured by following the following steps with the help of drawings, descriptions and lists of materials predefined or entered by the user.

Step 1: Define the default model in the TcPCM *Designation spreadsheet*

Step 2: Enter the drawing number *associated with the item (wind tower)*

Step 3: Select the material class (*Material cLassification "IEZ")*

Step 4: Enter the sketch/sketch of the tower - related drawing/sketch to… (jpg)

Step 5: Select the region/country of execution Region

Step 6: Define the number of exchanges considered in the calculation

Step 7: Select the technology cost model *"Technology Cost Model"*

Step 8: Define the number of parts "*Annual requirement usable parts"*, (1)

Step 9: Define the number of manufacturing lots "*Number of manufacturing lots"*, (1)

Step 10: Click Start on the predefined Excel sheet

Step 11: Copy/Paste the sheet format list used for wind tower execution and weld preparation (…) "*Harmonized plate list" & "Harmonized Bevel list*" from our template.

Step 12: Cross Check "Calculation Premises"

Step 13: Cross check *"Cycle times" & "Consumables"*

Step 14: Once the excel is completed, go back to TcPCM and click "Import Excel"

The 14 Steps to follow in applying the TCPCM software, algorithm described by the author, are described in the following figures:

**STAGE 1**

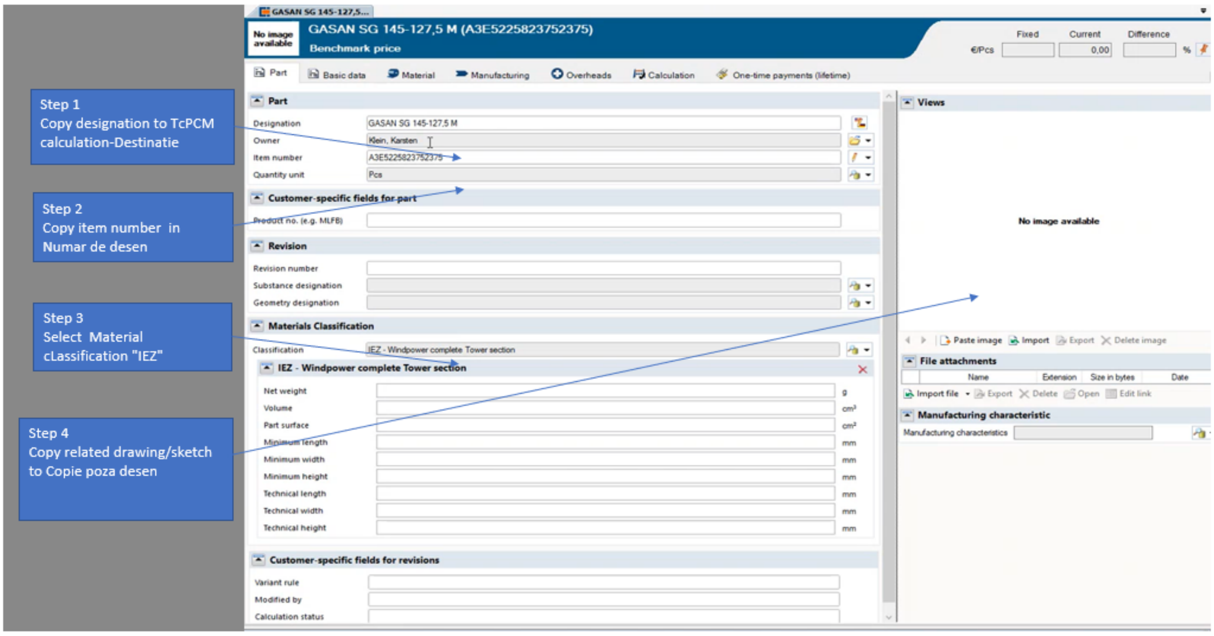



**Figure no. 52. STAGE 1, steps 1-4**

## STAGE 2

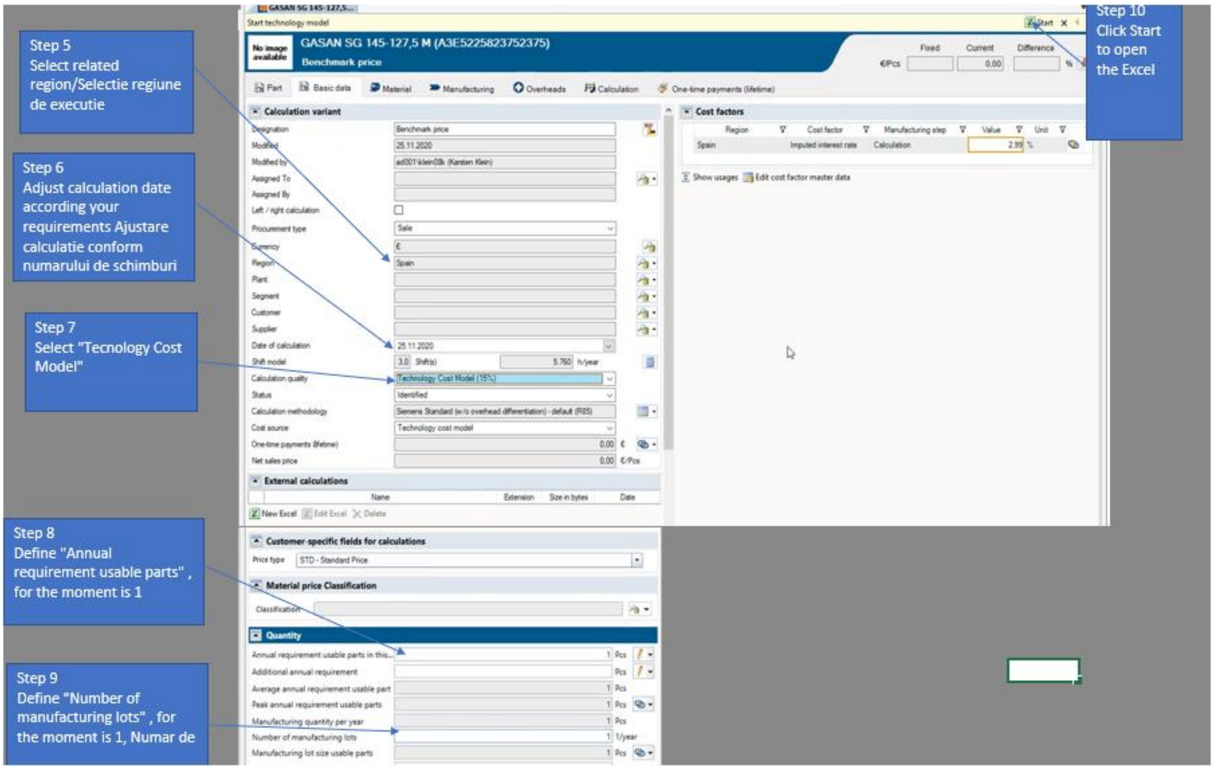



Figure no. 53. STAGE 2, steps 5-10

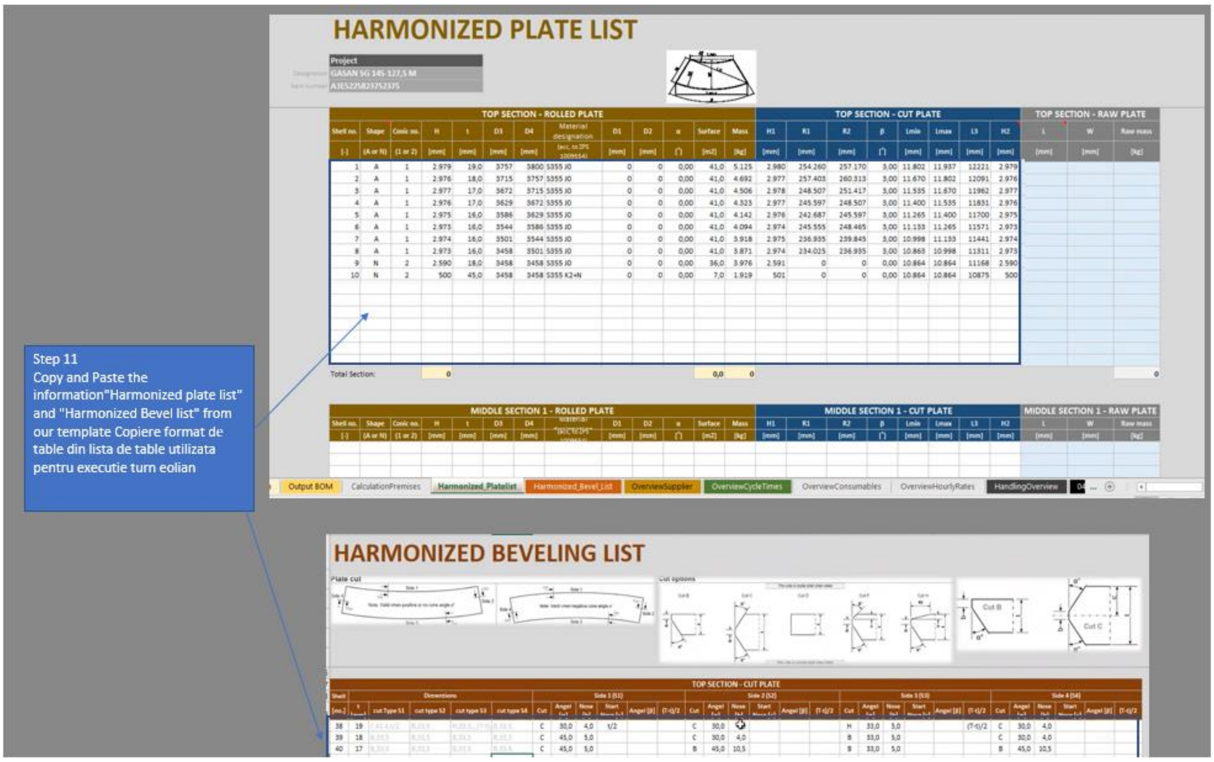



Figure no. 54. STAGE 2, step 11

## STAGE 3

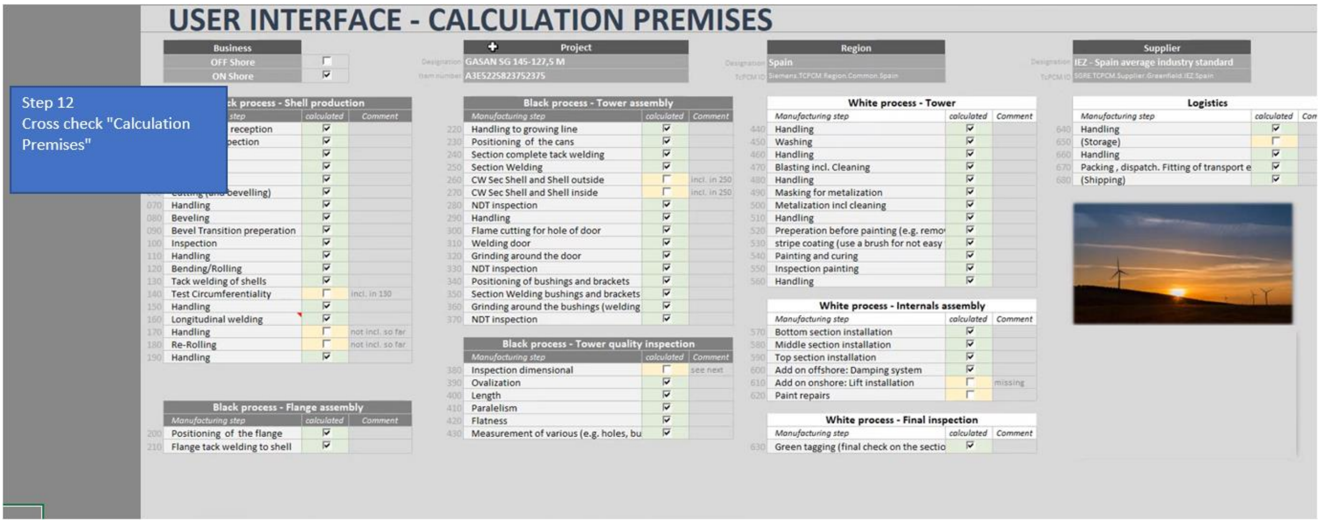



Figure no. 55. STAGE 3, step 12

## STAGE 4

ETAPA 4

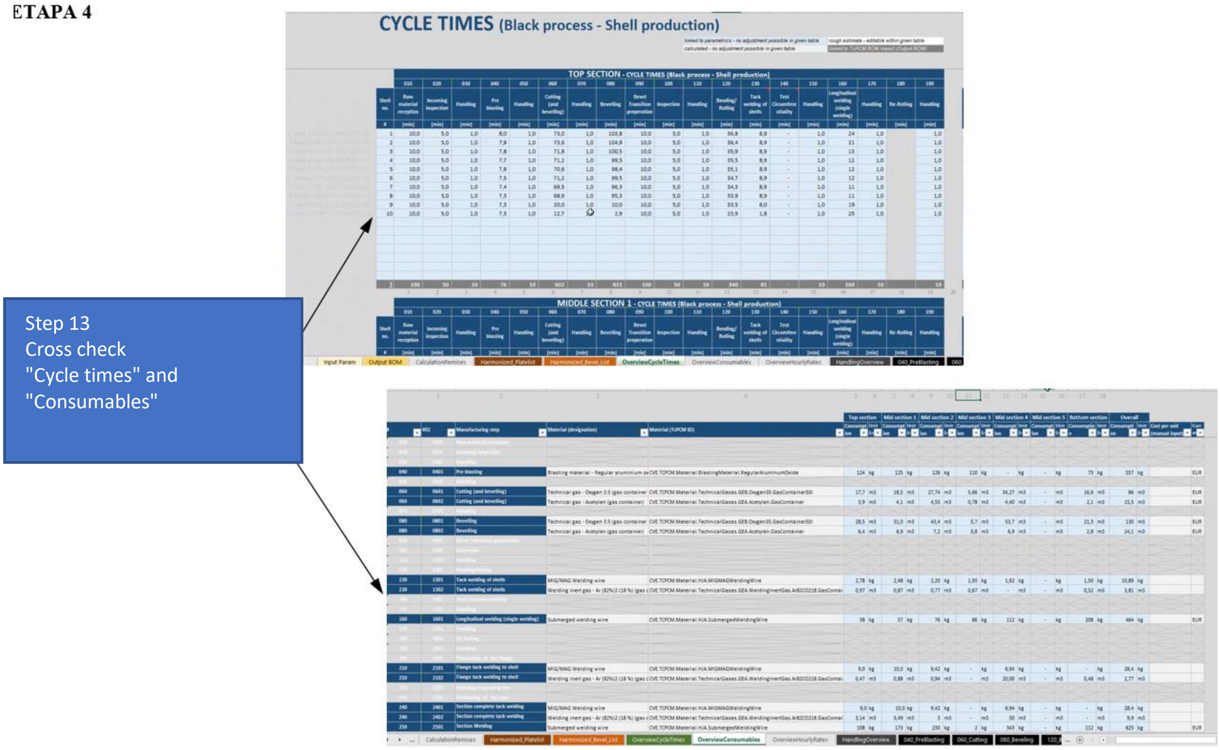



Figure no. 56. STAGE 4, step 13

## STAGE 5

Step 14
Once the excel is fullfiled go back to TcPCM and click "Import Excel"

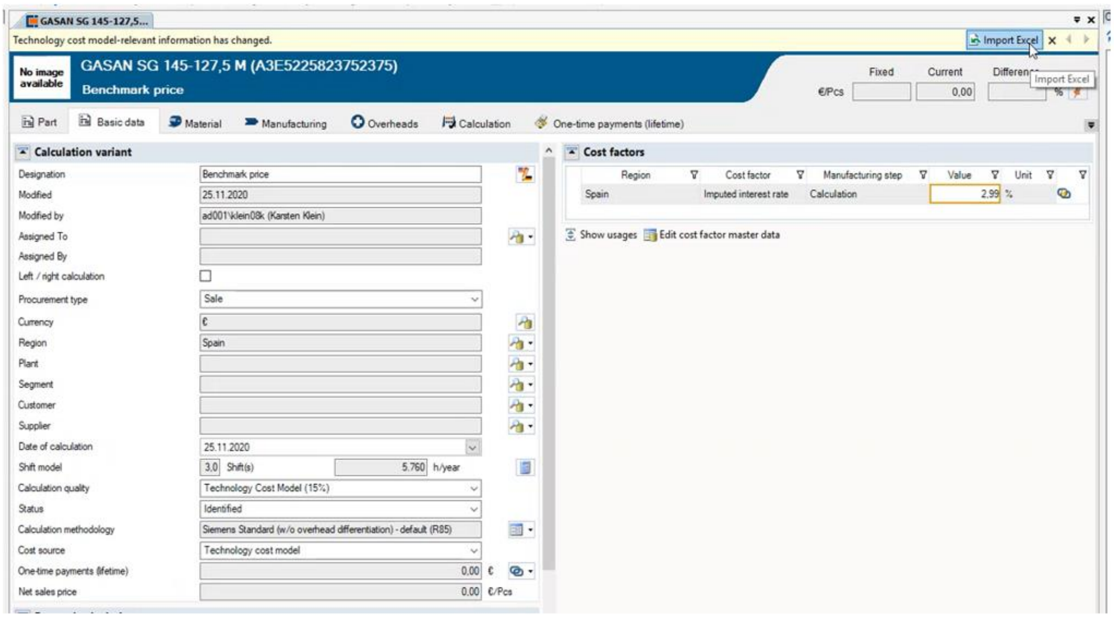



**Figure nr. 57. STAGE 5, step 14**

### 5.2.1.7. Practical application of selecting an optimized wind turbine nacelle design by applying the ABC method

This chapter describes the main elements of a wind turbine, the construction parameters to be considered and the selection criteria. Optimizing the size of the nacelle protective shell is the subject of the trade-off made by the author at the wind company. The trade-off and the elements considered in the analysis start from several theoretical considerations, applied by the author as key elements for weight reduction. The evaluation of the variants must be done through comparisons, so as to result in an analysis in which the weight of importance specified in Table no. 10.

In the wind industry, to choose a suitable design for the wind tower, one of the most important parameters to be considered is the transport dimensions. Starting from the structure of the turbine nacelle, in which the main parts of the turbine are found, we made a "trade off" (*selection following an analysis*) for an optimal design, with a significant reduction in weight and height, selecting from several advanced variants by the design department. We considered the following:

- Design optimization in accordance with the assembly method and the function performed
- The cost engineer works together with the designer to obtain the best cost with a fixed fixed design
- Optimized product line. Product cost performance
- The cost engineer works together with the designer using the *Design to cost process*

**General considerations on the nacelle of a turbine**

Generally, the common elements of each turbine are the hub, the rotor, the generator, the inverter, the hydraulic components and the bearings (see Figure no. 59)

The nacelle is the component part of the WTG (Wind Turbine Generator - wind tower), which includes the elements necessary for a turbine to transform wind energy into mechanical energy, operating a generator that will produce electricity. The wind turbine can reach impressive heights of over 130 meters, weighing over 200 t and the construction options depend a lot on the manufacturer and the developed power.

**Figure no. 59. Nacelle image (inner structure) source: nacelle picture - Bing images**

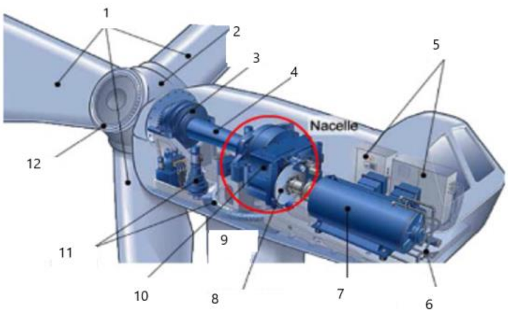



**Figure no. 60. Wind nacelle component elements**

1. **Blades**
2. **Hub**
3. **Bearings main shafts**
4. **Main shafts**
5. **Electronic power control system**
6. **Hydraulic cooling system**
7. **Generator**
8. **Emergency stop mechanism**
9. **Tower**
10. **Drive train**
11. ***Yaw system***
12. ***Pitch system***

*Yaw system* is the part of the turbine with the task of orienting the direction of the wind to the rotor. *Pitch system* is the system that controls the angle of the blades in a turbine and is composed of electric motors and geared gears or hydraulic cylinders as execution elements. This angle is determined by the wind speed, the resulting speed in the generator and the electrical power produced. Together with a set of gears of various sizes, the reducer converts the slow rotation of the blades from about 30–60 rpm to the 1000–1800 rpm needed for the generator to produce power.

Optimizing the size of the nacelle protective cover is the subject of the trade-off made by the author at the wind company.

*The trade-off* and the elements considered in the analysis start from several theoretical considerations, applied by the author as key elements for weight reduction. The evaluation of the variants must be done through comparisons, so as to result in an analysis in which the weight of importance specified in Table no. 10 (page 51).

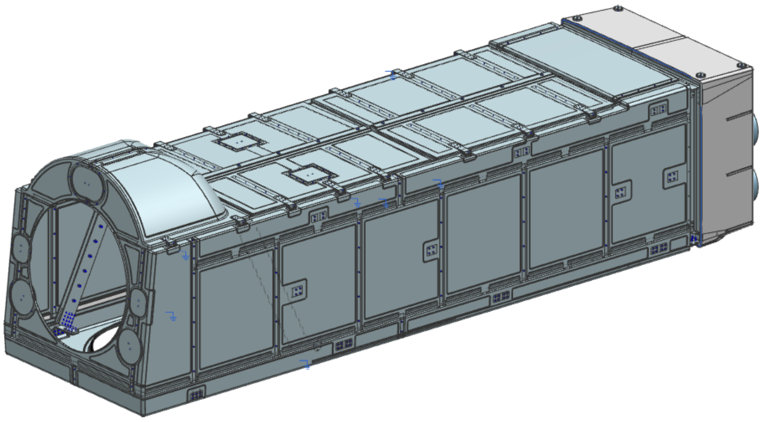


**Figure no. 64. Protective cover nacelle used for one of the most famous products of the wind company**

1) *WTG turbine cost* (**LCC** - *Life Cycle Cost*)

2) *Levelized Cost of Energy* **(LCOE)** is based on energy production throughout the life of the turbine and the energy produced in accordance with the minimum design required for a competitive product. The main goal is to develop an economic result based on LCOE. The costs are structured as follows: *A) Initial Cost (IC)* composed of: • Recurring Costs, includes Design, Development and Investments, • Material list or purchase price • Manufacturing, Construction and installation cost (MC) + *B) Price of property Ownership Cost (OC):* • Operational and maintenance costs (O&MC), • Decommissioning and residual costs (DC) and estimated end-of-life value (RV).

3) *Technology Readiness Level* (**TRL**) – Technological maturity level ≥ by 6.

4) *Patent Infringements* (Use of licenses, patents, etc.), the company must ensure that it does not infringe any kind of existing license on the market.

5) *Time to market* **(TM)** is the time required for the product to be available on the market.

6) *Logistic constraints* (**LC**) **-** logistic constraints evaluated for maximizing product capability, considering all strategic aspects, standardization and the entire production system, product delivery, service, starting from the purchase of raw materials to delivery to the consumer (SC *supply chain*).

7) *Technical Risk* **-** *The occurrence of technical risk.* All technical solutions must correspond to the specified requirements, which are evaluated for different solutions. Classification and identification of risks in accordance with the probability of their occurrence - a component of LCC.

8) *Health and safety (HSE)* - *Safety and health at work (SSM)* **-** ensuring the avoidance of any risk.

**9) Environmental Impact - The environmental impact** must be realized for each solution and must consider the following: **-** Identification of waste losses, emissions that can have an impact on the environment; **-** Their quantification can take place where it can be applied, **-** Identification of the costs of waste disposal, cost included in the LCC; **-** Evaluation of the total impact on the environment

LCOE must be determined in correlation with other elements that cannot be evaluated in cost such as planning risks, supply chain (the entire system of production and delivery of a product or service, from the beginning of manufacturing and its delivery including service, up to end users) as well as (8), (7), (4 **-** Use of licenses, etc.) highlighted in Table no. 10 and 15.

**Evaluation criteria's:**
-Components / Subsystems that can be manufactured and shipped in sufficient quantities by at least 4 different suppliers in each of the markets: USA, China, Europe
- Components / Subsystems that can be manufactured and shipped in sufficient quantities by at least 3 different suppliers in each of the markets: USA, China, Europe
- Components / Subsystems that can be manufactured and shipped in sufficient quantities by at least 2 different suppliers in each of the markets: USA, China, Europe - Sufficient capacity; 2 suppliers worldwide
- Production capacity but only one global supplier
- Only one supplier; Capable of unsafe production
- Only one supplier insufficient production capacity

**Evaluation criteria used by the author:**

| Criteria | Level |
|---|---|
| The component does not cause any danger in operation or function | 9 |
| The component may cause small scratches in operation and in operation | 8 |
| The component does not cause any hazard in operation or operation if appropriate protective equipment is used | 7-5-6-4 |
| Possibility of fatal accidents in operation or operation | 2-3 |
| The possibility of serious accidents in operation or functioning | 1 |
| **Criteria** | **Level** |
| Materials used are 100% recyclable and use little energy to recycle them | 9 |
| The materials used are 100% recyclable but use a considerable amount of energy to recycle them | 8 |
| Materials used are 100% recyclable but use a considerable amount of energy to recycle them | 7 |
| The materials used are 80% recyclable | 5-6 |
| Recyclable materials in limited quantities | 4 |
| Non-recyclable materials | 2-3 |
| Prohibited materials on the company's list for use | 1 |

**10) Technological perception - represents the way the market perceives each product concept:**

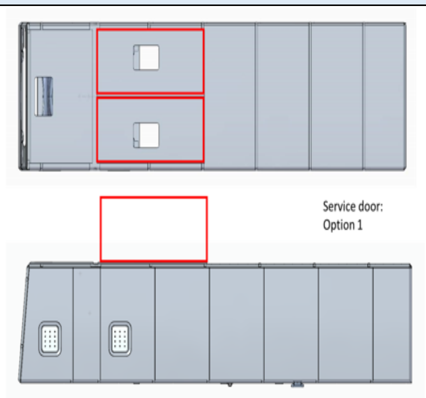
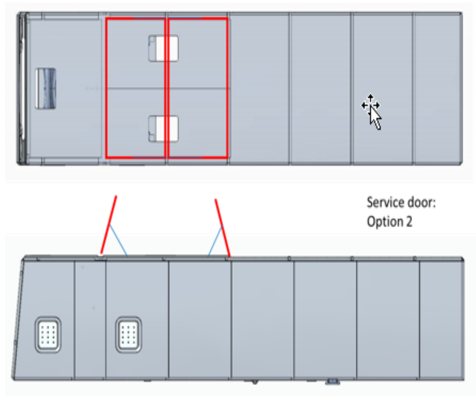
1) Excellent 9
2) Very good 8
3) Good 9
4) Fair 5-6
5) Better than weak 4
6) Weak 2-3
7) Very weak1

**Synthesis of the weight of the 10 key parameters**

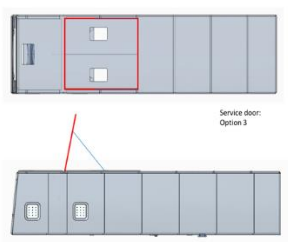
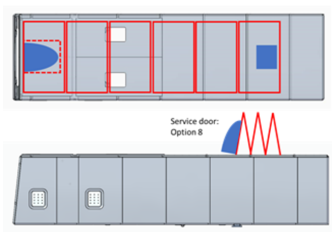
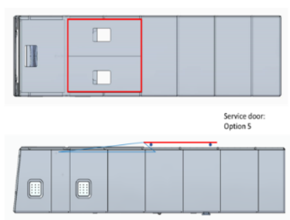
| Key parameter | ***1) (LCC)*** | ***2) Levelized Cost of Energy (LCOE)*** | ***3) Technology Readiness Level (TRL)*** | ***4) Patent Infringement (PI)*** | ***5) Time to Market (T2M)*** | ***6) Logistic Constrains (LC)*** | ***7) Technical Risk (TR)*** | ***8) Health & Safety Risk*** | ***9) Environmental Impact*** | ***10) Technology perception*** | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentage | **30%** | **25%** | **5%** | **2%** | **10%** | **4%** | **10%** | **9%** | **3%** | **2%** | **100%** |

Starting from these considerations and by involving stakeholders such as SER - service, LOG - logistics, CNS - construction and technical and ACH - procurement, we analyzed a nacelle roof concept with **7 concepts developed by the technological department as initial scenarios:**

1) **Tabel no. 11. Concepts 1, 2**

| **Concept:** | **Concept 1** | **Concept 2** |
|---|---|---|
| Drawing |   **Figure nr. 65** |   **Figure nr. 66** |
| **Drawing Disadvantages (CNS wind tower construction department)** | Insufficient space for actuators (drive systems) | |
| ***Significance Score from the table: 1****- unsatisfactory*, ***2 - Poor, 3*** *- Acceptable but subject to the fulfillment of other requirements*, ***4*** - Good, ***5 - Excellent - the highest!*** | | |
| *Safety* CNS | 4 | 2 |
| Production design | 4 | 2 |
| Easiness of assembly | 4 | 2 |
| Service | 3 | 2 |
| Transport /handling | 4 | 2 |
| Fabrication cost | 3 | 2 |
| Design robustness | 4 | 2 |
| Quality work assurance (SSM) | 1 | 1 |
| System warranties | 1 | 1 |
| Service / Feasibility | 3 | 3 |
| **Score** | **31** | **19** |

2) **Tabel no. 12. Concepts 3, 4 și 5**

| **Concept:** | **Concept 3** | **Concept 4** | **Concept 5** |
|---|---|---|---|
| Desen |  **Figure no. 67** |  **Figure no. 68** |  **Figure no. 69** |
| *Safety* CNS | 3 | 4 | 3 |
| Production design | 2 | 4 | 3 |
| Easiness of assembly | 4 | 4 | 4 |
| Service | 4 | 4 | 3 |
| Transport /handling | 4 | 3 | 3 |
| Fabrication cost | 3 | 3 | 3 |
| Design robustness | 3 | 4 | 3 |
| Quality work assurance (SSM) | 1 | 2 | 1 |
| System warranties | 1 | 4 | 1 |
| Service / Feasibility | 3 | 2 | 1 |
| **Score** | **28** | **34** | **25** |

**3) Tabel no. 13. Concepts 6 și 7**

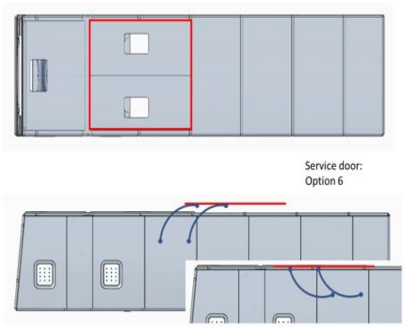
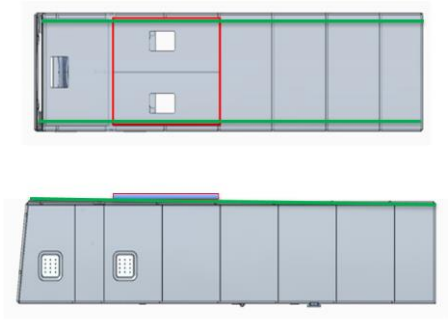
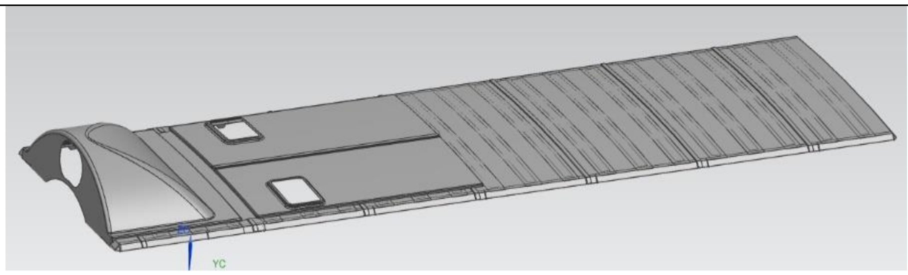
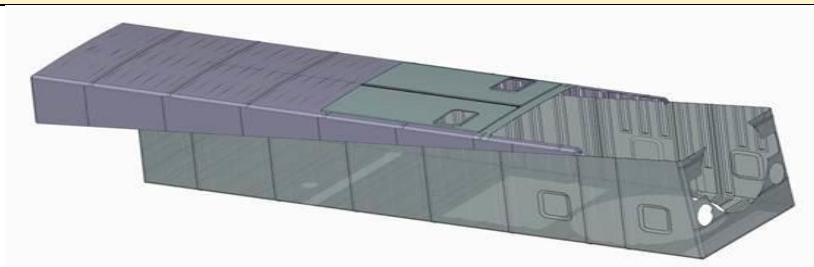
| **Concept:** | **Concept 6** | **Concept 7** |
|---|---|---|
| **Drawing** |   **Figure no. 70** |  **Figure no. 71** |
| **Disadvantages (CNS wind tower construction department)** | It depends on the mechanism. No additional tools are required. For H&S CNS the score is low due to the uncertainty of the way this system works. | NA |
| *Safety* CNS | 3 | 3 |
| Production design | 4 | 4 |
| Easiness of assembly | 3 | 4 |
| Service | 3 | 3 |
| Transport /handling | 4 | 3 |
| Fabrication cost | 3 | 3 |
| Design robustness | 3 | 4 |
| Quality work assurance (SSM) | 1 | 1 |
| System warranties | 1 | 1 |
| Service / Feasibility | 1 | 1 |
| **Score** | **23** | **24** |

**Table no. 14. By evaluating all the mentioned factors, 4 concepts will be proposed:**

| | |
|---|---|
| **Proposal 1** *Description* Roof panels will be simplified shipped in one container. The CNS construction department must remove the transport protection and install them. The transport height will become 3.5 m from the original 3.9 m. |  **Figure no. 72.** |
| | |
| Proposal 2<br><br>The roof of the nacelle will be transported to the indicated position. Dep CNS has to manipulate the roof with the help of special tools. The transport height will be 3.5m |  **Figure no. 73.** |
| | |

**Proposal 3**

The roof mounted in Production at the height of 3.5 m will be pushed using a spring device - bolts must be added from top to bottom. Transport of the roof will be done with it in the lowered position

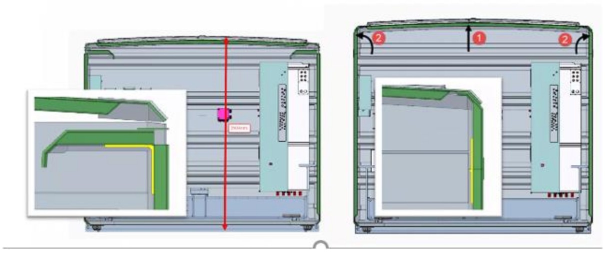


**Figure no. 74.**

**Proposal 4**

A fixed roof will result in a height of 3.5m the height from the floor to the rotor holding system in front of the wind when its direction changes. It is necessary to use a pass-through piece called a **dome** to fill the space between the floor and the hub (the component that holds the blades and connects them to the main shaft)

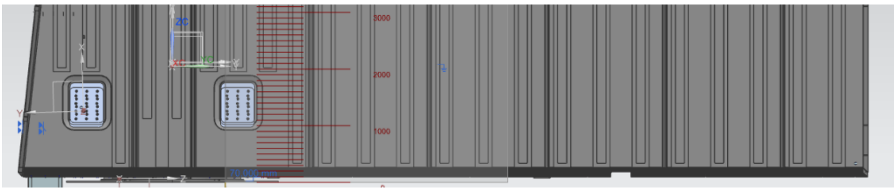


**Figure no. 75**

**Table no. 15. Evaluating the trade off for the remaining, chosen concepts**

| | **1) WTG cost (LCC)** | ***2) Levelized Cost of Energy (LCOE)*** | ***3) Technology Readiness Level (TRL)*** | ***4) Patent Infringement (PI)*** | ***5) Time to Market (T2M)*** | ***6) Logistic Constrains (LC)*** | ***7) Technical Risk (TR) -*** | ***8) Health & Safety Risk*** | ***9) Environmental Impact*** | ***10) Technology perception*** | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Score** | 30% | 25% | 5% | 2% | 10% | 4% | 10% | 9% | 3% | 2% | **100%** |
| **Proposal 1** | **6** | **3** | **3** | **9** | **5** | **7** | **5** | **7** | **4** | **7** | **5.1** |
| **Proposal 2** | **5** | **6** | **3** | **9** | **4** | **7** | **5** | **3** | **4** | **4** | **5.0** |
| **Proposal 3** | **6** | **5** | **3** | **9** | **4** | **7** | **4** | **4** | **4** | **5** | **5.0** |
| **Proposal 4** | **7** | **6** | **2** | **9** | **4** | **7** | **5** | **9** | **4** | **5** | **6.1** |

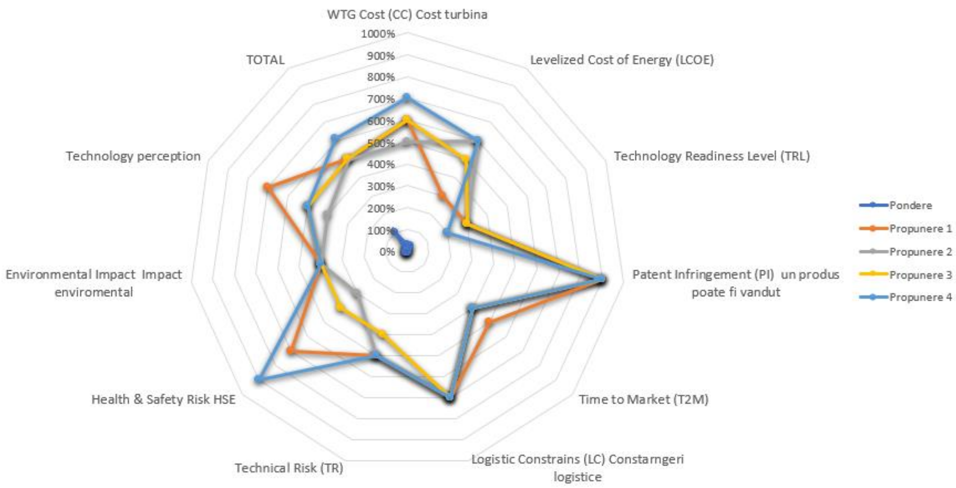



**Chart no. 2. Spider web diagram used for comparisons between objectives and achievements:**

By applying the ABC cost method, the indicated proposal can be evaluated in terms of cost and design changes and the activities leading to its manufacture can be identified.

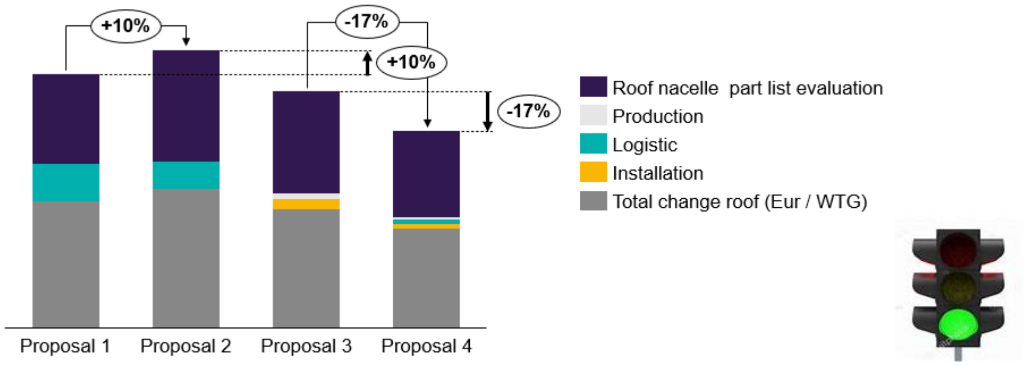



**Chart no. 3. Estimating the cost of the remaining concepts after the trade off analysis by applying the ABC method,**

The BOM (list of materials) used in the 4 design proposals was calculated, reaching the following conclusion: Proposal 4 is the one recommended to be adopted from the point of view of cost, also taking into account the invested capital (see Graph No. 4.)

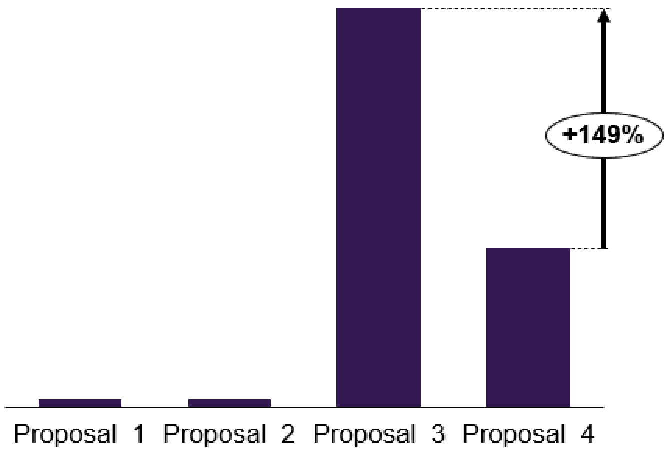



**Chart no. 4. Comparisons between the four author proposals**

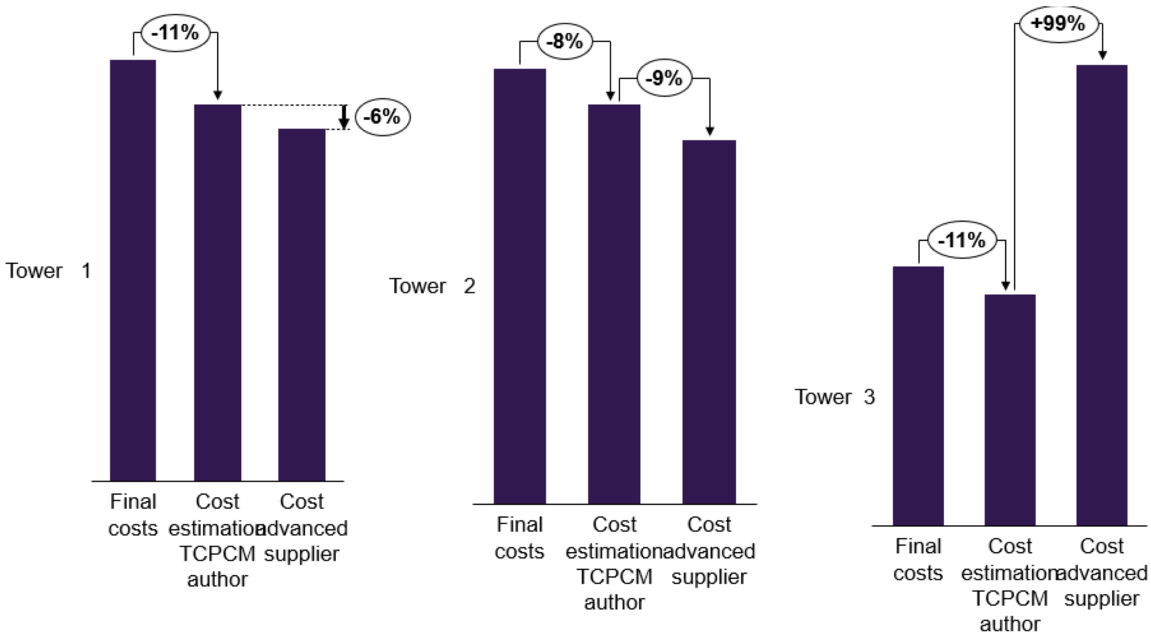



**Chart no. 5. Verified information obtained with the TCPCM software by the author**

The analysis of the capital required for the execution of the concepts by the ABC method was also carried out by the author. As it appears from the article published by the author together with the most famous "guru" of the ABC method, Gary Cokins, most companies suffer from finding a management accounting method that can classify customers as profitable or unprofitable, from the point of view of the support provided after selling the product. Even those in marketing know the situation of the existence of unprofitable customers, but they lack a tool to highlight this fact (*Hegner-Kakar et al.,* 2018).

By adapting the ABC method in a parametric model or by applying a specially created software based on the principles of the ABC method of converting indirect costs into direct costs, it is possible to identify all component costs in the final cost of the product. Through this integrated software, one hundred percent of the resources can be reallocated to the final cost of the product and of course this can support the final decisions of the company (Ballings et al., 2018).

### 5.2.2. Applied Contributions in the Oil and gas Industry

*The activity-based costing* method or activity accounting seeks a better correlation of the cost of resources with cost objects (products, orders, services), through the consumption of activities carried out by the company.

Practical applications from the period 2012-2017 are described, in which the author made an important contribution to the cost improvement program (with savings in the order of millions of USD) at the "MPS Basic Product Line 2012-2017", Valentina Zaharia - *Cost Engineer – FMC Technology*", through an application in the field of the petroleum industry on some equipment used in the extraction of crude oil at depths of more than 3000 m depth. The extraction of oil from great depths is carried out with the help of special underwater equipment.

Drilling wells are connected by pipelines to a fixed platform, a floating system (transport vessels) for collecting crude oil mixed with various other impurities, including water and other substances that require purification stage is done with the help of existing industrial facilities on board these vessels and stored in some special tanks, to be transported to the ground. There can be several probes acting simultaneously on a frame called a manifold (**MPS -Subsea Manifold Production System)** and the connection between all the equipment required for extraction. Manifold is a manifold with multiple connections designed to control, distribute and monitor the flow of drilling fluid. The manifold includes a set of valves, valves, connectors to join the flow lines, as well as connection points for individual production wells. *Manifolds* require some type of frame to provide support structurally to the various pipes and valves. Sometimes this frame and manifold are incorporated into the towing head of the manifold, in which case it is commonly referred to as a PLEM. Manifolds are often configurated for specific functions, such as a manifold "preparing" (pass sections) used in well control operations, a fracturing manifold for directing treatment fluid, and a compression manifold used in plugging operations. In each case, the functional requirements were individualized in the collector configuration according to the degree of control and the tool set required by each platform.

A central manifold is connected to 4-6 metal "Christmas tree" structures containing extraction drills, the entire manifold serving as a foundation and protection for the manifold and shafts and is represented in Figure 77.

**Figure no. 77. *Production Manifold* (Source: Onesubsea – Cameron & Schlumberger company)**

During 2012-2017, I have had an important contribution to the cost improvement program (with savings in the order of millions of USD) at the "MPS 2012-2017 Core Product Line", Valentina Zaharia - *Cost Engineer* - *FMC Technology*, through - an application in the field of the oil industry on some equipment used in the extraction of crude oil at depths of more than 3000 m depth. In Figure no. 78 we introduced an outline of the fabrication of integrated template structures. Costs in the manufacture of large-scale welded components from the large-scale MPS component "Integrated Template Structures" can be reduced by standardizing the elements highlighted in Figure 78 with yellow color (Typical parameters adapted to the project requested by the customer). By applying the ABC method, the main activities that can lead to the reduction of the total cost were highlighted (see Table 16).

**Table no. 16: Activities and associated costs (NOK and LEI)**

| ACTIVITIES | NOK | LEI | Exchange |
|---|---|---|---|
| Welding and metallic constructions | 2.900.000 | 1.392.000 | 1 NOK = 0,48 lei |
| Termic treatment | 1.000.000 | 480.000 | |
| TMGB | 900.000 | 432.000 | |
| Mud mat hatch | 700.000 | 336.000 | |
| Support Rods | 600.000 | 288.000 | |
| Anodes | 200.000 | 96.000 | |
| Project Management | 100.000 | 48.000 | |
| Final assembly and weight | 1.000.000 | 480.000 | |
| Support equipment | 80.000 | 38.400 | |
| Interface metallic frame | 150.000 | 72.000 | |

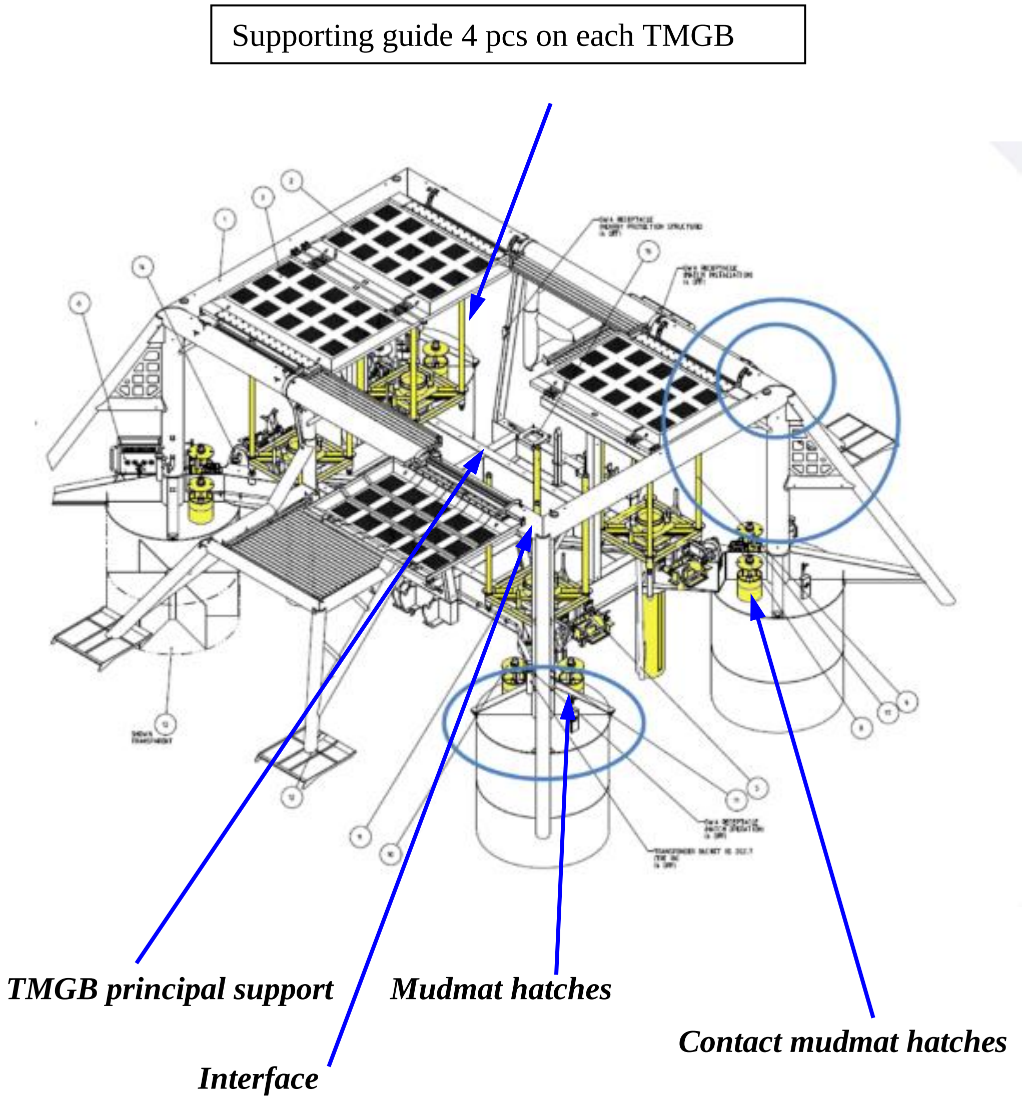



**Fig. no. 78. Auxiliary parts for standardization and execution**
**Valentina Zaharia – Cost Engineer – FMC Technology**

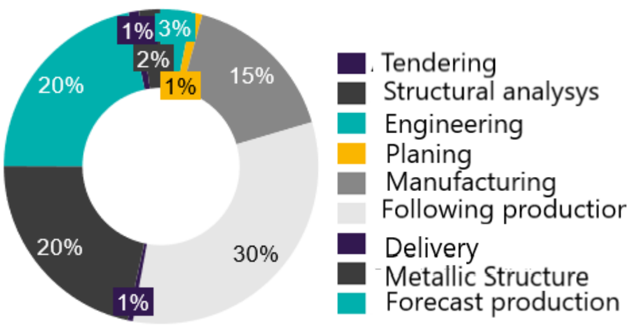
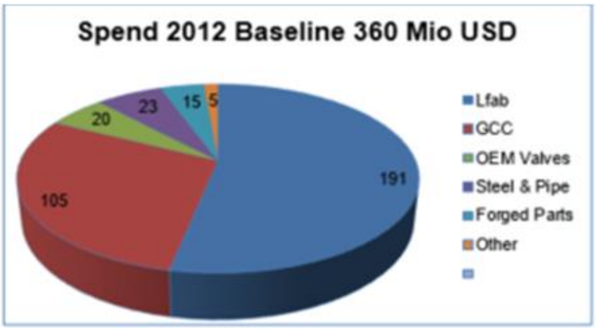
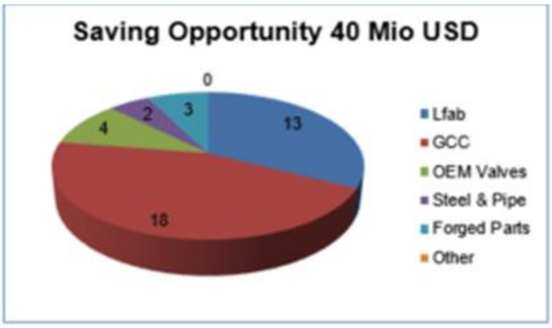



**Chart no. 6. Manufacturing cost reduction in Manifold through author ideas**




7A 7B


7C

**Chart no. 7. Initial expenses (7A), Cost reduction potential by applying the TD-ABC method (7B) and distribution of cost reduction (7C) at the end of the GCC UCON H project, analyzed by the author within the oil company**

Second example of the application of the ABC method applied to the oil and gas field by the author, as a cost engineer, was done for the part UCON, (is a connecting device between the components in the manifold for the *Cradle Support* element described Figure 79) and detailed with detail components system in Figure 80, was achieved a cost reduction of 55,000 NOK - 17.9%. Total project cost 9M NOK; The raw material represents approximately 35% of the cost; Optimized pricing is based on large order quantity (50+ pieces). By using Value Engineering, the total cost reduction per piece 50,400 kr (37%) so for 150 pieces / year, the annual saving is 6,000,000 NOK = 3,000,000 lei.

**Figure no. 79. UCON system used to connect various devices when extracting oil from the bottom of the water at depths even over 6000 m.**

Sursa: Subsea Connection Systems - FMC's UCON System Maritime Technology News (marinetechnologynews.com) Microsoft PowerPoint - UCON-H presentation - FFU 2012.pptx

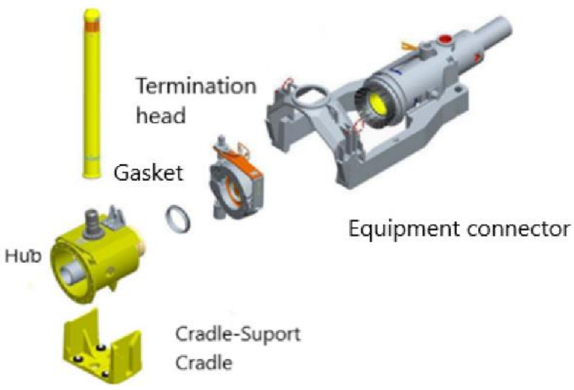



**Figure no. 80. UCON-H Components: Housing (HUB), Cradle (Support), Termination, gaskets, Inner / Outer Connection, Hub**

In table no. 18 we entered the input data and assumptions.

**Tabel no. 18. Assumption used in estimation cost:**

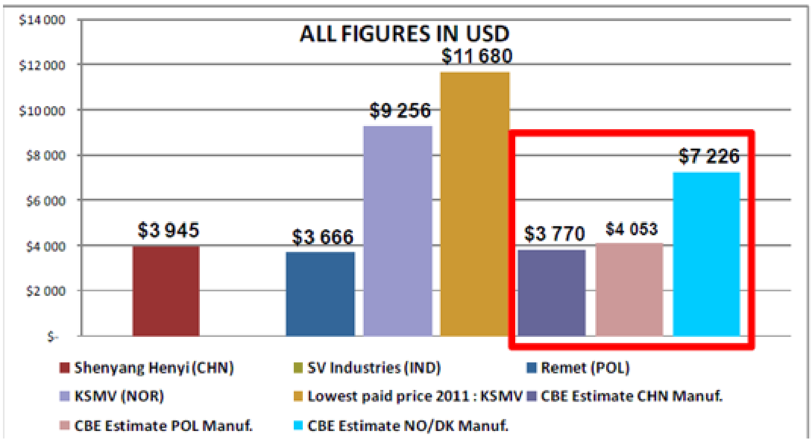
| | |
|---|---|
| Raw material | Casted steel ( specification M10603) |
| Cost raw material | $ 1,9 /kg |
| Assumptions casted part | Raw material cost1 USD / kg + directe laor cost<br>20-24 hours for doing casting |
| Machine | Numerical Comand Center CNC: investment 860.000 $, capacity utilization80%, 2 shifts, 1 operator per shift, depreciation over 12 years, machine cost75 USD /hour |
| Labor direct hourly cost | NOR = 75 USD; CHN/IND = 3 USD; POL = 9 USD |
| Machining hours | 9-15 hours to machine first 3 parts, nedistructive control, NDT 3,5 - 4,5 hours |
| SG & A (General administrative expenses) | 28% from all activies as added value |

**Table no. 19. Costs estimated by the ABC method for different manufacturing regions for the UCON Cradle component in Figure no. 78 – in different (China – Poland – Norway)**

| Supplier | Shenyang Henyi (CHN) | | SV Industries (IND) | | Remet (POL) | | KSMV (NOR) | | CBE Estimate CHN/IND Manuf. | | CBE Estimate POL Manuf. | | CBE Estimate NO/DK Manuf. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Process | Cost | % | Cost | % | Cost | % | Cost | % | Cost | % | Cost | % | Cost | % |
| Material | $ 1 501,73 | 38 % | $ 575,12 | | $ 2 809,82 | 77 % | No | | $ 1 208 | 32 % | $ 1 208 | 30 % | $ 1 208 | 17 % |
| Casting | $ 500,58 | 13 % | $ 2 063,68 | | | 0 % | breakdown | | $ 731 | 19 % | $ 849 | 21 % | $ 2 171 | 30 % |
| Machining | $ 1 473,77 | 37 % | **Not quoted** | | $ 781,38 | 21 % | | | $ 1 011 | 27 % | $ 1 087 | 27 % | $ 1 947 | 27 % |
| Coating | | 0 % | | | | 0 % | | | | | | | | |
| Testing | $ 153,85 | 4 % | | | | 0 % | | | $ 14 | 0 % | $ 40 | 1 % | $ 338 | 5 % |
| Packing | $ 230,77 | 6 % | | | $ 37,51 | 1 % | | | $ 231 | 6 % | $ 231 | 6 % | $ 231 | 3 % |
| Transportation | $ 84,31 | 2 % | | | $ 37,51 | | | | $ 84 | 2 % | $ 84 | 2 % | $ 84 | 1 % |
| SG&A,R&D+Profit | $ - | | | | $ - | | | | $ 492 | 13 % | $ 553 | 14 % | $ 1 248 | 17 % |
| Total (USD) | **$ 3 945** | 100 % | | | **$ 3 666** | 100 % | **$ 9 256** | | **$3 770** | 100 % | **$4 053** | 100 % | **$ 7 226** | 100 % |
| Model cost | **$ 7 615** | | **$64 500** | | **$ 12 810** | | **$ 19 000** | | | | | | | |

***) SGA&RD and Profit***

**For privacy reasons, the offer from Norway is not shown.**




**Graph no. 9. Applications of ABC method in Norwegian oil and gas company made by the author for different UCON component parts in different regions: from the price comparisons, the significant cost reduction in China is highlighted**

In Figure no. 81, historical order prices based on an order size of 3-6 pieces is 369,000 NOK = 189,500 lei. By applying the TDABC method, a reduced cost of 123,000 NOK = 61,500 was reached, i.e. - 33%.

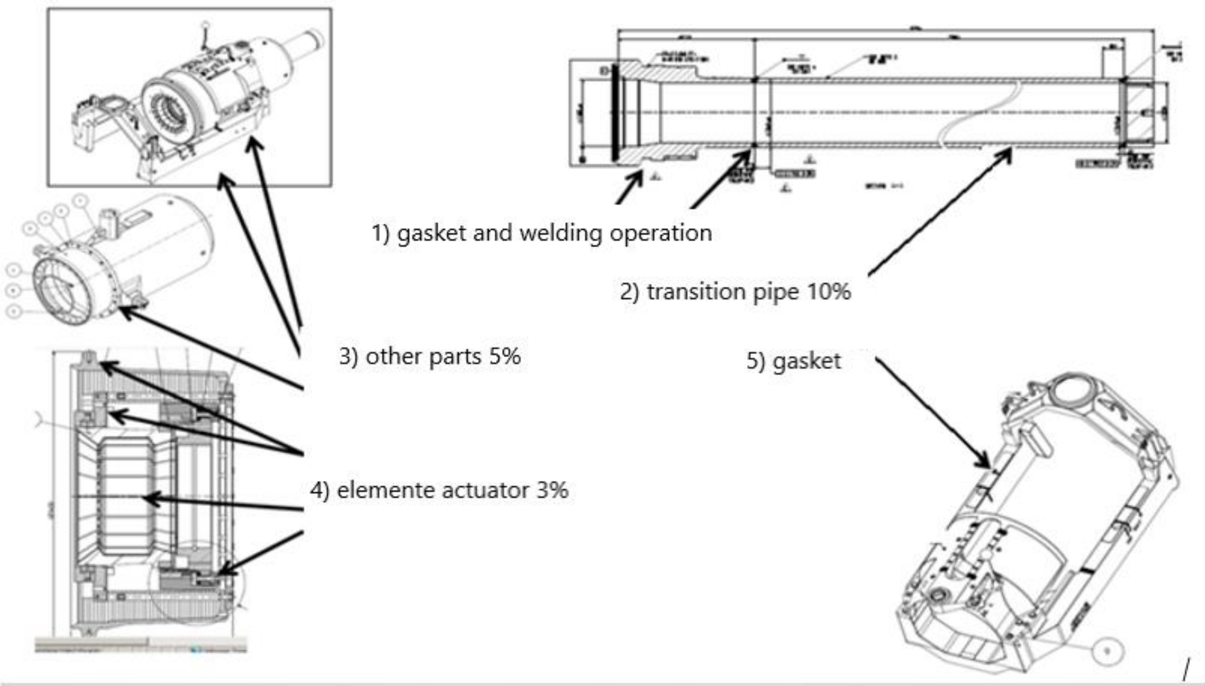
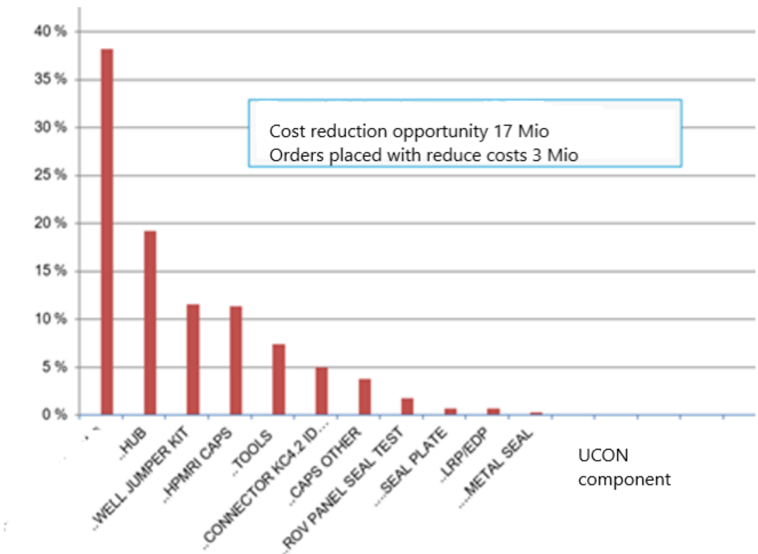



**Figure nr. 83. UCON H-18 Capturing head Support, insulated (Cost: NOK 2,160,000 = 1,080,000 lei). Example**




**Graph no. 10. Cost reduction possibilities for UCON components**

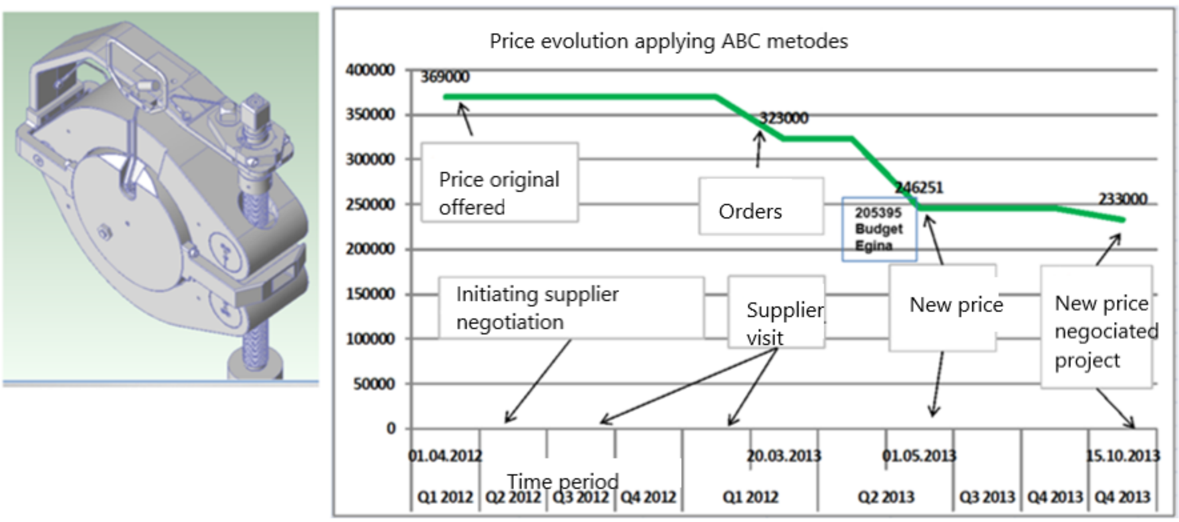
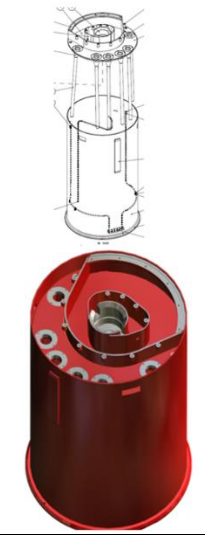


**Figure nr. 84. HPMRI piece cost reduction development produced by applying the TDABC method by the author**

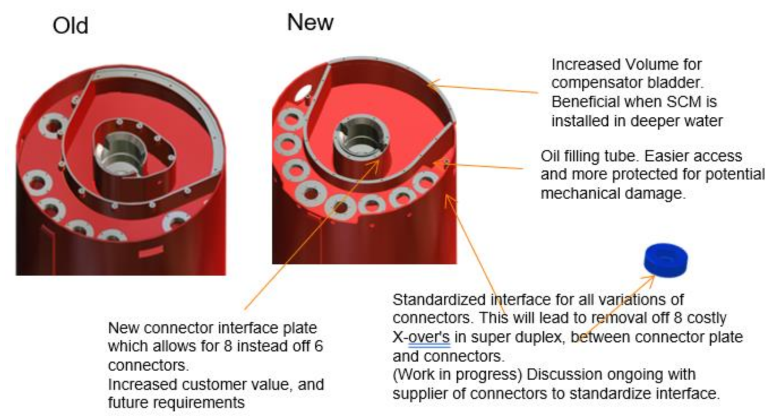


| Old design | In between we take away the parts marked with blue color | Nee design |
|---|---|---|

**Fig. no. 85a Production steps: Machining, welding, surface treatment and testing. Valentina Zaharia – Cost Engineer – FMC Technology, for the metallic component module control in MPS structure**

**Old price:**

Model with 6 connectors has a current costs of 105.000 NOK[4] = 52.500 lei, excluding duplex connecting plate




**New cost:**

8 connectors without the part = 84.500 NOK = 42.250 lei. Including duplex connecting plate (8 connectors)

Cost for plate connector with screw = 10.000 NOK = 5.000 lei more

**Fig.no 85b. Engineer Value applied with ABC method for a metallic construction part. Module control used in oil and gas industry** (sut.org)

[4] **1 Norwegian krone NOK = 0.50 lei (2022)**

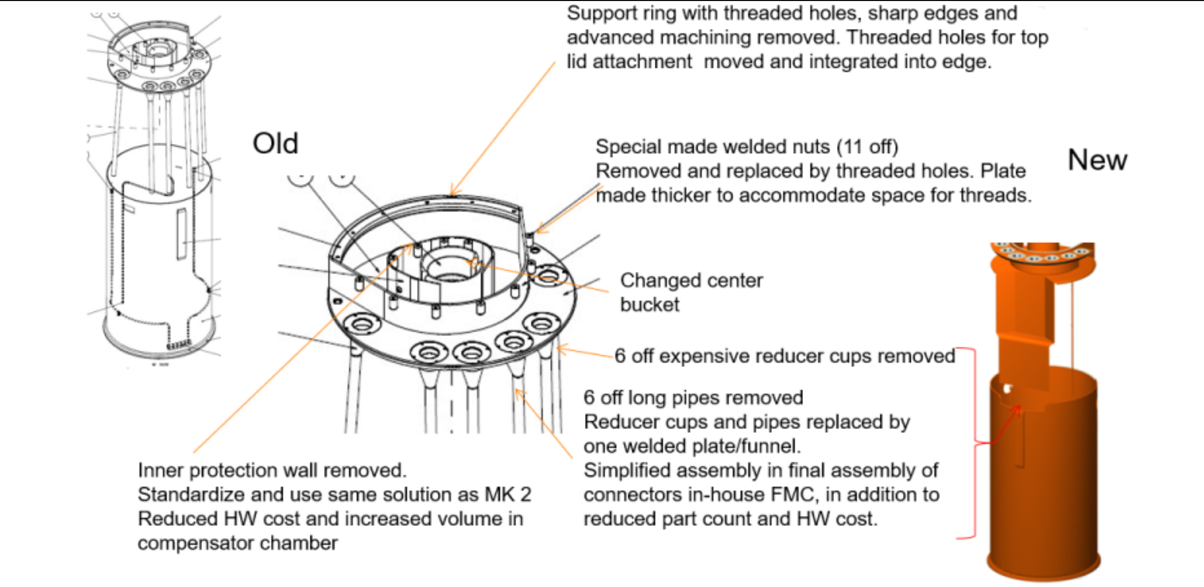



**Figure no. 86. Detailing of parts removed or changed**

**Table no. 20. Design results and benefits to reduce production cost**

| Benefits from value analysis | Procent |
|---|---|
| Reducing the Hardware costs for outercan with o mention the 8 cups | 25% |
| Increase volume for the compensatory room and performance | |
| The new concept does not minimize the quality, form, suitability and function | |
| Increasing the number of connectors will satisfy the future requests of the clients | |
| Reducing the final assembly and internal delivery time through the shortening assembly time of | |

**Table no. 21. Number of parts removed/changed**

| Parts removed/Changed | No |
|---|---|
| Reduction cups replaced by guiding funnel | 8 |
| Long pipes replaced by the guide funnel made of two plates | 8 |
| Inside wall | 1 |
| Supporting ring simplified | 1 |
| Welded nuts replaced by threaded holes | 11 |

**Table no. 22. Comparing the new concept with the old (additional) design is done by levelling the costs:**

| Denomination | UM | Numbers | Unitary price | Extra cost NOK |
|---|---|---|---|---|
| Connector plate support duplex | Pcs | 1 | 12.000 | 12.000 |
| Extra pipes | Pcs | 2 | 1.000 | 2.000 |
| Connectors X | Pcs | 8 | 1.050 | 8.400 |
| Price for cups | Buc | 8 | 1.000 | 8.000 |
| | | | **Total cost to easy compare two designs** | **30.400** |

**Table no. 23. Cost comparison between old and new design (NOK – Norwegian kroner)**

| | Old design (NOK) | New design (NOK) |
|---|---|---|
| Cost comparison | **135.400** | **84.500** |

**Conclusion: By using Value Engineering, the total cost reduction per piece 50,400 NOK (37%) so for 150 pieces / year, the annual saving is 6,000,000 NOK = 3,000,000 lei.**

*The activity-based costing method or activity accounting* (ABC) determine a better correlation of the cost of resources with cost objects (products, orders, services), through the consumption of activities carried out by the company.

Thus, when we open a component that has not been estimated before, aPriori displays the Cost Guide on the left side of the desktop. The guide is a wizard-like interface, divided into three tabs (tabs) that guide you to enter the production, tolerances, machine used and process information necessary to generate an accurate correlation of the manufacture of the respective component. Such an example only highlights premature costs that are far from accurate, but the Cost Guide guides the user to the cost factors that must be considered. Process routing is the sequence of manufacturing steps that a component must pass through in its evolution.

For a process sequence, the most important setting is the process group selection. When aPriori first encounters a new CAD file, it cannot automatically determine what kind of component it is, so the first thing it does is select the appropriate process group.

The virtual manufacturing environment is the aPriori cost base: this is a virtual factory that typically defines the production capabilities and related cost drivers such as: available machines, manufacturing processes, parameters, and physical location (country, region, etc.). APriori provides a core set of virtual production environments that are modified for each type of user as needed. For example, if switching to a different virtual production environment is to be done (the component is to be manufactured in Mexico instead of the US), then the virtual environment will change to display the *Virtual Production Environment Selection* window. Some of these fields include: manufacturing information (entered in the Info administration tab of the *Cost Object window*), routing options, presented as a simplified version of the aPriori route selection window (chosen from the menu Edit → Process Manufacturing → *Routing Selection*). This simplified version emphasizes primary routing alternatives, secondary process choices, an easy-to-navigate pop-up check box format (by including these secondary processes in the "*Select a Processing Route*" window, tolerances for GCD- individual values (from the Edit menu → Processing panel Tolerance) or the context menu from the Geometric Cost Drivers panel, the process configuration options (from the *Edit Machine menu → Machine Selection*) Estimating the cost of a part using aPriori and comparing the estimated cost with three suppliers, in the *CDM_Media Converter* Cost Module Analysis.

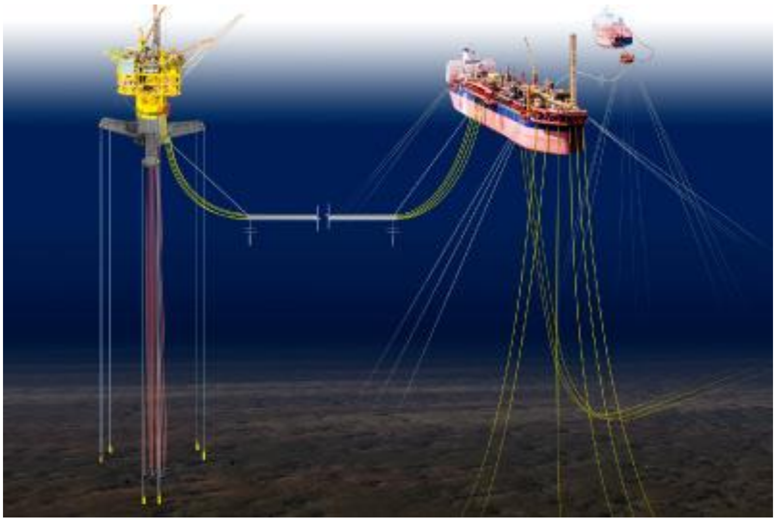


**Figure no. 88. Copper-to-fiber conversion by a media converter allows two network devices with copper ports to be connected over long distances using fiber-optic cables.**

**A third example of the author's** cost reduction is in a media converter (CDM). In the context of network hardware, the Media Converter Jumper is a flexible device for implementing and optimizing fiber links in any type of network. The Media Converter Jumper enables the extension of an Ethernet IP network from a deep-sea electronic module using a single optical fiber inserted into the cable to connect to a memory converter or media conversion module with the "umbilical" terminal unit " (Umbilical Termination Unit). It converts the electrical signal used in the network cable into light waves used for fiber optic cabling. If the distance between two network devices is greater than the transmission distance of the copper cable, it is essential to have fiber optic connectivity.

**Table no. 24. The purpose of the project - the starting assumptions for the purpose of estimating the cost**

| | |
|---|---|
| **Project name:** | Cost Analysis_Media Converter Module_CDM |
| **Part Number:** | MCM - Assembly |
| **Application** | *The Media Converter Jumper* allows the extension of an IP Ethernet network from a deep-sea electronic module using a single optical fiber inserted into the cable to connect to a memory converter or media conversion module with the "umbilical" terminal unit ” (*Umbilical Termination Unit).* |
| **Technical parameters** | Material Titan Grad 5, Raw material: Rectangle plate |
| **Annual volume** | MC Mechanical assembly Inițial Design: 3 pcs |
| **Raw material** | Titan Grad 5 |
| **Raw material info** | Titan Grad 5: rectangular bar = 375 NOK/Kg = 193,31 lei/kg |
| **Machine** | Investment: Mazak FH12S00 - 7236000 NOK = 3.730.158,00 lei, Hermle B300-2500000 NOK = 1.288.750,00, 2 shfts, 1 operator/shift |
| **SG&A, Profit** | To the estimated cost is added: 25% more on the Manufacturing process + 5% on the Material + 2% Indirect costs for the intermediary + 3% on the transport costs from one Supplier to another. |
| **Total Time** | 1160 NOK/hour (Mazak) = 598 lei/hour |
| **(Machine+Labor)** | 909 NOK/hour (Hermle) = 468,60 lei/hour |
| **Hourly rate (direct and indirect)** | 500 NOK/hour = 257,75 lei/hour |

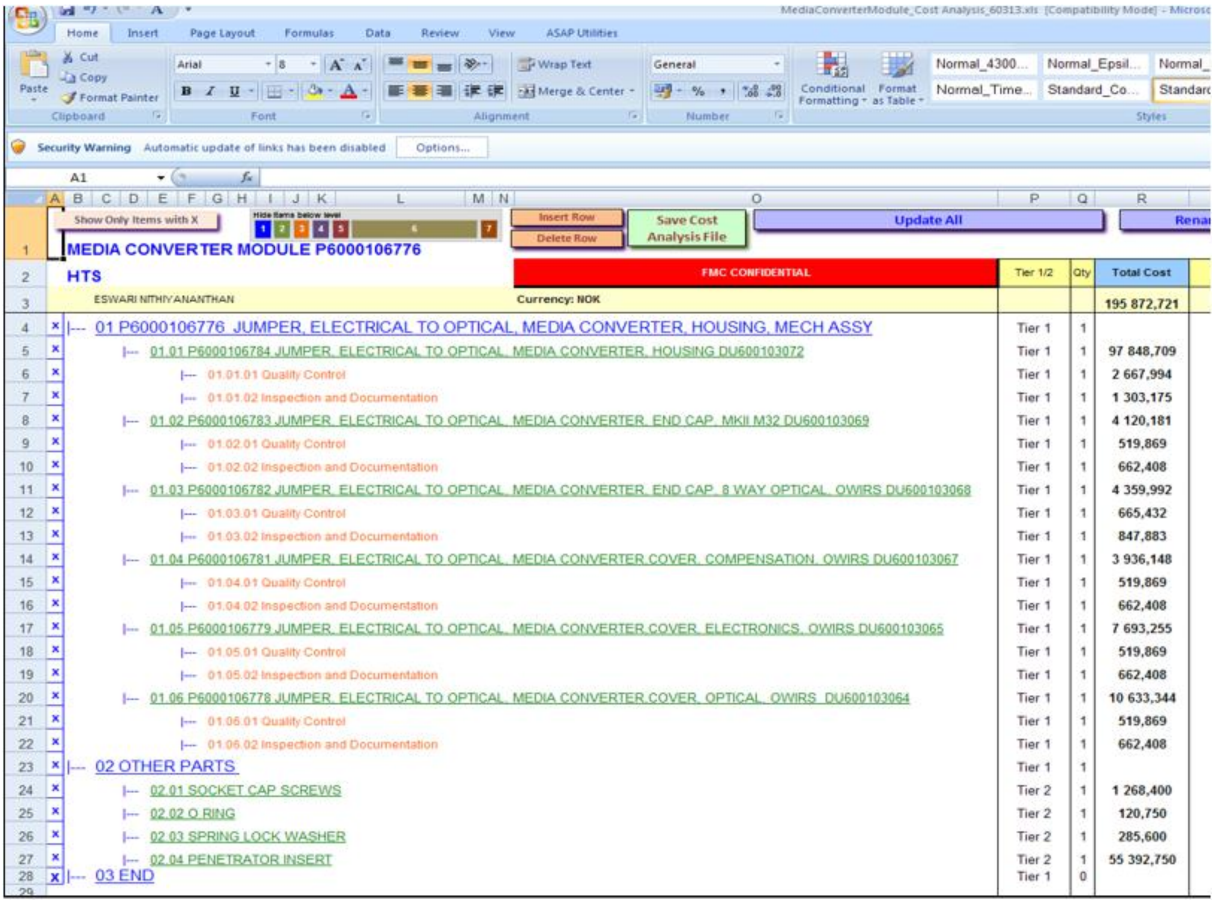



**Figure no. 89. Media Converter (MC) - Analysis of assembly mechanical costs by applying TDABC (*Time Driven Activity Based Costing*) with the help of aPriori software**

**Table no. 25. Report with summary of expenses: XXXXX JUMPER, MEDIA CONVERTER, Mechanical assembly of the case (for 6 components); NOK = Norwegian kroner**

| | NOK | Curs NOK/ lei | LEI |
|---|---|---|---|
| **MATERIAL:** | **79.524,88** | **0,52** | **41.352,94** |
| ***Supplier 1 Materials*** | **25.174,88** | **0,52** | **13.090,94** |
| ***Supplier 2 Components*** | **54.350,00** | **0,52** | **28.262,00** |
| **MANUFACTURING:** | **89.693,50** | **0,52** | **46.640,62** |
| ***Labor costs*** | **43.812,50** | **0,52** | **22.782,50** |
| ***Variable expenses*** | **25.188,05** | **0,52** | **13.097,79** |
| ***Fix expenses*** | **20.692,94** | **0,52** | **10.760,33** |
| **Another expenses+ PROFIT** | **26.654,35** | **0,52** | **13.860,26** |
| ***Supplier 1 administrative expenses,SGA + Profit*** | **23.936,85** | **0,52** | **12.447,16** |
| ***Logistic and transport*** | **2.717,50** | **0,52** | **1.413,10** |
| **TOTAL COST** | **195.872,72** | **0,52** | **101.853,81** |

Estimated costs are identified by dividing them into cost components and easily comparing them with offers (quotations) received from suppliers. Supplier X's price offer: NOK 488,600.00 = 251,873.30 lei Supplier Y's price offer: NOK 259,681.20 = 129,840.60 lei

**The cost estimated by the author using the TDABC method: NOK 195,872.721 = 100,972.40 lei**

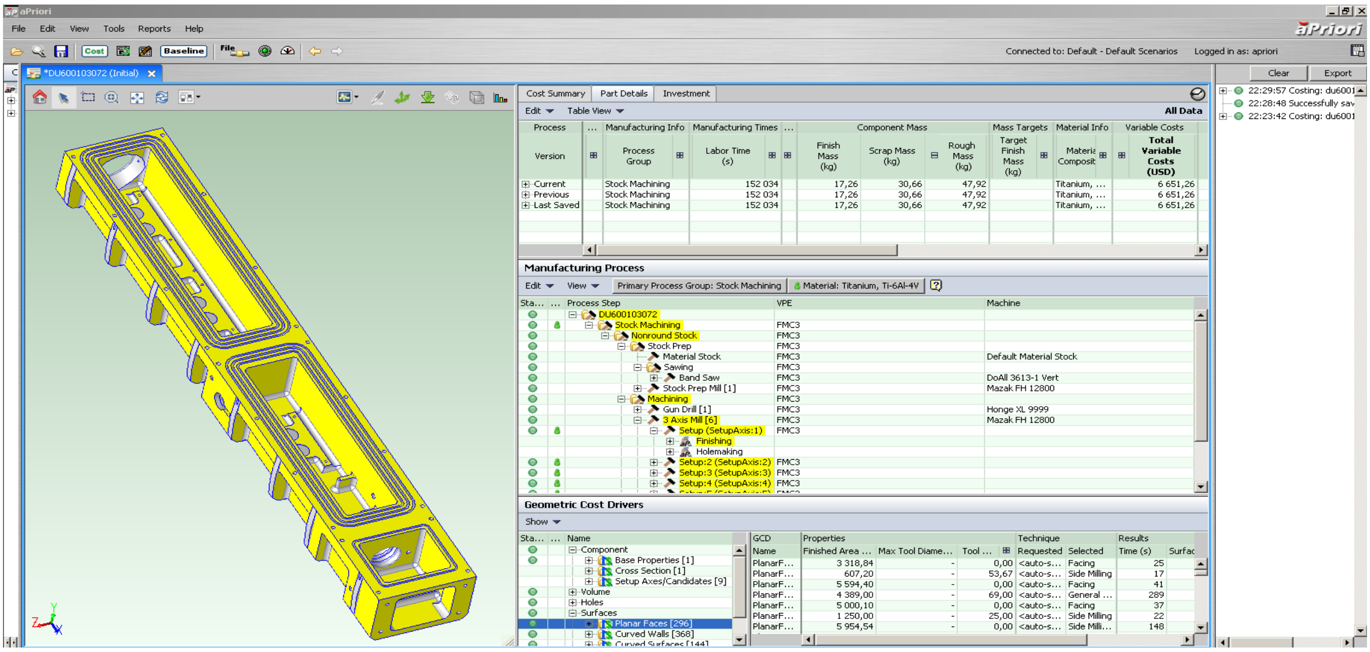



**Figure no. 90. Jumper, Electric / Optical, media converter, gasket another example of software application**

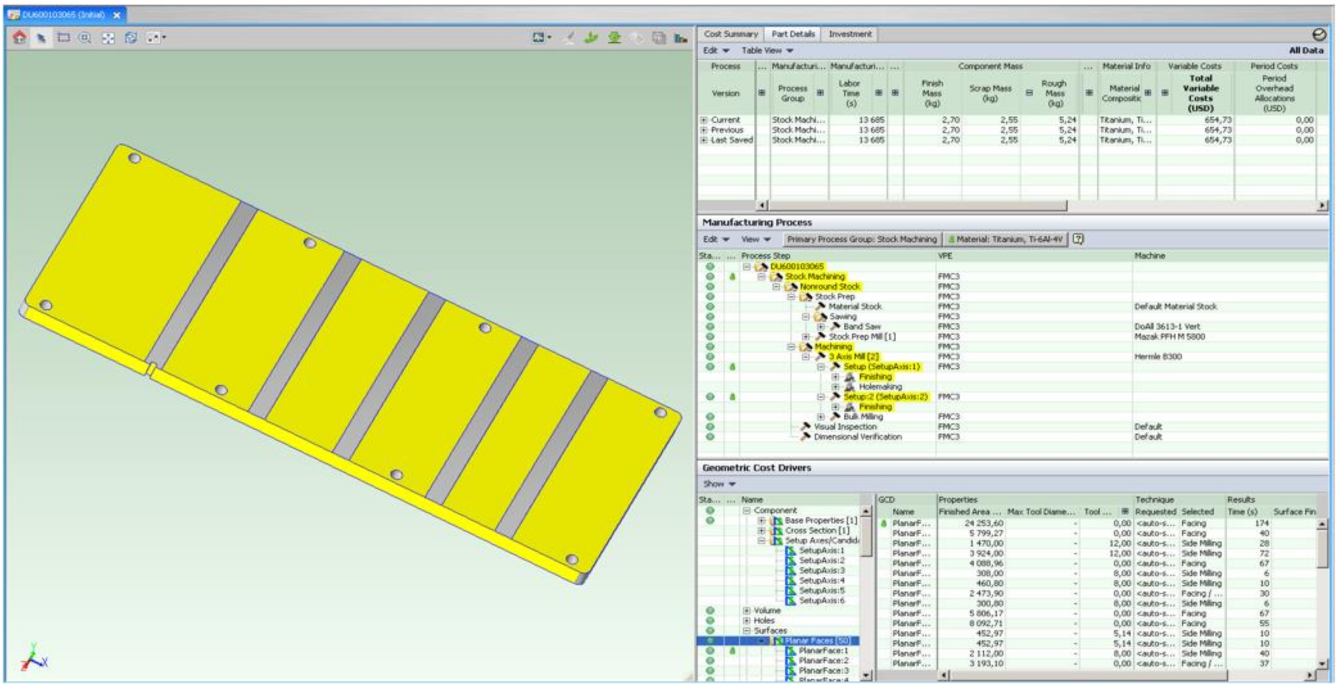


**Figure no. 91. Jumper, Electric / Optical media converter cover**

**According to point 4.3.3.2. Presentation of computer processing functions; cost software used in Chapter 4 of the thesis,** I will exemplify modern human resource management by connecting to cost-simulation systems that contain real values of working hours and labor for each country in the case of Siemens TCMP Teamcenter Product Cost Management and aPriori Cost Software, through industrial processes, as shown in Figures 92-93:

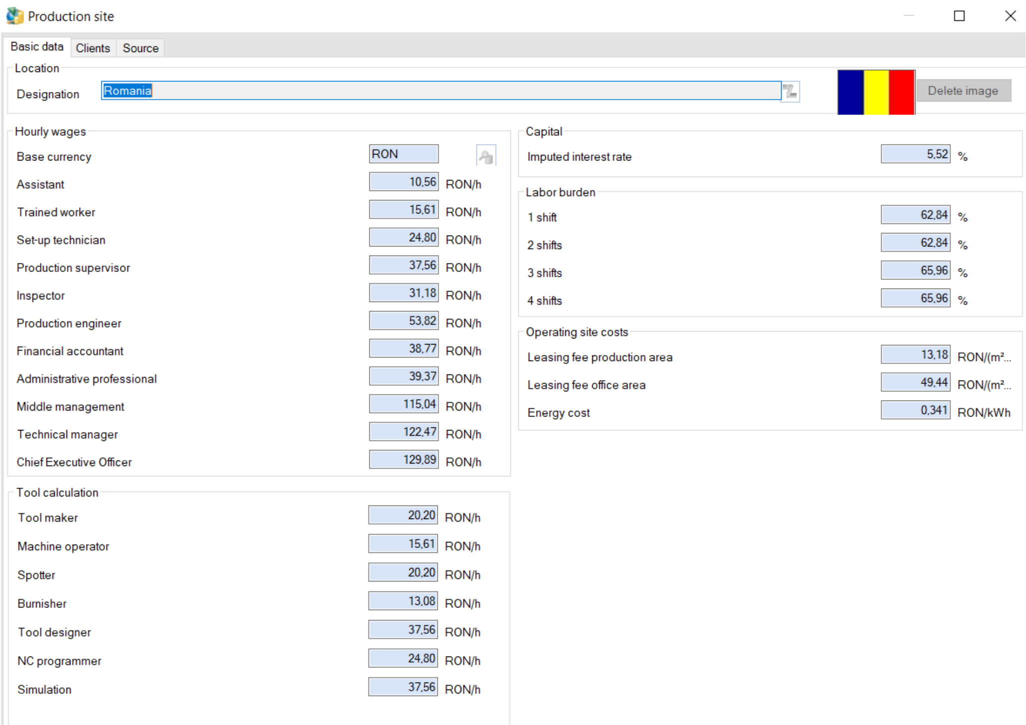



**Figure no. 92. Siemens graphic interface for Romania - Siemens program resources hourly rates of different categories of work Skilled worker, Supervisor, Administrative staff**

aPriori costing software window for determining the cost per country:

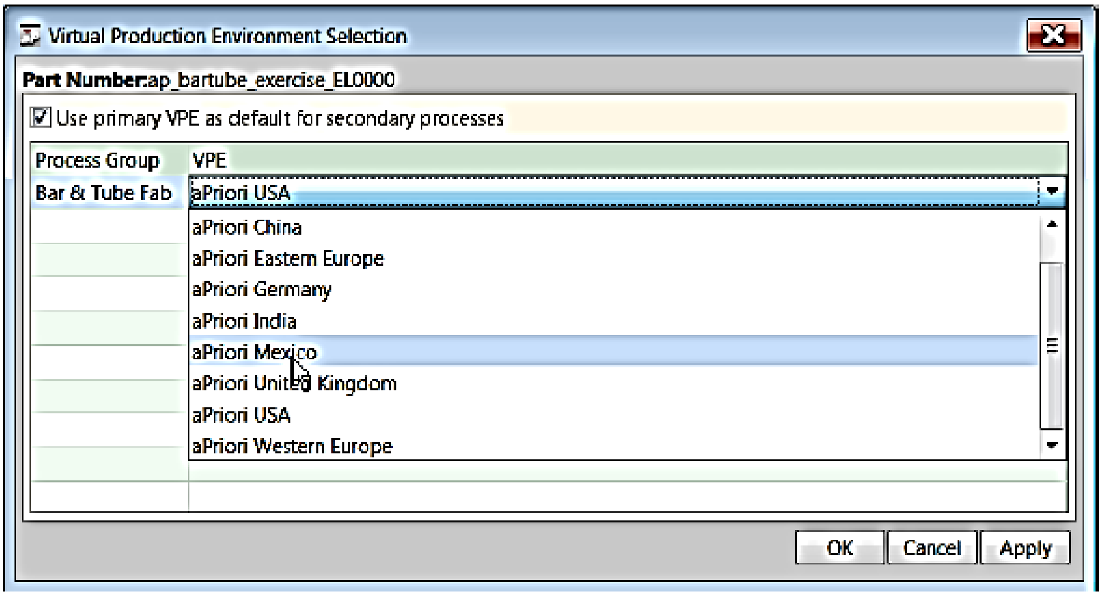



**Figure no. 93. Detail, aPriori software machine cost interface (hourly rates included in aPriori software)**

**The main steps in an example of a cost estimate using the aPriori calculation program:**

PURPOSE: To identify the cost of the product, from the semi-finished product to the finished part

1. View the three-dimensional display
2. 3D files can be loaded from any known CAD system family (Katia, AutoCad, Siemens NX, etc.)
3. There is a database of materials and parameters associated with each machining process in the calculation software
4. The industrial process time and related costs are calculated for all the industrial processes necessary to obtain the component
5. The main geometric cost characteristics are identified (radius, straight line, associated specific geometric shapes according to which the processing operations are established)
6. Processes are configured. Examples: covering with insulating material, plating with different metals
7. The routes of processing operations are configured, from the most expensive to the cheapest option, and the optimal option is chosen.

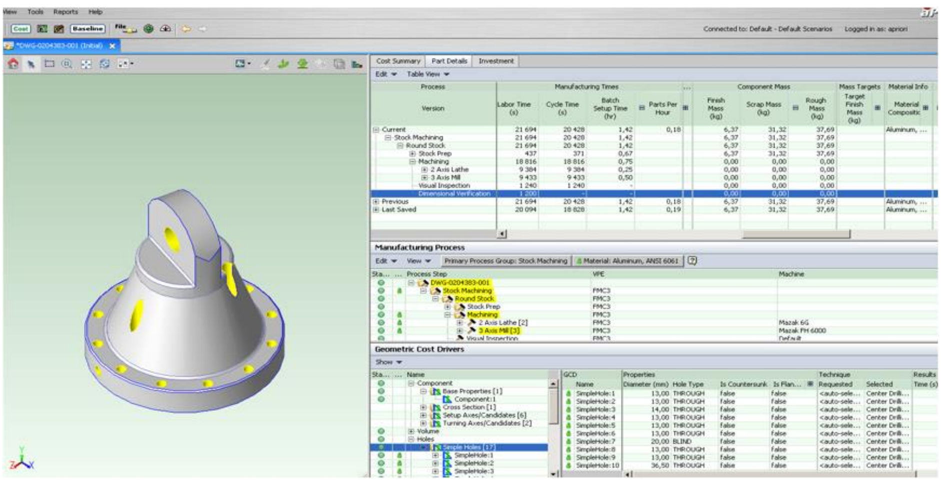


**Figure no. 95. Part Estimating Using aPriori Cost Software: PAD EYE_Running Tool** • Material cost: aluminum alloy 40kgs_157USD • Production Cost_210USD (see selection from Priori's program below.))

### 5.2.3. Applicative contributions in the Automotive industry

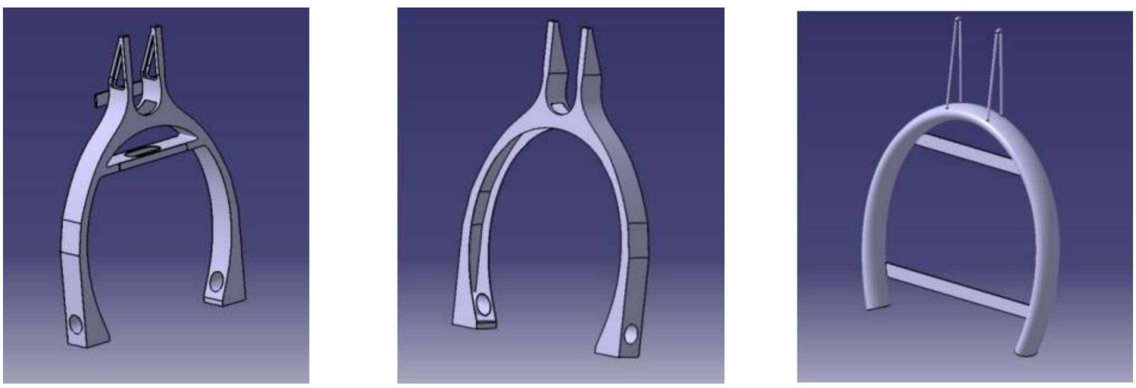
At **5.2.3.** *Application contributions in the Automotive Industry* are described the application of aPriori and TCPCM software to reduce production costs for car seats (5.2.3.1.), respectively for the **TaaS** shared transport service (**5.2.3.2.)**

### 2.3.1. aPriori AND TCPCM soft applications: Car seats


**Figure no. 96. The car seat example from the A2mac1 guidance website**

To adjust the costs of a component (e.g. a car seat), we use already existing solutions on the market as a basis for evaluation. The main source of information can be a2mac1.com, a company that buys new cars, completely disassembles them and documents the whole process. Data such as mass, dimensions and component placement along with detailed images can be easily found on its website. Analyzes related to structural performance on components and their costs are missing. All available solutions were therefore considered to have at least the same structural performance requirements as the reference seat. A cost model is developed based on the sum of all components in a reference chair, to which extra costs have been added for materials used, complexity, difficulty of shapes or other special manufacturing techniques.

The choice of the manufacturing method of the structural support of a car seat, from three possible feasible variants according to cost (pressing, towering, extrusion), can be done by the TDABC Method - *Time Activity Based Costing*, using the aPriori software. The synthetic data are highlighted in Table no. 26. Analysis of the cost of the seat support manufacturing process, starting from the CAD model and considering the material price of 4.2 SEK (Swedish kroner)/kg, 1 SEK = 0.48 lei = 0.10 euro, so 2.06 lei/kg (calculations performed by the author in the company NEVS Sweden)



Stamping Casting Extrusion

**Fig. no. 97. Examples for choosing the manufacturing method**

**Table no. 26. Analysis of the cost of the seat support manufacturing process, starting from the CAD model and considering the material price of 4.2 SEK (Swedish kroner)/kg, 1 SEK = 0.48 lei = 0.10 euro, so 2.06 lei/kg (calculations performed by the author in the company NEVS Sweden)**

| Manufacturing process | Cost support (SEK) | 1 SEK / LEI | Support (Lei) |
|---|---|---|---|
| Stamping device | 4.500,00 | 0,47 | 2.115,00 |
| Stamped part | 230,00 | 0,47 | 108,10 |
| Casting tool | 3.400,00 | 0,47 | 1.598,00 |
| Casted part | 182,00 | 0,47 | 85,54 |
| Extrusion tool | 20.000,00 | 0,47 | 9.400,00 |
| Parts extruded | 149,00 | 0,47 | 70,03 |

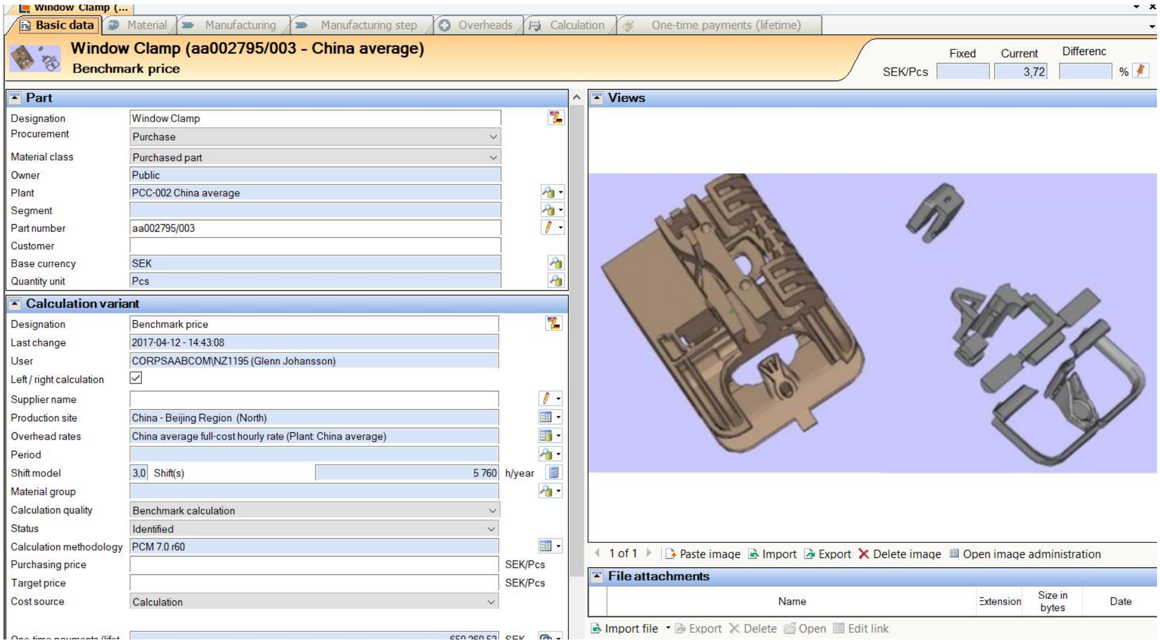



**Figure no. 98. TCPCM soft interface example - Cost estimate for a plastic part (hinge) calculated for the Chinese market - Valentina Zaharia, Cost Engineer SAAB Trolhattan**

### 5.2.3.2. Serviciul TaaS

*Hybrid models approach in efficient solution of production planning and control problems in automotive industry.*

The adoption of self-driving cars will lead to the creation of an extremely competitive market share between existing companies and new entrants; those who make such exaggerated subsidies for network opportunities and do not perceive the network effects, will "play" at a loss. They are already engaged in the provision of pre-TaaS platform such as Uber, Luft and Didi, with more companies to join this competitive race. In this intense commercial environment, companies will offer services on a cost-based basis. As a result, their fleets will slowly transition from *Internal Combustion Engine* **(ICE)** to *Autonomous-Electric Vehicle **(A-EV)*** due to road cost factors, including vehicle utilization rates. 10 times higher, 800,000 km vehicle life (potentially improved to 1.6 million km in 2030) and much lower maintenance, energy, financing, and insurance costs (Lindgren, 2007).

As a result, the **TaaS** (*transport-as-a-service*) transport (**430**) will offer an extremely cheap transport alternative - 4-10 times cheaper per km than buying a new car and 2-4 times cheaper than exploiting an existing one in 2021. Other sources of revenue from advertising, data monitoring and curation, entertainment, and product sales could pave the way for even free transportation in a Trans-pools model, public and private will try to merge. Cost reduction will also be the key factor in determining consumers to adopt TaaS.Many decision will be chosen based on the economical advantages (including the investment return, time saving, infrastructure costs and PIB), also the social consideration and environment (less death casualty and accidents, access to mobility and emission reduction). But other decisions will be influenced by existing industries that try to delay this competition. Given the nature of the beneficiaries of the A-EV race, releasing the fear that TaaS will have big gains in the client.

Currently, the automotive industry is dominated by advances in mobility services, autonomy, digitization, electric propulsion, etc. Modern industrial companies require the integration and synchronization of information flows on stocks of materials and finished products, located in different production sites that are part of the supply chain (**SC** - *supply chain*).

*Outsourcing* is a common solution to integrating and synchronizing flows. From this strategic perspective, entrepreneurs request suppliers from the development and engineering phase of new products (Figure no. 99). It is observed that car manufacturers are becoming more and more dependent on suppliers.

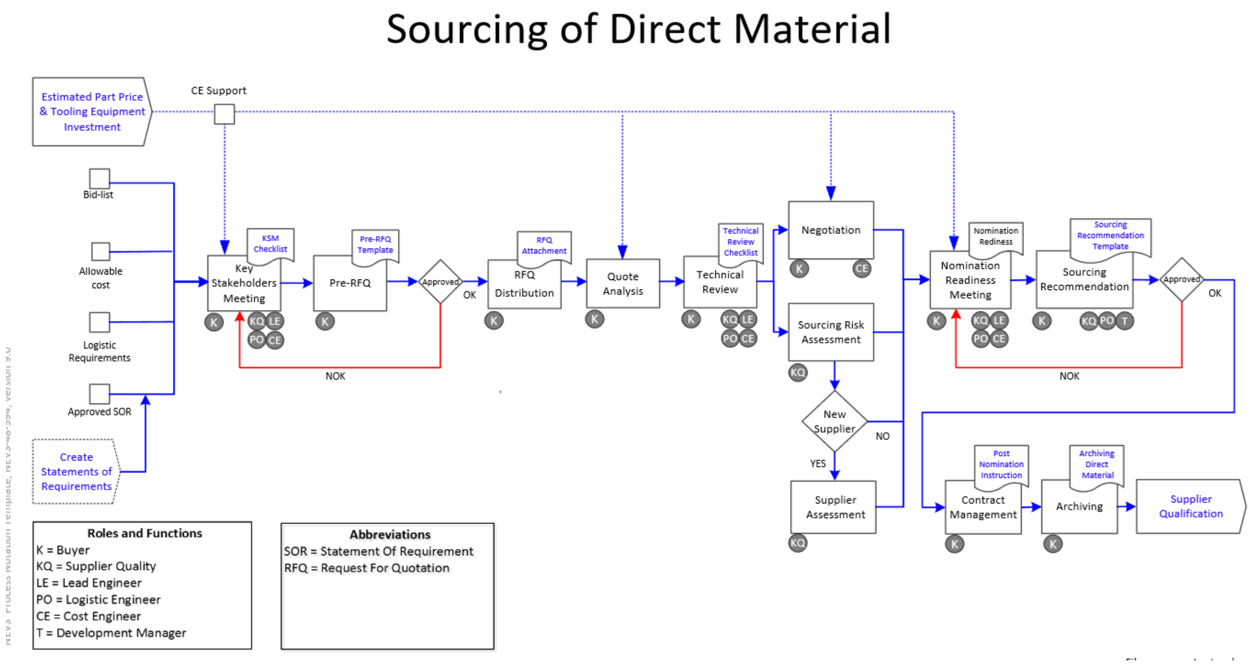



**Figure no. 99. Example of supplier analysis by estimating the price of the product made in a car manufacturing plant, when purchasing any part.**

One example is the use of autonomous vehicles as a service, not as private property (TaAS - transport as a service). This type of service will have a big impact on passenger transport. As a result, using TaAS offers transport alternatives with almost four times lower cost per km than by purchasing a personal vehicle (e.g Uber, Didi, Nevs (from Sweden)). As a cost engineer in the Swedish company, I collaborated on a study with expert Tony Seba regarding cost estimates using TaAS. It is estimated that by 2030 the price of the TaAS product will decrease to such a great extent that car owners will give up their personal cars. The use of TaAS services only requires access to an application on the phone. The service allows you to counter-order the trip free of charge and the low price per transport kilometer is decisive for choosing this service.

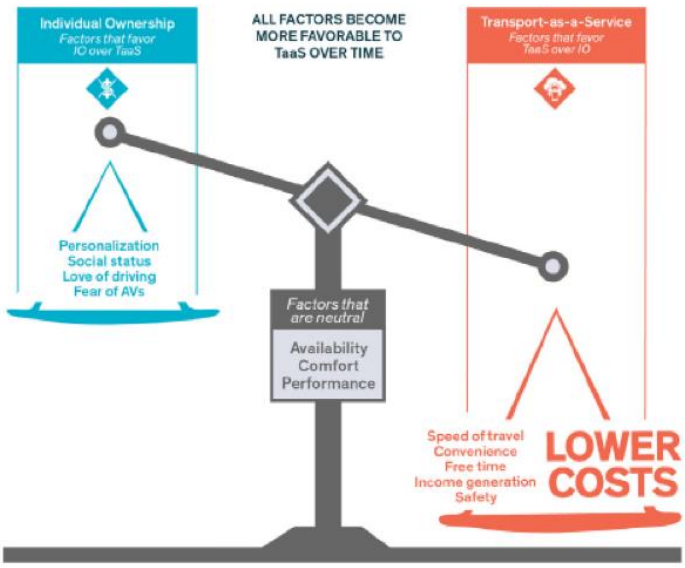



**Figure no. 101. Main factors that select the adoption of TaaS solutions. Co-authored by Tony Seba.**

Inaccurate analyzes induce substantial risk in cost-benefit planning.

***Cost is the most important factor in choosing TaaS.*** Taas Transport owns and operates fleets of electric vehicles with autonomous (autopilot) capabilities, which offer passengers services with higher quality levels and at a cost up to 10 times cheaper than today's privately owned vehicles. These will lead to the following disruptive solutions:

- A new internal combustion engine (ICE) vehicle will cost 30% more by 2030, bringing the cost per mile (1 mile = 1.62 km) to 0.65 USD in 2021 to $0.78 USD in 2023.
- Electric vehicles cost per mile 0.62 USD down to 0.61 USD - The investment recovery for a combustion vehicle will be quite high due to the initial price and fuels, which are constantly increasing in price. - Operational costs for ICE will drop from 0.34 USD to 0.31 USD using TaaS
- Using Taas platform, from 0.16USD down to 0.10 USD
- For destination pool facility, TaaS Pool usage will drop from 0.05USD to 0.03 USD
- Annual savings per vehicle in 2021 TaaS vs. Combustion vehicles: 2,000 USD; TaaS vs. new ICE: 5,600 USD

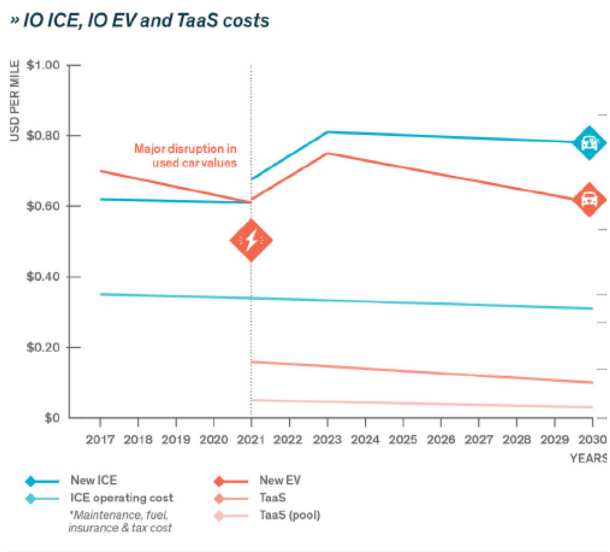



**Chart no. 13. Example of cost per vehicle mile using Taas compared to other types of vehicles, made by the author at NEVS Sweden**

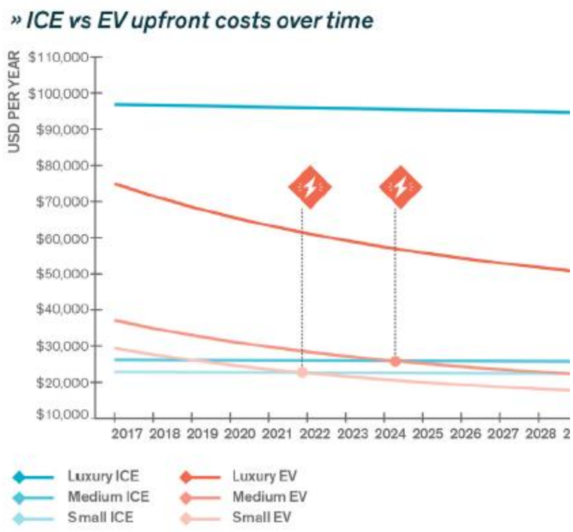



**Chart no. 14. Comparison between the price and cost of electric and fuel-based vehicles (Chart made by the author at NEVS Sweden)**

**Why is Taas concept is so convenient?**

Taas vehicles will be available 24 hours a day upon request. The data underlying the calculations made by the author, as a cost estimator within the NEVS company, together with Tony Seba, are based on the following:

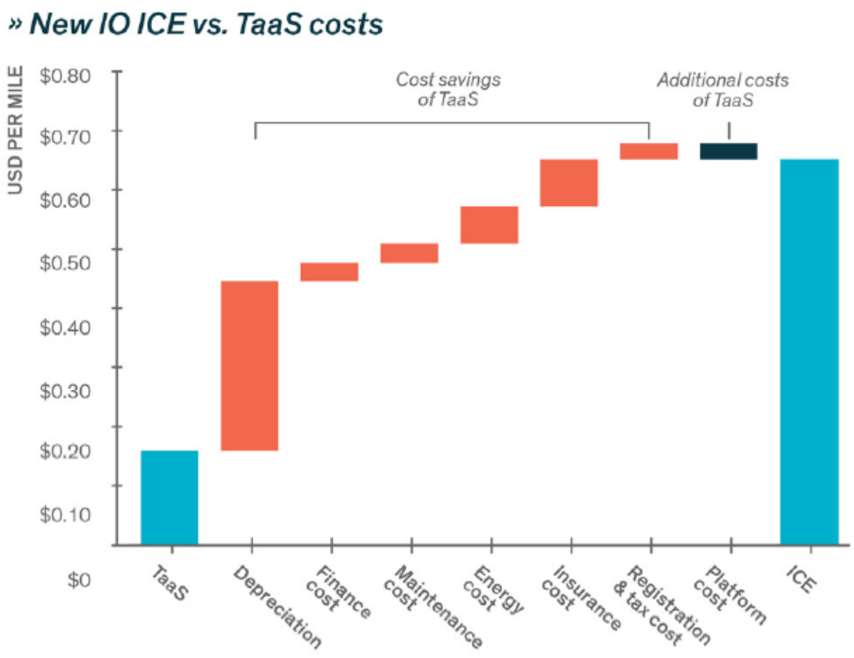
- Vehicle type - the most popular brands on the market, under the three categories small, medium and luxury
- It is assumed that the electric vehicle will reach an autonomy of 250 miles = 402 km in 2022, and the cost of a battery will be 300 USD.
- The forecast of the costs of these vehicles comes from discussions with specialists in the automotive field: The lifetime of the vehicle is given by the possibility of replacing the main elements
- In the case of electric cars, the propulsion system is less complex than in the case of combustion cars.
- consumables are also considered: replacing brakes, lights, etc.

At the start, the life of an electric vehicle will be around 500,000 miles for the battery and more for the other components versus 200,000 miles for a combustion car.

Depreciation of the vehicle will be recorded in the depreciation calculations of the purchase cost of the vehicle and according to the kilometers traveled during its life.

Maintenance costs are valued at 20% of those used to purchase a combustion vehicle. TaaS fleet vehicle insurance costs are only assessed on cost per km, while personal car insurance on a daily basis includes driver experience, year of car manufacture, accident history, number of km driven, etc., etc., resulting in very high costs large borne by the owner. In conclusion, the total annual expenses for personal combustion cars are 70% higher than for electric cars in the fleet of a TaaS company.

Taas considers the ownership of the autonomous electric vehicle for its entire life, while the combustion car is sold before the end of the residual value (few owners keep a vehicle for its entire life). By applying the ABC method, the cost of Taas vehicles per km can be estimated by dividing it into the following components:




**Graph no. 15. Combustion vehicle vs TaaS, graph made by the author according to the different types of component costs**

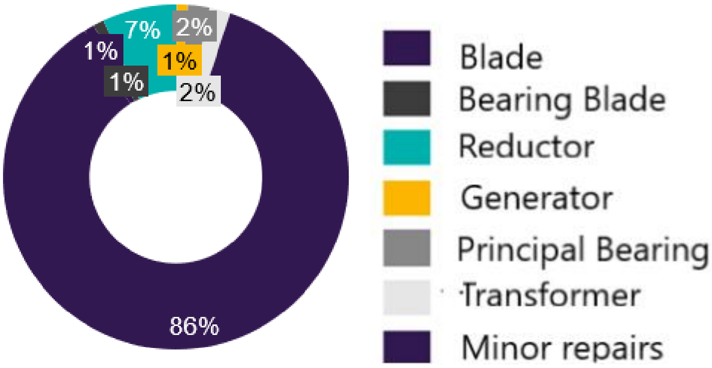
The cost estimation model highlighted above, in the case of the automotive industry/services, we also adapted it to assess the maintenance costs within the wind company.

Lack of practical knowledge of the turbine manufacturing process leads to erroneous product cost estimates. Starting from the accumulated experience together with the service department, we managed, by applying the ABC method, to estimate the value of the activities dedicated to the maintenance of the turbine.

Thus, to estimate the service costs of a wind turbine as accurately as possible, we started from a set of predetermined costs for the time of interventions and the reliability of the equipment WTG:

*rental of intervention tools, extra costs for (broken/fractured) bolts supporting the blades, extra costs for changing and inspecting sample elements (estimated at 2 times over the entire life of the turbine), replacing blades bearings (requiring a 2nd crane), the costs of additional training of the PRAT technician team, the cost of wasted time due to unfavorable weather conditions that stopped work, etc*. So we started from a system that provides cost correlations - failure rates - time and geographic region of intervention. Reliability cost includes labor, materials, machinery (rented), spare parts.

**Calculations made by the author for the cost of quality of maintenance service**




**The cost of warranty expenses (their proportion of the total cost) 86% for a turbine with a height greater than 127 m. The second main component is the reducer**

### 5.2.4. Application of the ABC method to estimate the welding cost operation

The IT approach in the integration of costing from the design process is becoming essential today. For example, in the wind industry, cost engineers, UTS (Welding Tools and Technology) instructors and technical staff involved will use simulation software to virtually model the target product using a specific set of welding parameters (current, voltage, thickness, material type, heat affected area, etc.). Thus, the aim is to optimize these parameters to obtain the most cost-effective production solution. Welding costs can be divided into two categories: "fixed" costs involve less the filler metals or the selected welding process, but rather those related only to the welding procedure. Fixed costs include material handling, joint preparation, fixing, stapling, preheating, cleaning and inspection of welds. The calculations of these costs are taken from the manufacturer, as they depend on their capabilities and equipment.

The cost of depositing the weld metal will vary considerably with the filler metal and welding process selected. This cost element is also influenced by the workmanship, the deposition rate and efficiency of the filler metal, the cost of materials and the energy consumed during the process. Estimating weld metal storage costs can be a difficult task due to the many variables involved. Design engineers must specify the type and size of the weld to withstand the loads it must support. The welding engineer must select the welding process and type of filler material at the lowest possible cost. To determine welding costs, large firms will frequently perform their own deposition tests and procedure times, unlike smaller firms who do not know the true cost of storing weld metal. The costs related to heat treatment are extremely important; if the material selection is changed, implicitly the associated heat treatment, then an extra cost given by the heat treatment indicator must be accessed.

There are virtual simulators to meet the technological needs in industrial educational training. Specifications and user requirements comply with the harmonized international guidelines for welding personnel specified by the European Welding Federation (EWF). Online simulator tools and services have the advantage that engineers, students and instructors can interactively participate in real-time with essential welding parameters. Unfortunately, on the Romanian market there are no easily accessible and high-quality simulators, integrated in a process-oriented platform, that identify and correlate the general costs associated with welding technical processes and that provide an easy and reliable way to evaluates-anticipates the cost factors (costs for a certain length of the weld bead, a certain type of welding (as an operation), the profile of the joints – V, X, T, etc. – type of electrode, welding wire, preheating temperature, energy consumed, etc.) Simulation tools introduce a new industrial quality assurance process, both during the training phase and after the completion of practical laboratory work, by comparing the proposed quality with the measured quality. *There are currently no integrated and interactive online simulator tools available in the European welding training market, so I add one more future research direction: integrated and interactive educational simulator for estimating welding costs in different scenarios*. The application of a cost simulator in the estimation of welded joints on oil rigs, for example, greatly reduced the time for choosing the appropriate welding method. The welding simulation consists of 3 basic parts:

1. *A design simulation that allows a designer to opt for the optimal design from the point of view of production and cost.* The basic concept will be that the user selects alternative designs and changes key dimensions of the design.

2. *A cost simulator that provides the cost of a particular weld as a function of a set of pre-selected key variables dependent on the chosen process*. For example, changing fill data automatically changes fill volume, stock rate, weld hours, and so on. Also, changing the type of welding will influence both the requirements on the weld metal and the time to perform the welding operation. (Zaharia, Erik, Bordeianu – Productivity 2019).

3. *A technical calculation focused on material technology and the influence of the heat of the welding process itself.* A material simulation must be added to allow the consequences of changing material composition to be evaluated against a set of main welding parameters either predefined or imported from a **WPS.** Through such a simulation, a purchasing department may discover that a possible new material would create welding problems.

From the **simulation algorithm** presented below, I highlighted two screenshots that seemed significant to me (see Figures 102-103), each step constituting a stage in the simulation process.

Step 1: The joint configuration, the welding process and the process parameters are selected, after which the economic data is selected. NOTE: Data consistency between steps is checked so that data is defined only once and transparently passed downstream.

Step 2: Dynamically simulate the three input scenarios to see the consequences on the results. The user can select to store the previous simulation as well, to compare to a reference or to set a reference for comparison.

Step 3: Selecting a new material group or changing the chemical composition may require the addition of heat treatment as a technical necessity for the welding parameters as well as a cost driver in the cost calculation. By automatically selecting the material, heat treatment requirements are added to the other steps in the simulation. Note: Selecting a different material group could also disable certain welding processes from the process selection.

Step 4: Change the material group and influence other parameters. When selecting the material group will require other expensive processes such as heating, then the user should be warned during the material selection process. Step 5: Changing the joint configuration data will trigger feedback if the welding process is suitable for the selected data set.

Step 6: For cost estimation it can be assumed that the welding engineer has decided which welding procedure to use for a given project and imported the WPS data into the simulator at the level of the welding process and then performed the cost calculation directly. This option requires specifying an import data format. But it would make cost estimation much more dynamic. In Figure no. 104 graphically represents the cost of 600 m of welding by choosing the desired geometric shape of the welding and the considered welding procedure, including the costs of repairs and the labor of the execution of the welding seam. All parameters with numerical values highlighted in Figure 104 were entered in the final calculation. Labor costs, repairs, etc. were added to simulate the total costs of the structure.

The most used model for fusion welding processes having double ellipsoidal heat distribution is known as "Goldak distribution". Thus, the heat input model in **CWM** (*Computational Welding Mechanics*) must be calibrated according to experiments or obtained from **WPM** (*Weld Preparation Mill*) models. Therefore, classical CWM models have some limitations in predictive power when used to solve various engineering problems. For example, they cannot prescribe what penetration a given welding procedure will give. Therefore, the proper procedure for determining the heat input pattern is particularly important in CWM (Lindgren, 2007).

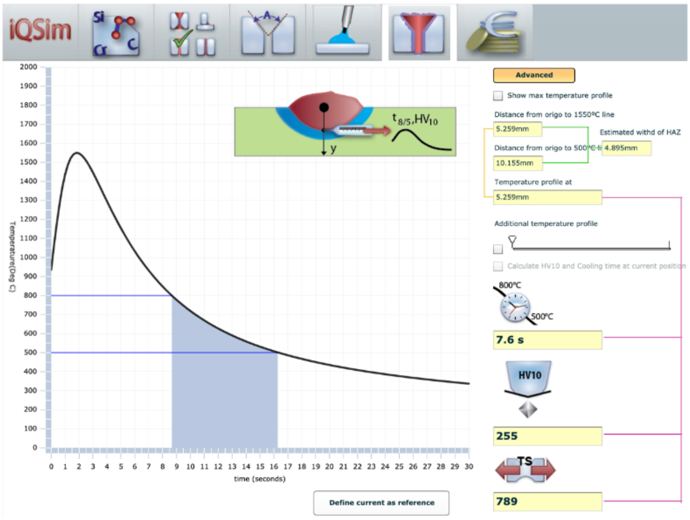



**Figure no. 102. Simulation of weld parameters to check tensile strength and hardness as well as estimated HAZ width**

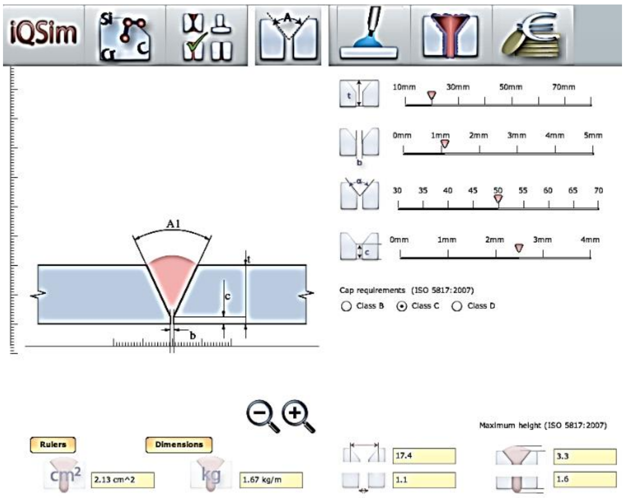



**Figure no. 103. Simulation of the welding environment and parameters**

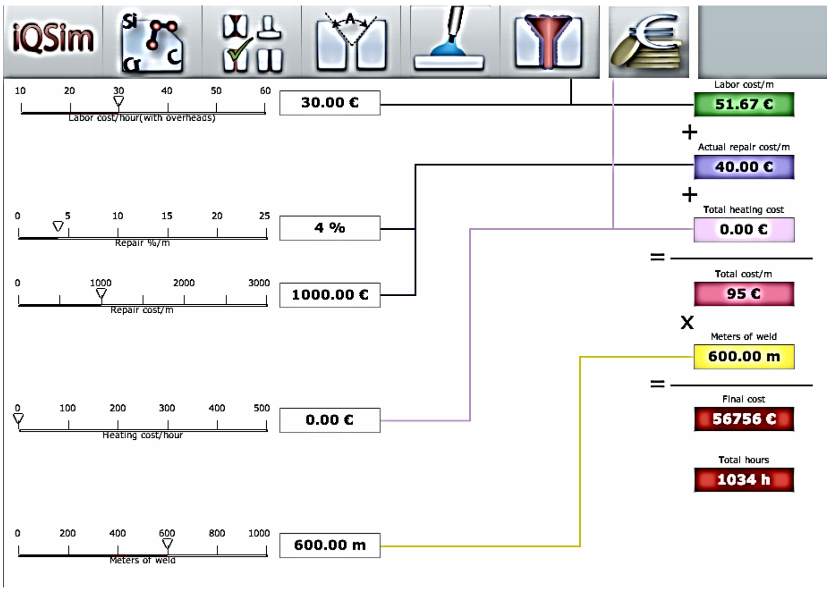



**Figure no. 104. Simulation performed by the author together with Erik Engh, Quality Coordinator at the quality assurance company in Norway.**

# DEL III - CONCLUSIONS

## CAPITOLUL 6. General conclusions, personal contributions and future research directions

### 6.1. General conclusions

In any enterprise there are several determinants of cost per unit of production and reporting to its competitors. The relative importance of cost factors varies across industries, among firms within a given industry, and even among different activities within a firm. By examining each cost driver in a given firm, we can analyze the firm's cost position relative to its competitors, diagnose sources of inefficiency, and make recommendations as to how the firm will make its costs more efficient.

Despite the premise of economies of scale, small and medium-sized companies continue to survive and thrive in competition with much larger rivals. The more complex a process / service, the greater the potential for learning. Superior process technologies can be a source of cost savings, but their full benefits require system-level changes: new job design, product design, changes in organizational structure and management control.

Designing products geared toward manufacturing facilities rather than functionality and aesthetics can provide substantial cost savings, particularly when related to the introduction of a new process. For example, car manufacturers have reduced product and component development costs by redesigning 30 different models on a single platform. If fixed assets are not used continuously, unit costs will increase because fixed costs would be spread over fewer units of production. Thus, the ability to quickly adapt production capacity to drops in demand can be a major source of cost reduction.

The ABC - *Activity Based Costing* method uses cost drivers in the relationship between the cost of the product and the knowledge used to make it, under what conditions it is produced, how long it is used and what financial resources are invested for this purpose. It is useful in planning budgets and evaluating financial performance, it also provides information on resources used and planned. The ABC method separates the important activities from the less important, helping to increase productivity efficiency. These results are consistent with the results reached by Effiong&Oti (2012) who concluded that materials, labor and overhead are what determine the cost of any manufacturing process. Credibility of costing reduces the risk of information distortion and provides accurate data for decision-making purposes. Problems and opportunities are identified giving managers the opportunity to make the right decisions.

Based on the study carried out, we highlighted the following recommendations: the accuracy of cost estimation - component of the ABC method - leads to increasing the efficiency of the production process, activities that do not add value and should be eliminated contribute to better planning and optimal control of the production process.

### 6.2. Personal contributions

My doctoral thesis *INTEGRATED PRODUCTION COST MANAGEMENT SYSTEMS* pursued the design of a new cost evaluation system, I came up with my own solution for detailed identification and mitigation of the effect of indirect costs using the "activity-based costing" method (ABC method ), through which managers will improve their costing process and be able to realize an optimized, efficient and profitable costing strategy.

To implement the data and information requirements in a **web portal (further research directions),** a particular data model is chosen. For the detailed cost estimation of the three industries (wind, oil and automotive), my research has identified a data infrastructure where I will explain the need and how to use the data and where it is found. Next comes the logical structuring of this data in a database. A catalog of data and information is created for different industries, which can be used as a benchmark, if uniformity/standardization is possible in the respective industrial fields, and that the catalogs are used by all companies as a reference point.

Reliability is related to the consistency of measurements, while validity focuses more on how precise the measurements are. While reliability is not related to accuracy, validity is! Reliability is easier to determine because validity contains more analysis just to know how valid something is. Saying "a sample is reliable" does not mean it is valid. Reliability is determined by tests and internal consistency, while validity is of four types: conclusion, internal validity, construct validity and external validity (Wallén, 1996, p. 65-66).

In the "Own Contributions" part, the modern management of human resources was exemplified by the connection with cost-simulation systems that contain real values of working hours and labor for each country in the case of Siemens TPCMP Teamcenter Product Cost Management and aPriori Cost Software In the aPriori software, calculating the total cost involves selecting values associated with each editable cost component. If we tick a certain checkbox, the corresponding cost value opens for editing. We can replace one or more values. The cost value that was checked for the "manual" cost calculation is no longer affected by the changes made to the other components. However, if we disable cost override, aPriori removes the manually specified values, reevaluates the CAD geometry, and automatically calculates the cost values for the component. We can use cost options for values automatically calculated by aPriori, as well as for those that it does not take into account at a given time.

For example, the material used to manufacture a part may require a special finish or machining performed by the supplier that is not reflected in the material inventory cost specified in the VPE (virtual factory). In this case the material cost for this part can be overwritten to reflect the actual material cost for the required finish. Cost overwriting can also be used to include the logistics cost of manufacturing a component (+ internal or external shipping and handling), providing a logistics field in the cost taxonomy.

When we override a cost value, the system displays a small comment window that allows us to enter and save notes about the override.

**In subsection 5.1. *Theoretical Contributions***, it is shown **how this research has significantly contributed to the understanding of internal cost estimation practices when creating estimates at the conceptual design stage.**

This point outlines the data and information requirements model for cost engineers to make detailed estimates of manufacturing costs in various industries. The data infrastructure was created by "mapping" for each stage the cost estimates of data processing and association. Sources from where data and information can be collected have been identified and can be classified into six major categories to provide easy access in a logical manner. The classification is accompanied by small comments with clear descriptions for better understanding by the cost estimator. In order to analyze the quality of the method of data collection from the studied companies, several facets were carried out in which companies with various objects of activity were involved. These pre-studies started from answers to questionnaires, interviews and ad hoc examinations of existing calculation tools (excel spreadsheets).

We have established a theoretical model **for information resources** to be classified into three major headings: internals and supplier resources and external environmental resources.

By implementing these data collections in the software of the providers, many new functions will be added such as: copy functions, search facilities for terms, features, comments, etc., which will increase the sophistication of the data infrastructure and shorten the search time.

At 5.1.2. **Adapted theoretical model**, we started from a model that those from Toyota and its suppliers implemented with great success, considering the five stages of the development process of the Lean product (Nolmdahl, 2010), and we adapted in the case study for 2 wind towers.

The calculation model developed by me is useful for all industrial engineering projects related to wind companies. Working groups were created in different departments of the company and meetings were organized on various topics. In the development project of a new wind farm, the functions of Industrialization and development of production, procurement and technological functions are involved.

**Subchapter 5.2**. **Contributions to practical applications** was entirely devoted to original practical contributions from my experience, describing no less than four examples from 3 different industrial fields: wind turbines, oil rigs and automotive.

**5.2.1.6**. *Details on the parametric calculation level*. *Project stages defined by the author*

To develop a parametric, flexible cost model for various types of towers (on-shore/"on land", respectively off-shore/aquatic ("on water"), a checklist of activities will be created. As a final result a cost quote (outcome) used in future negotiations with other manufacturers will be obtained.*The final format of the parametric calculation mode*l in which all activities have been simulated for several representative wind towers and for all activities, starting from at two representative dry/onshore - water / offshore towers. These were numbered in order of execution sequences by numbers. It is the most richly illustrated subchapter, capturing the algorithms, the steps of entering and extracting information, explicit screenshots, how to work with cost estimating software.

The cost savings that were realized in the design of the towers based on my work are of course introduced into the work.

At 5.2.2. *Application Contributions in the oil and gas industry* describes the practical applications from 2012-2017, where we made a significant contribution to the cost improvement program (with savings in the order of millions of USD) on the "2012-2017 MPS Core Product Line" ”, Valentina Zaharia – *Cost Engineer – FMC Technology*”, through an application in the field of the oil industry on some equipment used in the extraction of crude oil at depths of more than 3000 m depth.

**By using Value Engineering, the total cost reduction per piece 50,400 NOK (37%) so for 150 pieces / year, the annual saving is 6,000,000 NOK = 3,000,000 lei.** A second example of the application of the ABC method to retrograde equipment by the author, as a cost engineer, was the design of the UCON part, which is a connecting device between the components in the manifold for the *Cradle Support* element described Figure 79 and detailed how it enters in the component system in Figure 80, which achieved a cost reduction of NOK 55,000 - 17.9%. Total project cost NOK 9M; The raw material represents approximately 35% of the cost; Optimized pricing is based on large order quantity (50+ pieces). By using Value Engineering, the total cost reduction per piece 50,400 kr (37%) so for 150 pieces / year, the annual saving is 6,000,000 NOK = 3,000,000 lei.

A third example of the author's cost reduction is in a media converter (CDM). In the context of network hardware, the Media Converter Jumper is a flexible device for deploying and optimizing fiber links in any type of network. The Media Converter Jumper allows the extension of an IP Ethernet network from a deep-sea electronic module using a single optical fiber inserted into the cable to connect to a memory converter or media conversion module with the "umbilical" terminal unit ” (*Umbilical Termination Unit)*.

**The cost estimated by the author using the TDABC method: NOK 195,872.721 = 100,972.40 lei brought the company a cost reduction of 6000 euros / piece**

At **5.2.3.** *Application contributions in the Automotive Industry* are described the application of the aPriori and TcPCM software to reduce production costs for car seats (5.2.3.1.), respectively for the *TaaS shared transport service* (5.2.3.2.)

The choice of the manufacturing method of the structural support of a car seat, from three possible feasible variants according to cost (pressing, towering, extrusion), can be done by the TDABC Method - *Time Activity Based Costing*, using the aPriori software. The synthetic data are highlighted in Table no. 26. Analysis of the cost of the seat support manufacturing process, starting from the CAD model and considering the material price of 4.2 SEK (Swedish kroner)/kg, 1 SEK = 0.48 lei = 0.10 euro, so 2.06 lei/kg (calculations carried out by the author in the company NEVS Sweden).

Also, for the practical applications in the automotive industry, to which we had a significant contribution, an example of the application of the analysis of the cost-production relationship is described in the case of the shared transport service of the TaaS type (5.2.3.2.).

In this intense commercial environment, companies will offer services on a cost-based basis. As a result, their fleets will slowly transition from *Internal Combustion Engine* **(ICE)** to *Autonomous-Electric Vehicle* (**A-EV)** due to road cost factors, including vehicle utilization rates. 10 times higher, 800,000 km vehicle life (potentially improved to 1.6 million km in 2030) and much lower maintenance, energy, financing and insurance costs (Lindgren, 2007).

It turned out, TaaS service type transport ("transport-as-a-service") will offer extremely cheap transport alternatives - 4-10 times cheaper per km than buying a new car and 2-4 times cheaper rather than exploiting an existing one in 2021. Cost reduction will also be the key factor in determining consumers to adopt TaaS. Many decisions will be taken by the economical advantages (including raentability of investment, profit gained, time saving increasing profit indicators) and also social implications and environment (less wounds and death from the traffic roads easy access to the mobility service and emission reduction). But other decisions will be influenced by existing industries that try to delay this competition. Given the nature of the winners of the A-EV race, releasing the fear that TaaS will have big gains in the client.

The cost estimation model highlighted above, in the case of industry/auto services o, we also adapted it to evaluate the maintenance costs within the wind company.

Lacking of practical knowledge of the turbine manufacturing process can leads to erroneous product cost estimates.

Starting from the accumulated experience together with the service department, we managed, by applying the ABC method, to estimate the value of the activities dedicated to the maintenance of the turbine. Thus, in order to estimate the service costs of a wind turbine as accurately as possible, we started from a set of predetermined costs for the time of the interventions and the reliability of the turbine component equipment: *the rental of the tools for the intervention, the extra costs for the (broken/fractured) bolts that support the blades , the extra costs of changing and inspecting the sampling elements (estimated at 2 times during the entire life of the turbine), of replacing the blades bearings (requiring a 2nd crane), the costs of additional training of the PRAT technical team , the cost of time wasted due to adverse weather conditions that stopped work, etc*.

At **5.2.4.** *Using the ABC method to estimate the cost of the welding operation* described the example of the cost estimation of the welding operation. From the presented **simulation algorithm**, the cost of 600 m of welding is graphically represented by choosing the desired geometric shape of the weld and the considered welding procedure, including the costs of repairs and the labor of the execution of the weld bead. All parameters with numerical values highlighted in Figure 104 were entered in the final calculation. Labor costs, repairs, etc. were added to simulate the total costs of the structure. Applying this cost simulator in the estimation of welded joints on oil rigs, for example, has greatly reduced the time for choosing the appropriate welding method.

## 6.3. Future research directions

**1. Development of the TowerSelect application**
**2. Calculating the cost of flanges**
**3. Tower Transportation Cost**
**4. Cost of service for wind turbines**
**5. Educational simulator for industrial welding cost estimation**

Together with a specialized software company, we will develop within the Siemens-Gamesa company a software based on the ABC cost estimation method so that, through a correct distribution of indirect expenses, a reliable tool will be created to guide the financial departments involved in making decisions for the company.

### 6.3.1. TowerSelect App Development

Companies using existing software could integrate the infrastructure into an explicit cost estimation database, i.e., a web portal that was not developed in this research, but may be considered in future research directions, which, further, would support the user in obtaining a refined rate of costs. By implementing these data collections in the software of the providers, many new functions will be added such as: copy functions, search facilities for terms, features, comments, etc., which will increase the sophistication of the data infrastructure and shorten the search time. As mentioned above, there are many detailed cost models in the literature, but the practical aspects of their utility have often been treated superficially. Therefore, we considered it necessary to research the conditions for implementing the cost model in an industrial environment.

Realization of the TowerSelect application within the wind company aims to define a common cost method from the stage of sale of these towers (LCOE).

The division called *Operations* is designed to produce different wind towers from the product portfolio. The cost of products represents the vital part of the cost base of a community.

Starting from the cost estimation algorithm made by the author based on the ABC method, as a *future research direction* a cloud-app called *Tower Select* will be created that can nominate the most competitive wind tower design by connecting all the tools used.

**Purpose and description of the application:**

- **Increasing competitiveness** with design optimization based on specific projects and constraints specific to each wind field
- **Technical and commercial optimization** as quickly as possible, by analyzing the pre-design of the tower and shortening the time to achieve the benchmark in the commercialization phase, which is usually very long
- **"Engineering to order" -** The managerial process that aims to receive the firm order and that involves a set of sub-processes in the supply chain by connecting all these factors
- **"One source of truth"** - A single source of information that ensures decision-making, analyzing opportunities and risks, to ensure quick decisions.

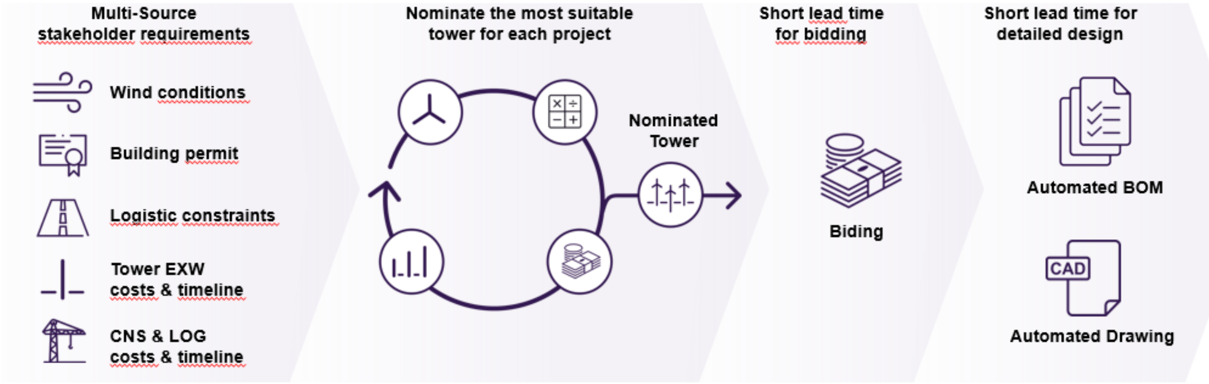



**Figure no. 105. Target Products: Wind Towers and Implementation Reasons**

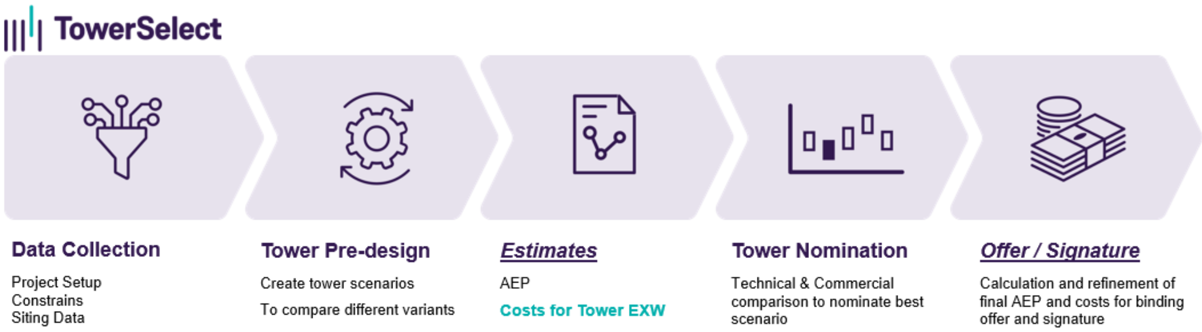



**Figure no. 106. The structure of the cloud app in its own conception.**

The design stage is the first step in achieving the performance objectives and meeting the functional specifications associated with the technical aspects of the product design. In the wind company, for example, so-called exchanges of information (trade off) are carried out between the designers and the other participants (manufacturing, service, purchase, etc.), several variants are analyzed, and the final design is accepted, the one that follows the concept of **LCOE** (*Levelized Cost of Energy*).

**Reason for application.** The **LCOE -** *Levelized Cost of Energy* **-** (the indicator that measures the amount of energy distributed to a wind installation during its lifetime) will improve. This integrated cost management system will bring great benefits to the company, especially in the final choice in cost/quality optimized form of wind tower type.

**Optimizing the choice of the type of wind tower**

Annual Energy Production (AEP) represents the total amount of electricity produced by a turbine during a year measured in (kWh or MWh). To achieve a PEA as large as possible, the following factors are considered:

- Application of a larger diameter at the base of the tower to obtain a lower cost.
- Reduction of Logistics and Execution costs
- Increasing the performance of the wind tower throughout its life

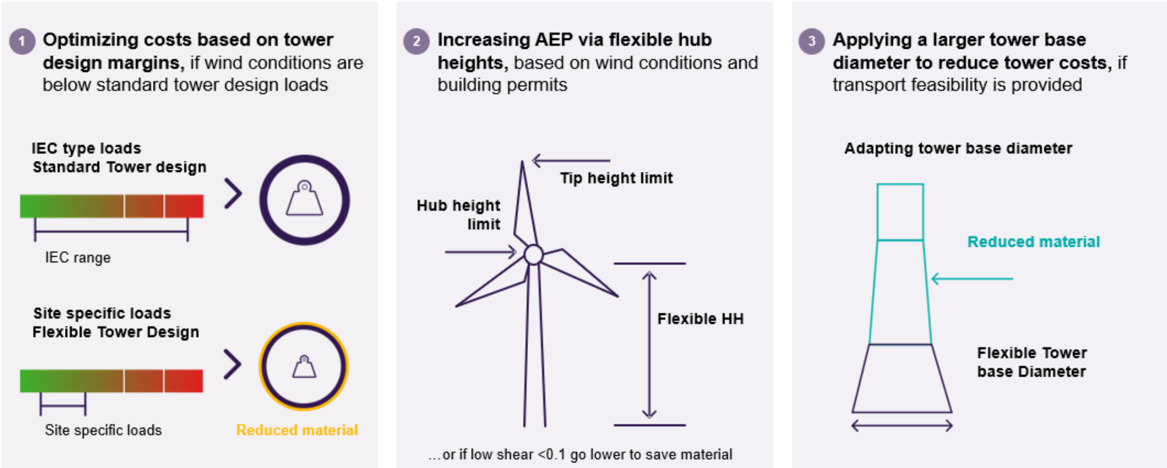



**Figure no. 108. Optimizing the choice of the wind tower type**

**Steps to follow in the TowerSelect application**

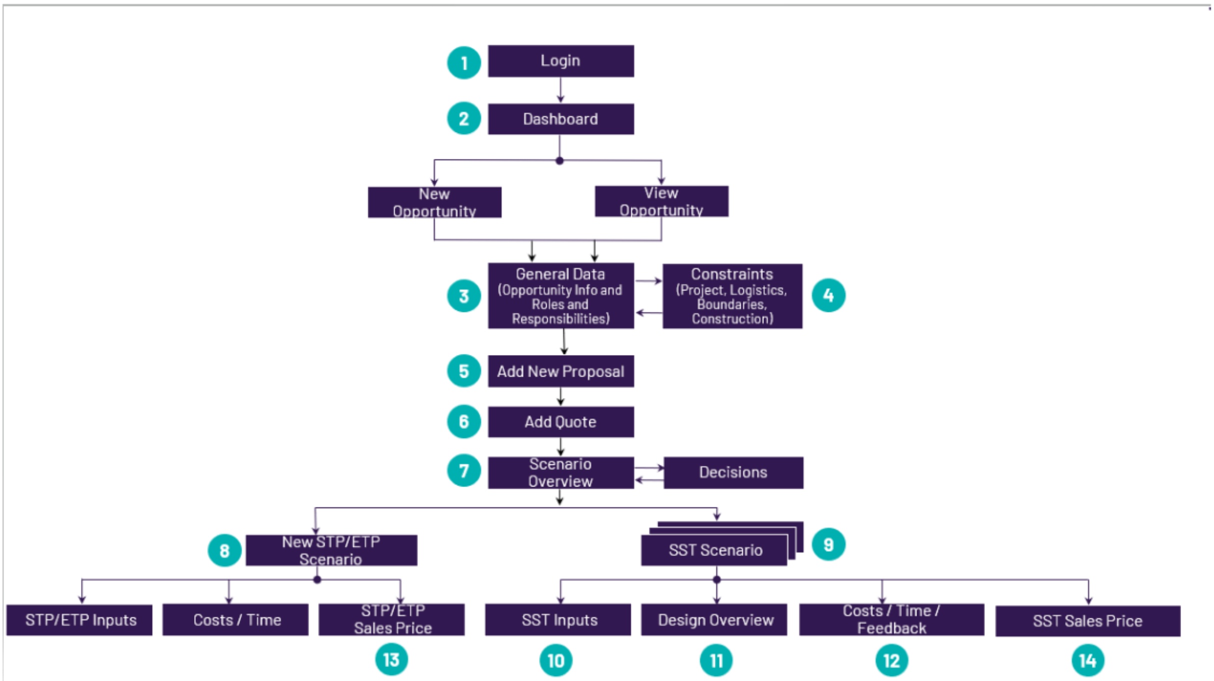



**Figure no. 107. Steps to be followed in the development of the TowerSelect software**

### 6.3.2. Cost estimation of the flanges

Another direction of research will be to estimate the costs of the flanges that make the connection between the sections of a tower. And here the ABC method will be applied for the purpose of estimating the execution of the component flanges.

### 6.3.3. Wind tower transport cost

For the application of the ABC method in transportation and its transformation into parametric calculation, a third future research direction will be to develop an application for calculating transportation costs for different destinations.

***Project objectives.***

- Providing necessary information in the early stages of the project to ensure a correct supply chain
- Development of an existing calculation model starting from the ABC method to the parametric model
- Verification of the model on concrete projects

***Purpose of future application and approach***

- Towers for specific use land /water, and flanges.
- Cost of transport / by road, train, intercontinental transport, sea, customs duties / ports, loading stations, customs, storage, transport tools.
- Understanding in detail the cost drivers of applying the ABC method – weight, diameter, volume, length.
- Validation and adaptation of an existing model for future estimations; otherwise creating a new model.

**Figure no. 113. Other methods of transporting wind towers**

### 6.3.4. Service cost for the wind tower

A fourth future direction of parametric calculation research is the construction of a calculation model for the execution ***of maintenance services*** after commissioning the ordered turbine. Starting from the article written by the author together with Gary Cokins and published in ICMAS, the next stage in the study of the ABC method and the transformation into parametric calculation, is the evaluation of the company's Service activities. A large-scale project will be launched on the initiative of the author together with the service department, in a maximum of 2 years (2024).

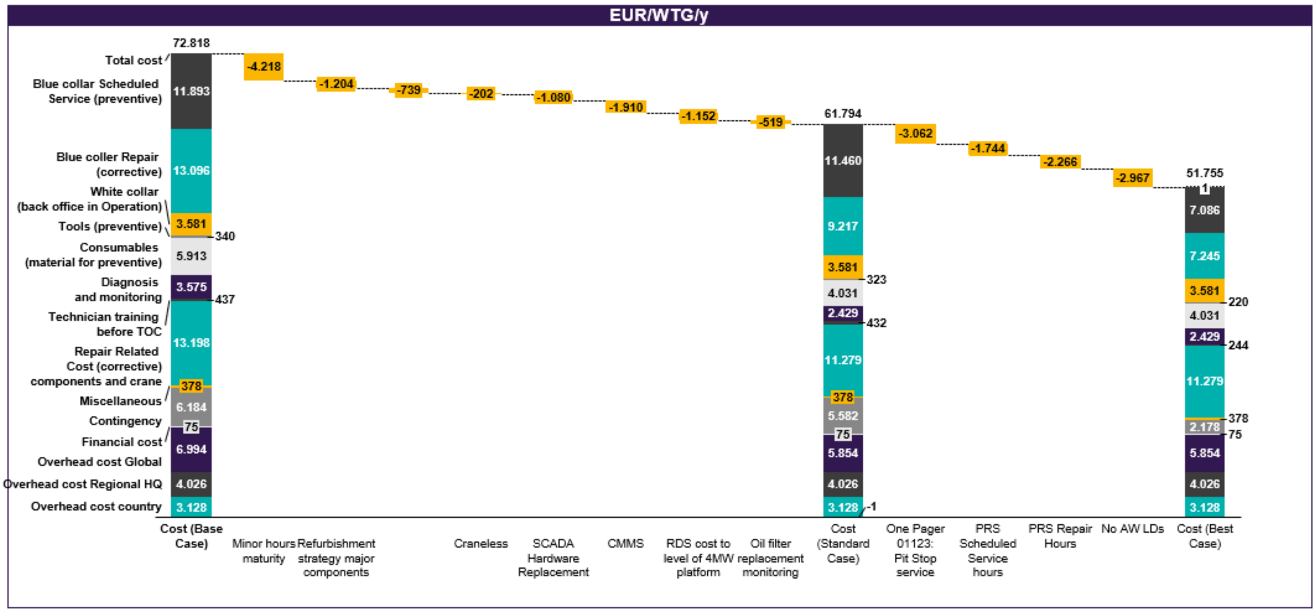



**Figure no. 114. Preliminary estimate by applying the ABC method of SER works for a wind tower**

### 6.3.5 Educational simulator for estimating the cost of industrial welding

By comparing alternatives, we can make decision strategies for manufacturing, assembly, and testing in a way that encompasses both technical and economic tasks. Simulation tools introduce a new industrial quality assurance process, both during the training phase and after the completion of practical laboratory work, by comparing the proposed quality with the measured quality.

*There are currently no integrated and interactive online simulator tools available in the European welding training market, so I add one more future research direction: integrated and interactive educational simulator for estimating welding costs in different scenarios.*

## 6.4. Dissemination of results

The studies carried out during the elaboration of the thesis were included in publications and international conferences. The appreciations received from the audience were considerable during the ICMAS Conferences, Productica and the spring and autumn conferences of the Romanian Academy of Scientists.

**1 ICMAS, Proceeding in Manufacturing System,**
**Volume 13, Issued 4, 2018, 157-164**
**Erik ENGH, Valentina ZAHARIA, Daniela BORDEIANU,** *Cost Strategy in manufacturing companies*

**2 Revista Annals of AOSR nr. 2/2018**
**Erik ENGH, Valentina ZAHARIA, Daniela BORDEIANU,** *A System Of Management Integration Of Product Costing In Industry*

**3 Revista Annals nr.1/2019 AOSR**
**Valentina ZAHARIA, Daniela BORDEIANU, Erik ENGH,** *Innovative Online Simulator Welding Tools For Cost Calculation Production Process*

**4 Productica Scientific Session 26 May 2017 nr 9, vol 1/2017, Volume 9 2017 Number 1, ISSN 2067 - 2160**
**Corneliu NEAGU, Valentina ZAHARIA,** *An informal review regarding the ABC method in cost engineering discipline*

**5 ICMAS, Proceeding in Manufacturing System,** Volume 15, Issue 1, 2020
*29th International Conference on Manufacturing Systems – ICMaS 2020*
**Gary COKINS, Valentina ZAHARIA, Daniela BORDEIANU -** *Measuring And Management Customer Profitability In Wind Industry*

## 6.5. Bibliography


| | |
|---|---|
| **1.** | AACE International Transactions, p ES261. |
| **2.** | Abernathy WJ. et al., Industrial Renaissance (New York: Basic Books, 1983); |
| **3.** | Ades AE, Lu G, Claxton K. Expected value of sample information calculations in medical decision modeling. Med Decis Making 2004;24:207–27. doi:10.1177/0272989X04263162 |
| **4.** | Afetornu, C., 2011. The influence of estimator attitude on project cost reliability. PhD Thesis, Loughborough University. |
| **5.** | Agnetis, A.; Pacifici, A.; Rossi, F.; Lucertini, M.; Nicoletti, S.; Nicolo, F.; Oriolo, G.; Pacciarelli D.; Pesaro, E. |
| **6.** | Ahcom, J., Uddin, S. & Shash, A.A. (2006), "A Pragmatic Setup for Cost Estimation", AACE International Transactions, pp. ES261. |
| **7.** | Alberini, A. (2005). *What is life worth ? Robustness of VSL values from contingent valuation surveys.* Risk Analysis, 25 (4):783–800. |
| **8.** | Alexander, D., Britton, A., Jorissen, A. (2004), "*International Financial Reporting and Analysis",* Second Edition, 2005, ISBN 978-1-84480-201-2 |
| **9.** | Amer, F., I (2014), A dynamic scheduling model for construction enterprises. PhD Thesis, Loughborough University. |
| **10.** | Andrei, T, Bourbonnais, R. (2008). Econometrie, Editura Economică, Bucureşti |
| **11.** | Anghel, M.G. (2014). The System of Financial Analysis Indicators Applying to the Activity run by an Economic Agent, Romanian Statistical Review Supplement, Issue 7, pp. 75-83 |
| **12.** | Annand, David (2015) *Financial Accounting,* doi:10.24926/8668.0701 ISBN 978-1-946135-10-0 |
| **13.** | Annand, David (2015), *Introduction to Financial Accounting,* Athabasca University, ISBN 978-0-9953266-4-4 |
| **14.** | Antoniadis, D N, Edum-Fotwe, F T and Thorpe, A., (2006) Project reporting and complexity. In: Boyd, D (Ed) Procs 22nd Annual ARCOM Conference, 4-6, September 2006, Birmingham, UK, Association of Researchers in Construction Management, p 123-133. |
| **15.** | Apriori.com |

| | |
|---|---|
| **16.** | Arnold, Kenneth L. (1994), *The Manager's Guide to ISO 9000*, New York: Free Press, p. 244, ISBN 978-0-02-901035-8, OCLC 29845272, The main objective of quality cost reporting is to provide means for evaluating effectiveness and establishing the basis for internal improvement programmes. |
| **17.** | Arnold, Kenneth L. (1994), *The Manager's Guide to ISO 9000*, New York: Free Press, pp. 244–245, ISBN 978-0-02-901035-8, |
| **18.** | Arora M.N. (2009) *Cost and Management Accounting (Theory and Problems*); Himalaya Publishing House, Ramdoot, Dr. BhaleraoMarg, Kelewadi, Girgaon, Mumbai-400 004. 4. |
| **19.** | Asaf S. (2004), *Executive corporate finance, (p.92)* Pretience Hall, Pearson, London, |
| **20.** | Asiedu Y and P. GU, 1998 Product life cycle cost analysis Yin, Robert K, 2009 Case Study Research: Design and Methods (Applied Social Research Methods) |
| **21.** | Askarany, D., Yazdifar, H., 2011. An investigation into the mixed reported adoption rates for ABC: evidence from Australia, NewZealand and the UK. International Journal of Production Economics. doi:10.1016/j.ijpe.2011.08.017 |
| **22.** | Asmar, El M., Hanna, S. A., and Whited, C. G., (2011). New approach to developing conceptual cost estimates for highway projects. Journal of Construction Engineering and Management. 137 (11), p 942 (8). |
| **23.** | Atkinson, A., Kaplan, R. S. and Young, M., (2003). Management Accounting. 4th ed. Prentice Hall. |
| **24.** | Aucamp, D.C., 1987. A lot-sizing policy for production planning with application in MRP. International Journal of Production Research 25 (8), 1099–1108. In Proceedings of the TMS Conference, Orlando, FL, USA, 25 February 2007; pp. 11–24. |
| **25.** | Avram, Michael; Neumann, Gustaf (2015-07-01). "*Multilayered analysis of co-development of business information systems*". *Journal of Internet Services and Applications*. **6** (1). doi:10.1186/s13174-015-0030-8. |
| **26.** | Baciu, T.A. (2001) - “Costs - organization, planning, accounting, calculation, control and analisys“, Dacia Publishing House, Cluj-Napoca. |
| **27.** | Bagley, C. E. & Dauchy (2003), C E. *"The Entrepreneur's Guide to Business Low", (p.51)* 2nd Edition, Thomson, |
| **28.** | Baiden, B. K., (2006). Framework for the integration of the project delivery team. PhD Thesis, Loughborough University. |
| **29.** | Baiyi, L., (2008). Managing a collaborative preconstruction planning process, PhD Thesis, Loughborough University. |
| **30.** | Bajaj A, Gransberg D, and Grenz, M., (2002). Parametric Estimation for Design Costs. 2002 AACE International Transactions. ABI/INFORM Research, p 81. |
| **31.** | Baldwin, A., and Bordoli, D., (2014). Handbook for construction planning and scheduling. Willey Blackwell. |
| **32.** | Ballard G., (2006). Rethinking Project Definition in Terms of Target Costing, In: Proceedings IGLC-14, July 2006. Santiago, Chile, 2006. IGLC NET |
| **33.** | Ballard, G., (2000a). The last planner system of production control. PhD Thesis, University of Birmingham. |
| **34.** | Ballard, G., (2008). The Lean Project Delivery System: An Update. Lean Construction Journal. |
| **35.** | Ballings, M., McCullough, H., & Bharadwaj, N. (2018). Cause marketing and customer profitability. *Journal of the Academy of Marketing Science, 46* (2), 234-251. doi.org/10.1007/s11747-017-0571-4 |
| **36.** | Bandivadekar, A.; Bodek, K.; Cheah, L. On the Road in 2035: Reducing Transportation’s Petroleum Consumption |
| **37.** | Barnes, N. M. L., (1977). Cost modeling – an integrated approach to planning and cost control. Engineering and Process Economics. 2, p 45-51. |
| **38.** | Bărbulescu, C., (2002) *Diagnosticarea întreprinderilor în dificultate economică. Strategii și politici de redresare și dinamizare a activității*, Editura Economică, București,. |
| **39.** | Beamon, B.M., 2000. A multi-objective approach to simultaneous strategic and operational planning in supply chain design. Omega 28, 581–598. |
| **40.** | Bearton, Ken - (1975) - Cutting quality and inspection costs. *Industrial Management*, *75* (11), 32-33. http://dx.doi.org/10.1108/eb056581 |
| **41.** | Benedettini, O., Iavagnilio, R., Mossa, G., Mummolo, G., Ranieri, L., 2001. Integrating resource allocation and simulation in project-type production planning and control of supply chains: A casefrom theaeronautics industry. Special Interest Group (SIG) on Advanced Techniques in ARTICLE IN PRESS M.G. Gnoni et al. / Int. J. Production Economics 85 (2003) 251–262 261 Production Planning and Control Aalborg, Denmark, 28–29 August 2001. |
| **42.** | Bennet S., 2003, Finanshandboken, Industrilitteratur AB, Stockholm. |
| **43.** | Berk, Joseph (2010). *Cost reduction and optimization for manufacturing and industrial companies*. Hoboken, N.J.: John Wiley. pp. 117–124. doi:10.1002/9780470643815.ch13. |
| **44.** | Bertsche, B. (2008). Reliability in automotive and mechanical engineering. Berlin: Springer. |
| **45.** | Bhise V. (2014), *Designing Complex Products With Systems Engineering Processes And Techniques*, CRC Press, New York, |
| **46.** | Bicheno, J. and Holweg, M., (2009). The Lean Toolbox (The Essential Guide to Lean Transformation, Buckingham, Production and Inventory Control, Systems and Industrial Engineering). 4th ed. PICSIE Books. |
| **47.** | Billington, C., 1992. Managing supply chain inventory: Pitfalls and opportunities. Sloan Management Review (Spring) 65–75. |
| **48.** | Binder Claudia, R., *From material flow analysis to material flow management* Part I: *social sciences modeling approaches coupled to MFA.* // Journal of Cleaner Production. 15, (2007), pp. 1596-1604. DOI: 10.1016/j.jclepro.2006.08.006 |
| **49.** | Bisset, R. (1960), Installing a standard material cost program, National association accountants, Dec 1960, 42, 2, pp79-83 |
| **50.** | Blackstone, W., Christian, E., Chitty, J., Lee, T., Hovenden, J., & Ryland, A. (1893). *Commentaries on the laws of England*. Philadelphia: J.B. Lippincott. |

| | |
|---|---|
| **51.** | Blessing, 2009, Design Research Methodology in Bruns, William J Jr. Kaplan, Robert S 2007 *Accounting & Management Field study perspectives* Cooper R.G. 2008 Product Development Institute Dekker, |
| **52.** | Blomquist, G. C. (2004). *Self-protection and averting behavior, values of statistical lives, and benefit cost analysis of environmental policy. Review of Economics of the Household,* 2:89–110. Disponibil la: http://ideas.repec.org/a/kap/reveho/v2y2004i1p89-110. html. |
| **53.** | Bognar, E. & Schoenbauer, C. (1999), "Multi-project costing and reporting techniques", AACE International Transactions, pp. V41. |
| **54.** | Boiteux, M. (2001). *Transports: choix des investissements et coûts de nuisances (dit "Rapport Boiteux 2").* Rapport technique, Commissariat Général du Plan, France.: http://www.ladocumentationfrancaise.fr/rapports-publics/ 014000434/index.shtml. 9, 23, 40, 41 |
| **55.** | Bojian, Octavian (1999) *Contabilitatea întreprinderilor. Contabilitate financiară. Contabilitate de gestiune*, Editura Economică, Bucureşti, |
| **56.** | Boldea, I. (2001). *Sistemul informațional și managementul întreprinderii.* Timișoara: Editura EUBEEA |
| **57.** | Bolton, B, & Thompson (2000), *J. Entrepreneurs? Talent Tempérament and Technique*, (p.18) Butterworth Heinemann, London, |
| **58.** | Booth C., (2014) *Strategic Procurement: Organizing Suppliers and Supply Chains*, ed.Kogan Page, London, |
| **59.** | Bose, S., Pekny, J.F., 2000. A model predictive framework for planning and scheduling problems: A case study of consumer goods supply chain. Computers and Chemical Engineering 24, 329–335. |
| **60.** | Botchkarev A. Assessing Excel VBA Suitability for Monte Carlo Simulation. |
| **61.** | Bourn, J. (1979). *Management in central and local government*. London: Pitman. |
| **62.** | Bragg, S. (2013). *Accounting Best Practices*, 7th Edition. John Wiley & Sons. |
| **63.** | Brandl, R. (2008). *Cost accounting for shared IT infrastructures*. Wiesbaden: Gabler. |
| **64.** | Briciu, C. V., Filip, I. & Indries, I. I., (2016). Methods for cost estimation in software project management. IOP Conference Series: Materials Science and Engineering. 106 (1), p 10. |
| **65.** | Bridge, S., O'Neill, K. & Cromie, S., (2003), *Understanding Enterprise- Entrepreneurship and Small Business, (p.13)* 2nd Edition, Palgrave MacMillan, |
| **66.** | Browning, E., & Zupan, M. (2011). *Microeconomic theory & applications* (p. 199). Hoboken, N.J.: Wiley. |
| **67.** | Bruce A, M, (1992), Aspects of Cost Control, Cost Engineering, 34 (6), 19-23 |
| **68.** | Brunner, P. H.; Rechberger, H. Practical handbook of material flow analysis. // The International Journal of Life Cycle Assessment. 9, 5 (2004), pp. 337-338. DOI: 10.1007/BF02979426 |
| **69.** | Buffett, M., & Clark, D. (2008). *Warren Buffett and the interpretation of financial statements.* New York: Scribner. |
| **70.** | Bugaian, L. (2018). *Managementul strategic al costurilor în baza materialelor întreprinderilor industriei prelucrătoare*. Iași: Editura Universitară. |
| **71.** | Burciu, A. (1999), *MBO&Ciclul afacerilor*, Editura Economică, București, |
| **72.** | Burduș, E. (2015) *Management comparat*, Editura Economică, București, |
| **73.** | Burrow J., Les Dlabay (2008), *Business Finance*, (p.30) Thomson, London, |
| **74.** | Buse, H., H.P., 2000. Inter-organizational logistics systems in flexible production networks An organizational capabilities perspective. International Journal of Physical Distribution & Logistic Management 30 (5), 388–408. |
| **75.** | Byrne, M.D., Bakir, M.A., 1999. Production planning using a hybrid simulation—analytical approach. International Journal of Production Economic 59, 305–311. |
| **76.** | Cagwin D., Ortiz D. (2005), *The Context – Specific Benefit of Use of Activity Based Costing with Supply Chain Management and Tehnologiy Integration*, Academy of Accoutant and Financial Studies Journal, p.47-70, accesat20.01. 2013 |
| **77.** | Cârstea, Gheorghe (1980), *Cost calculations*, Editura Didactică și Pedagogică, București, |
| **78.** | Cheah, L.; Evans, C.; Bandivadekar, A.; Heywood, J. Factor of Two: Halving the Fuel Consumption of New Publication: Cambridge, MA, USA, 2007. Massachusetts Institute of Technology: Cambridge, MA, USA, 2008. |
| **79.** | Cheatham, C., & Cheatham, L. (1993). *Updating standard cost systems*. Westport, Conn.: Quorum Books. |
| **80.** | Chegrani, P. (2007). *Évaluer les bénéfices issus d'un changement d'état des eaux.* Rapport technique B3-07-089/pc, D4E, Ministère chargé de l'écologie. Disponible à l'URL: http://www.economie.eaufrance.fr/IMG/pdf/07089pc_Evaluer_ benefices__changement_etat-eaux.pdf. |
| **81.** | Christiansen, B. (2016). *Cultural and Technological Influences on Global Business.* Berlin: IGI Global. |
| **82.** | Christopher, M., Towill, D.R., 2000. Supply chain migration from lean and functional to agile and customised. Supply Chain Management: An International Journal 5 (4), 206–213. |
| **83.** | Chun, S C (2010). Study on inventory and transportation integration of auto parts based on supply chain. Chongqing University |
| **84.** | Cobb, R.A., Elliott, D.P. & American Association of Cost Engineers (1989), Cost estimating: techniques and applications, American Association of Cost Engineers, Morgantown, WV. |
| **85.** | Cohen, M.H., Lee, H.L., 1988. Strategic analysis of integrated production–distribution systems: Models and methods. Operations Research 36 (2), 81–104. |
| **86.** | Colceru, A., & Soare, I. (1995). *Organizarea și conducerea sistemelor calitatii la nivel de întreprindere (firma).* Bucuresti: Tribuna Economica. |

| | |
|---|---|
| **87.** | Colin, Drury (2014), *Management and Cost Accounting*; International Thomson Business Press, London. 12. K.S. Thakur: *Cost Accounting – Theory & Practice; Excel Books*, Naraina, Phase-I, New Delhi-110028. |
| **88.** | Conso, Piere, Hemici, Farouk (2005) *Gestion financière de l'entreprise, 11* édition, Dunod, Paris, |
| **89.** | Corportion M. Increase the productivity of Users' with enhanced Office.js APIs in Office 2016. Microsoft Office Development Blogs |
| **90.** | Cowing, T., & Stevenson, R. (1981). *Productivity measurement in regulated industries.* New York: Academic Press. |
| **91.** | Crawford, R. J. 1998. Reinterpreting the Japanese economic miracle. Harvard Business Review (January-February): 179-184. |
| **92.** | Crecană, C. (2006), *Analiză economico-financiară, Editura Economică*, Bucureşti, 2006. |
| **93.** | Creese, R.C. (2002), "Estimating construction costs", Cost Engineering, 44 (11), p 36. |
| **94.** | Crosby, Philip B. (1979*), Quality Is Free*, New York, New York: McGraw-Hill, pp. 121-123, ISBN 978-0-07-014512-2, |
| **95.** | Crosby, Philip B. (1985), *Quality Is Free*, New York, New York: McGraw-Hill, p. 122, |
| **96.** | Curran, R., Raghunathan, S., & Price, M. (2004). Review of Aerospace Engineering Cost Modelling: The Genetic Causal Approach. Progress in Aerospace Sciences, 40 (8), 487–534. |
| **97.** | Cusumano M.A., The Japanese Automobile Industry: Technology and Management at Nissan and Toyota (Cambridge: Council on East Asian Studies/Harvard University Press, 1985); |
| **98.** | David D. (2009), *Administration accounting*, Gutenberg Univers Publising, Arad, |
| **99.** | Davis, G (2008). Insurance insider secrets: How to save money. Contractor55. 1 Jan: 18, 58. |
| **100.** | De la Garza, Jesus M. & Rouhana, K.G. 1995, "Neural networks versus parameterbased applications in cost", Cost Engineering, 37 (2), p14. |
| **101.** | Department of Finance and Administration, Financial Management Group (2006). Handbook of Cost-Benefit Analysis. Commonwealth of Australia.: http://www. finance.gov.au/publications/finance-circulars/2006/01.html. |
| **102.** | Document F. Overview \| The Document Foundation - The House of LibreOffice and Document Liberation Project. 2016. Project F. The APACHE Software Foundation. 2016. |
| **103.** | Doost, R., Blocher, E., Chen, K., & Lin, W. (2002). *Study guide for use with cost management* (p. 45). Boston, Mass.: McGraw-Hill/Irwin. |
| **104.** | Du, W. (2013). *Informatics and management science* I (p. 59). London: Springer. |
| **105.** | Dudovskiy J., (2016). The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance, July 2016. E-Book. Available: Research-Methodology.net |
| **106.** | Dumbravă P., Pop A. (2011), *Contabilitatea de gestiune în industrie, ediţia a II-a, actualizată și completată,* Editura Intelcredo, Deva, p. 297 |
| **107.** | Dupuit, J. (1844). *De la mesure de l'utilité des travaux publics. Annales des Ponts et Chaussées,* pages 332–375. 32 Eurocontrol (2007). Standard inputs for Eurocontrol cost beneVt analyses. Rapport technique, Eurocontrol EATM Infocentre. Disponible à l'URL http://www.eurocontrol.int/ ecosoc/public/standard_page/cba.html. |
| **108.** | Dutescu, A. (2002), *Ghid privind intelegera și aplicarea Standardelor Internationale de Contabilitate*, Ed. CECCAR, Bucureşti |
| **109.** | Edlin R, McCabe C, Hulme C, et al. Cost Effectiveness Modelling for Health Technology Assessment. 2015. doi:10.1007/978-3-319-15744-3_9 |
| **110.** | Effiong, S.A&OTI, P.A. (2012). Analyical evaluation of cost elements and their influence of manufacturing firms, Journal of Finnce and Investment Analysis.1 (3), 171-180 |
| **111.** | Eliot, G. (2016). *The mill on the Floss.* New York: Open Road Integrated Media. |
| **112.** | Emmanouilidis, C., Taisch, M., & Kiritsis, D. (2014). *Advances in production management systems* (p. 78). Londra: Springer. |
| **113.** | Enz C. (2005), *Hospitality strategic management,* (p.69),John Willey, New York, |
| **114.** | Epstein, M., Lee, J., & Allain, E. (2014). *Advances in management accounting*. Berlin, Heidelberg: Springer. |
| **115.** | Epuran M., Băbăiţă V., Grosu C. (1999), *Contabilitate și control de gestiune,* Editura Economică, București, p.172 |
| **116.** | Ettore Settanni, Nils E. Thenent, Linda B. Newnes, Glenn Parry & Yee Mey Goh (2015), To Cost an Elephant: An Exploratory Survey on Cost Estimating Practice in the Light of Product Service-Systems, https://www.tandfonline.com/doi/full/10.1080/1941658X.2015.1016588 |
| **117.** | Evaluation Unit, D.G.R.P. (2008). *Guide to cost-benefit analysis of investment projects*. Rapport technique, European Commission: http://ec.europa.eu/ regional_policy/sources/docgener/guides/cost/guide2008_en.pdf. 22, |
| **118.** | Fairley, R. (1979). *Selected papers in software engineering and mini-micro systems.* North Hollywood, Calif: Western Periodicals. |
| **119.** | Falkman, 2000. Kassaflödesredovisning Fixson Sebastian, 2002 Modularization and outsourcing: who drives whom? A study of generational sequences in the US Automotive cockpit industry Holmdahl L, 2010 Lean Product Development. |
| **120.** | Fandel, G., & Gal, T. (2008). *Multiple Criteria Decision Making Theory and Application.* Berlin: Springer. |
| **121.** | Feigenbaum, Armand V. (1991), *Total Quality Control* (3 ed.), New York, New York: McGraw-Hill, p. 109, 111 |
| **122.** | Feigenbaum, Armand V. (1994*), Total Quality Control (*3 ed.), New York, New York: McGraw-Hill, pp. 130-131 |
| **123.** | Feigenbaum, Armand V. (1998), *Total Quality Control* (3 ed.), New York, New York: McGraw-Hill, p. 113 |
| **124.** | Feigenbaum, Armand V. (November–December 1956), *"Total Quality Control*", Harvard Business Review, 34 (6) |
| **125.** | Feleagă, N., Malciu, (2002), L. *Politici și opţiuni contabile*, Editura Economică, Bucureşti, |

| | |
|---|---|
| **126.** | Fellows, R.; Liu, A. (2008), Research methods for construction, 3rd Edition, Blackwell, Oxford. |
| **127.** | Ferrag, M., & Ahmim, A. (2010). *Security soluțions and applied cryptoCharty in smart grid communications*. Londra: Elsevier. |
| **128.** | Ferry, J. D. & Brandon S.P., (1991) Cost Planning of Buildings. 6th ed. BSP Professional Books: Oxford. |
| **129.** | Fleming, Q.W. & Koppelman, J.M. (1997), "Earned value project management", Cost Engineering, 39 (2) 13. |
| **130.** | Fleurbaey, Marc (2004). "Normative Economics and Theories of Distributive Justice," The Elgar Companion to Economics and Philosophy, J.B. Davis and J. Runde, ed., pp. 132-58. |
| **131.** | Flick, U., (2006). An introduction to qualitative research. 3rd ed. London: Sage. |
| **132.** | Flynn, M.S. "Comparison of U.S.-Japan Production Costs: An Assessment," in Automobiles and the Future: Competition, Cooperation, and Change, ed. R.E. Cole (Ann Arbor, MI: Center for Japanese Studies, the University of Michigan, 1983); |
| **133.** | Forbes H. L. and Ahmed, S. M., (2011). Modern Construction Lean Project, Delivery and Integrated Practices, Taylor and Francis: New York. |
| **134.** | Fox, M.S., Barbuceanu, M., Teigen, R., 2000. Agent-oriented supply chain management. The International Journal of Flexible Manufacturing Systems 12, 165–188. |
| **135.** | Friedrich, R., Rabl, A., et Spadaro, J. V. (2001). *Quantifying the costs of air pollution*: the Externe project of the EC. Pollution Atmosphérique, December:77–104. 39 |
| **136.** | Frolich, M.T., Westbrook, R., 2001. Arcs of integration: An international study of supply chain strategies. Journal of Operations Management 19, 185–200. |
| **137.** | Fulkerson, B., 1997. A response to dynamic change in the market place. Decision Support Systems 21, 199–214. |
| **138.** | Gaither, N., & Frazier, G. (2002). *Operations management.* Australia: South-Western/Thomson Learning. |
| **139.** | Garcia-Castro, R., & Francoeur, C. (2014). When more is not better: Complementarities, costs and contingencies in stakeholder management. *Strategic Management Journal*, *37* (2), 406-424. http://dx.doi.org/10.1002/smj.2341 |
| **140.** | Garrett, G. (2008). *Cost estimating and contract pricing* (p. 69). Riverwoods, Ill.: CCH. |
| **141.** | Garrigosa, E., & Tatjé, E. (1992). *Profits and total factor productivity: A comparative analysis.* Omega, 20 (5-6), 553-568. http://dx.doi.org/10.1016/0305-0483 (92) 90002-o |
| **142.** | Gheorghiu, A., *Diagnosticul global al firmei*, Revista Tribuna economică nr. 49/1997 6. |
| **143.** | Gill S. (2015) *Cost And Optimization in Government*, Vikas, Londra, |
| **144.** | Glanville, R. (2007). *Cybernetics and design*. [Bradford, England]: Emerald. |
| **145.** | Gnoni, M.G., Iavagnilio, R., Mossa, G., Mummolo, G., 2000. Solving a lot sizing and scheduling problem by hybrid modelling. 3rd International Workshop on Advanced Techniques in Production Planning & Control, Florence, February 24–25. Florence University Press, Florence, http:// www.unifi.it/e-press/inglese/index eng.htm. |
| **146.** | Gopalakrishnan, M., 2000. A modified framework for modeling set-up carryover in the capacitated lot sizing problem. International Journal of Production Research 38 (14), 3421–3424. |
| **147.** | Gopalakrishnan, M., Miller, D.M., Schmidt, C.P., 1995. A framework for modelling setup carryover in the capacitated lot sizing problem. International Journal of Production Research 33 (7), 1973–1988. Haag, E., Vroom, R.W., 1996. Theapplication of STEP in theautomotivesupply chain. Computers in Industry 31, 223–234. Lee, H.L., |
| **148.** | Grandguillot, B., Grandguillot, F., Analyse financière, 4-e édition, Editura Gualino, Paris, |
| **149.** | Greaves, Michael (2003), *Manufacturing Excellence Based on a Virtual Plant Prototype*". Centrul pentru Gestionarea ciclului de viață și inovare de la Florida Institute of Technology „Digital Twins" |
| **150.** | Grennberg T. (1994), "Project types in building and construction", International Journal of Project Management, 11 (2), p 68-71. |
| **151.** | Griliches, Z., Berndt, E., Bresnahan, T., & Manser, M. (1992). *Output measurement in the service sectors*. Chicago: University of Chicago Press. |
| **152.** | Haig M. (2005), *Manual de e-marketing*, Editura Rentrop&Straton, București, |
| **153.** | Hale, A. (2003). *Safety management in production. Human Factors And Ergonomics In Manufacturing*, 13 (3), 185-201. http://dx.doi.org/10.1002/hfm.10040 |
| **154.** | Hall P, Edlin R, Kharroubi S, et al. Expected net present value of sample information: from burden to investment. Medical decision making : an international journal of the Society for Medical Decision Making 2012;32:E11–21. doi:10.1177/0272989x12443010 |
| **155.** | Hanid, M., Siriwardena, M., and Koskela, L., (2011). What are the big issues in cost management? Paper presented at the 19th Annual Conference of the International Group for Lean Construction. Lima, Peru. |
| **156.** | Harris, J., Curry, D., & Horngren, C. (1997). *Student guide and review manual*, Cost accounting (p. 66). Upper Saddle River, NJ: Prentice Hall. |
| **157.** | Harsanyi, John C. (1987), "*Value judgments*," The New Palgrave: A Dictionary of Economics, v. 4, pp. 792–93 |
| **158.** | Hayes, R. (2001). *Models for management, decision-making, and planning.* San Diego, Calif.: Academic Press. |
| **159.** | Hegazy, T. and Moselhi, O., (1995). Elements of cost estimation: A survey in Canada and the United States. Cost Engineering. 37 (5), p 27-31. |
| **160.** | Helms, H. and Lambrecht, U. (2003) *Energy Savings by Light Weighting*. IFEU-Institut für Energieund Umweltforschung Heidelberg GmbH. |
| **161.** | Helms, H.; Lambrecht, U. *The potential contribution of light-weighting to reduce transport energy* |

| | |
|---|---|
| **162.** | Hendrickson C., (2008). Effects of Project Risks on Organization, PM Hut Project Management for Construction. |
| **163.** | Hofer M. (2007), *Business succes*, (p.121),Springer, New York, |
| **164.** | Hollenberg J. Markov Cycle Trees: *A New Representation fo Complex Markov Processes. Medical Decision Making* 1984;4:529–30. |
| **165.** | Horngren C.T. (2009): *Cost and Management Accounting - A Managerial Emphasis;* Pearson Education Asia, 482, F.I.E. Patparganj, Delhi-110 092. |
| **166.** | Howell, R. and M. Sakurai. 1992. Management Accounting (and other) Lessons from the Japanese. Management Accounting (December): 28-34. |
| **167.** | http://doingbusiness.ro/financiar/raport/1489384/ |
| **168.** | http://phdthesis.uaic.ro/PhDThesis/Martiniuc,%20Adriana,%20Possibilities%20to%20improve%20the%20cost%20calculation%20methodology%20of%20industrial%20companies.pdf |
| **169.** | http://www.auto.ro/toyota/Toyota-vrea-vehicule-pe-hidrogen-pana-in-2015--49060.html |
| **170.** | http://www.businessdictionary.com/definition/management-accounts.html |
| **171.** | http://www.ey.com/gl/en/issues/driving-growth/growing-beyond--cost-competitiveness |
| **172.** | http://www.oliverwyman.de/content/dam/oliver-wyman/v2/publications/2017/jun/Art9-Achieving-automotive.pdf |
| **173.** | http://www.scribd.com/doc/22596848/Toyota-management |
| **174.** | http://www.scritub.com/management/Analiza-Swot-a-companiei-Toyot52134118.php |
| **175.** | https://iet.jrc.ec.europa.eu/sites/about-jec/files/documents/V3.1_TTW_App_1_07102008.pdf |
| **176.** | https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/591a2e4be6f2e1c13df930c5/1509063152647/RethinkX+Report_051517.pdf |
| **177.** | https://web.archive.org/web/20060722155057/http://www.onr.navy.mil/02/matoc/05_09/solicitations/docs/05-0002-02.pdf |
| **178.** | https://www.forbes.com/sites/joshbersin/2016/07/18/the-hr-software-market-reinvents-itself/#301a38725d0a |
| **179.** | https://www.gm.com/content/dam/gm/events/docs/5237319-645997-GeneralMotorsStrategicandOperationalOverview-9-21-2016 |
| **180.** | https://www.nevs.com/media/filer_public/97/ac/97acba85-5a23-473c-b3ad-3b58914b6d9c/nevs-corporate_profile_2017.pdf |
| **181.** | https://www.researchgate.net/publication/227420909_Detailed_cost_estimating_in_the_automotive_industry_Data_and_information_requirements |
| **182.** | https://www.siemens.com/global/en/home |
| **183.** | https://www.statista.com |
| **184.** | Imai, Masaaki (1997). *Gemba Kaizen: A Commonsense, Low-Cost Approach to Management*. McGraw Hill Professional. p. 109. |
| **185.** | J.E. Harbour, "Comparison and Analysis of Automotive Manufacturing Productivity in the Japanese and North American Automotive Industry for the Manufacture of Subcompact and Compact Cars" (Berkley, MI: Harbour and Associates, 1981); |
| **186.** | Jaba, O. (1999*), Analiza strategică a întreprinderii*, Editura Sedcom Libris, Iași, |
| **187.** | Jackson, K. and Darlington, R. (2011). Advanced engineering methods for assessing welding distortion in aeroengine assemblies. IOP Conference Series: Materials Science and Engineering, 26:012018. |
| **188.** | Jawahar Lal (2010), *Cost Accounting; McGraw-Hill Education (India)* Ltd. B-4, Sector 63, GautamBudh Nagar, Noida – 201 301. |
| **189.** | Jefferys J., Maccoll M. and Levett G. (2011) *The Distribution Of Consumer Goods*, Cambridge University Press, Cambridge, |
| **190.** | Jianyun, Y. (2011). Application of ABCM to Construction Project, In: International Conference on Information Management. Innovation Management and Industrial Engineering. Shenzhen, China. 1, p 205-208. |
| **191.** | Jinga, G. (2009). *Sisteme contabile de management prin costuri*. București: Editura Universitară Academia de Studii Economice. |
| **192.** | Johnny Jackson (2005), *Introduction to Financial Accounting*, Thomas Edison State University. |
| **193.** | Johnson, H.T. and Kaplan, R.S. 1987. "Relevance Lost: the Rise and Fall of Management Accounting", Boston, Harvard Business School Press. |
| **194.** | Jorgensen, B. and Emmitt, S. (2009). Investigating the integration of design and construction from a "lean" perspective. Construction Innovation: Information, Process, Management. 9, p 225-240. |
| **195.** | Jrade, A. & Alkass, S. (2001), "A conceptual Cost Estimating Computer Program for Building Projects", AACE International Transactions, p IT91. |
| **196.** | Jrade, A. and Alkass, S., (2002). An integrated system for conceptual cost estimating of building projects. Cost Engineering. 44 (10), p 28. |
| **197.** | Juran, Joseph M. (1962), *Quality Control Handbook* (2 ed.), New York, New York: McGraw-Hill, pp. 1–38–1–39, |
| **198.** | K. Ohmae – The Mind of Strategist, McGraw - Hill, Inc 1982, pag. 192 |
| **199.** | Kalyanaram, G.; Gurumurthy, R. (1998). "Market Enrty Strategies: Pioneers versus Late Arrivals" (p.71). Strategy and Business: |
| **200.** | Kanter, H. A., Muscarello, T. J., 2000. "Learning (experience) curve theory: A tool for the systems development and software professional". Technical Report,4.17.2000, available from: http://cobolreport.com/columnists/howard\&tom/ |
| **201.** | Kaplan, R.S. and Anderson, S.R. 2004. "Time-Driven Activity-Based Costing", Harvard Business Review, November: pp. 131-138. |
| **202.** | Kaplan, R.S. and Anderson, S.R.2003."Time-Driven Activity-Based Costing" Social Science Research Network, www. Google. Com. pp. 1-17 |

| | |
|---|---|
| **203.** | Kent R (2016)., *Quality Management in Plastics Processing*, ed. Elsevier, Amsterdam, |
| **204.** | Kerschberg, L and Jeong, H (2005) Just-in-Time Knowledge Management, Third Conference on Professional Knowledge Management, April 10-13, 2005, Kaiserslautern, Germany. Available at <http://eceb.vse.gmu.edu/pubs/JIT_KM_Kerschberg_Jeong.pdf>. |
| **205.** | Khan & P.K. Jain (2014) *Theory and Problems of Management and Cost Accounting;* McGraw-Hill Education (India) Ltd. B-4, Sector 63, Gautam Budh Nagar, Noida – 20 |
| **206.** | Kishore, Ravi M. (2016) *Advanced Management Accounting*; Taxmann's, Taxmann Publication (P) Ltd. 59/32, New Rohtak Road, New Delhi – 110 005. M.Y. |
| **207.** | Klein, D. A. (1994). *Decision-Analytic Intelligent Systems: Automated Explanation and Knowledge Acquisition*. Hillsdale, NJ: Lawrence Erlbaum Associates. |
| **208.** | Knight, Joe R. (2012). *Project Management for Profit: A Failsafe Guide To Keeping Projects On Track And On Budget*. New York, N.Y.: McGraw-Hill. |
| **209.** | *Knowledge Guide (PMBOK),* 3rd edition, New York: Project Management |
| **210.** | Kobayashi, S.; Plotkin, S.; Ribeiro, S.K. Energy efficiency technologies for road vehicles. Energy Effic. 2009, 2,125–137. |
| **211.** | Koller J., Trinkner U. (2009). *"Calculating the Cost of the Universal Service Obligation: The Need for a Global Approach".* In: Progress in the competitive agenda in the postal and delivery sector, ed. by Michael A. Crew and Paul R. Kleindorfer, Edward Elgar. |
| **212.** | Koontz, S., & Lawrence, J. (2010). *Impacts of alternative marketing agreement cattle procurement on packer costs, gross margins, and profits: evidence from plant-level profit and loss data.* Agribusiness, 26 (1), 1-24. http://dx.doi.org/10.1002/agr.20234 |
| **213.** | Kumaranayake, L; Walker, D (2002) *Cost-Effectiveness Analysis and Priority Setting: global approach without local meaning?* In: Lee, K; Buse, K; Fustkian, S, (eds.) Crossing Boundaries: Health Policy in a Globalising World. Cambridge University Press, Cambridge, pp. 140-156. |
| **214.** | Kurosawa, K. (1975). *An aggregate index for the analysis of productivity and profitability.* Omega, 3 (2), 157-168. http://dx.doi.org/10.1016/0305-0483 (75) 90115-2 |
| **215.** | Kvale, S. 1997: Den kvalitativa forskningsintervjun. Lund: Studentlitteratur Maskel, Brian 2011 Practical Lean Accounting. |
| **216.** | Le, N., van Do, T., Nguyen, N., & Thi, H. (2018). *Advanced Computational Methods for Knowledge Engineering*. Cham: Springer. |
| **217.** | Lecomte, J. (1951). La methode des "Comptes de surplus" et ses applications macroeconomiques. Journal De Economie, 12 (8), 827-828. http://dx.doi.org/10.1051/jphysrad:01951001208082702 |
| **218.** | Lee, H, L., & Billington, C (1992). Managing Supply Chain Inventory: Pitfalls and opportunities. Sloan Management Review, vol.33:65~7 |
| **219.** | Lee, J. Y., R. Jacob and M. Ulinski. 1994. Activity-based costing and Japanese cost management techniques: A comparison. Advances In Management Accounting (3): 179-196 |
| **220.** | Legea Contabilităţii nr.82/1991. |
| **221.** | Lemke, K., Paar, C., & Wolf, M. (2006). Embedded Security in Cars. [New York]: Springer-Verlag Berlin Heidelberg. |
| **222.** | Leonardi, A. (2017). *Energia e territori di montagna*. New York: Wiley. |
| **223.** | Lewis D. (2005), *Connected Corporation: How Leading Companies Manage Customer-Supplier,* ed. The Free Press, |
| **224.** | Lewis R. (2003) *Vocational Business, financial Accounting*, (p.147) Published by Nelson Thornes, |
| **225.** | Lezeu, D.N. (2014), *Analiza situaţiilor financiare ale întreprinderii*, Editura Economică, Bucureşti, |
| **226.** | Li S. (2007), *The legal environement and risk for foreign investment*, Springer, (p.59) New York, |
| **227.** | Liebowitz, J. (1988). *Expert system applications to telecommunications*. New York: Wiley. |
| **228.** | Lindgren, L.-E. (2007). Computational welding mechanics. In Lindgren, L.-E., editor, Computational Welding Mechanics, Woodhead Publishing Series in Welding and Other Joining Technologies, pages 31 – 46. Woodhead Publishing. |
| **229.** | Lindgren, L.-E. (2007). Computational welding mechanics. In Lindgren, L.-E., editor, Computational Welding Mechanics, Woodhead Publishing Series in Welding and Other Joining Technologies, pages 31 – 46. Woodhead Publishing. |
| **230.** | Long J.A., (2000). Parametric Cost Estimating in the New Millennium. PRICE Systems. |
| **231.** | Long, L. D. and Ohsato, A., (2009). A genetic algorithm-based method for scheduling repetitive construction projects. Automation in Construction.18 (4), p 499-511. |
| **232.** | Maheshwari S.N. (2011): *Cost and Management Accounting*; Sultan Chand & Sons, 23, Daryaganj New Delhi -110 002. |
| **233.** | Management Marketplace, M. (1994). *Management Marketplace. Management* (Springhouse), 25 (11), 74. http://dx.doi.org/10.1097/00006247-199411000-00019 |
| **234.** | Mancini, D., Vaassen, E., & Dameri, R. (2013). *Accounting Information Systems for Decision Making*. Berlin, Heidelberg: Springer. |
| **235.** | Marquardt, W., & Pantelides, C. (2006). *16th European Symposium on Computer Aided Process Engineering and 9th International Symposium on Process Systems Engineering*. Amsterdam: Elsevier. |
| **236.** | Marsh, C. (2012). *Financial management for non-financial managers.* London: Kogan Page. |
| **237.** | Martin Shepperd, Gada Kadoda, Comparing Software Prediction Techniques Using Simulation, IEEE Transactions on Software Engineering, v.27 n.11, p.1014-1022, November 2001 |
| **238.** | Martin, J. R., W. K. Schelb, R. C. Snyder, and J. C. Sparling. 1992. Comparing the practices of U.S. and Japanese companies: The implications for management accounting. Journal of Cost Management (Spring): 6-14. |

| | |
|---|---|
| **239.** | Martinuic A. (2013), *Posibilităţi de perfecţionare a metodologiei de calculaţie a costurilor întreprinderilor industriale*, teză de doctorat, 2013, Iași, p.38, 186. (http://phdthesis.uaic.ro/PhDThesis/Martiniuc,%20Adriana,%20Possibilities%20to%20improve%20the%20cost%20calculation%20methodology%20of%20industrial%20companies.pdf) accesat 21 septembrie 2020 |
| **240.** | Masaaki, Fuse & Kiyotaka, Tsunemi (2012), Assessment of the effects of the Japanese shift to lead-free solders and its impact on material substitution and environmental emissions by a dynamic material flow analysis, 438, pp. 49-58. DOI: 10.1016/j.scitotenv.2012.08.017 |
| **241.** | Maskell, Brian. 2011. Contabilitate practică Lean, Practical Lean Accounting: A Proven System for Measuring and Managing the Lean Enterprise, Second Edition |
| **242.** | Matson, J., and McFarlane, D. (1999) "Distributed Co-ordination and Control of Steel-making Operations: Problem Formulation, System Modelling and Simulation (Poster)." HSC'99, Nijmegen, Holland. |
| **243.** | Matsumoto M. Mersenne Twister: A random number generator (since 1997/10).. 2016. |
| **244.** | Maxim, E. (2004), *Diagnosticarea și evaluarea organizațiilor*, Editura Sedcom Libris, Iași, |
| **245.** | Mărgulescu, D., Niculescu, M., Robu V. (2014), *Diagnostic economico-financiar*, Editura Romcart, Bucureşti, |
| **246.** | McCormick, T, (2010), Strategic Cost Reduction Steps to Success, Accountancy Ireland, 42, 2 pp56-58 |
| **247.** | McGrath, R, G. & MacMillan (2000), I. "*The Entrepreneurial Mindset*" (p.206) Harvard Business School Press, |
| **248.** | Medina R.G. (2007), *Business Finance*, (p.46) Bookstore, Manilla, Philippines, |
| **249.** | Menn P, Holle R. Comparing Three Software Tools for Implementing Markov Models for Health Economic Evaluations.. PharmacoEconomics 2009;27:745–53. |
| **250.** | Microsoft Corporation. Description of the RAND function in Excel. 2016. |
| **251.** | Microsoft Corporation. Excel 2010 Performance: Tips for Optimizing Perfomance Obstructions. 2016. |
| **252.** | Microsoft Corporation. Excel specifications and limits. 2016. |
| **253.** | Microsoft Corporation. Multithreaded Recalculation in Excel. 2016. |
| **254.** | Mihăilescu, N., Răducan (2005), M*., Analiza activităţii economico-financiare*, Editura Victor, Bucureşti, |
| **255.** | Mircea, Delia - *Amortizarea fiscală vs. amortizarea contabilă* https://blog.smartbill.ro/amortizarea/ (accesat ianuarie 2022) |
| **256.** | Mironiuc, Marilena (2006), *Analiză economico-financiară: elemente teoretico-metodologice și aplicații,* Editura Sedcom Libris, Iași, |
| **257.** | Mitchell Philip (2002), Tool and Manufacturing Engineers Handbook: Plastic Part Manufacturing, TMEH, Michinghan. |
| **258.** | Mongin, Phillipe (2002). "*Is There Progress in Normative Economics?"* in Stephan Boehm et al., eds., Is There Progress in Economics?, pp. 145-170. |
| **259.** | Morgan and Liker, 2006 The Toyota Product Development System Möller, G., Möller, K., 2002. *Konstruktions begleitendes Supply Chain Controlling mit prozeßorientiertem Kostenmanagement* in: Hahn, D., Kaufmann,L. (Eds.), Handbuch Industrielles Beschaffungsmanagement 2.Edn, Gabler, Wiesbaden, pp. 747–764. |
| **260.** | Moser R. (2017), *Strategic Purchasing and Supply Management: A Strategy-Based Selection*, ED.Gabler, Frankfurt, |
| **261.** | Mummolo, G., Ranaldo, S., Iavagnilio, R., 1999. Integrating analytic and simulation models for FMS loading and AGV fleet sizing. 3rd International Conference on Engineering Design and Automation, Vancouver, August 1–4, pp. 813–824. |
| **262.** | Narbaev, T. and De Marco, A., (2014) An earned schedule-based regression model to improve cost estimate at completion. International Journal of Project Management. 32 (6), p 1007 (12). |
| **263.** | Narbaev, T. and Marco, A. D., (2011). Cost Estimate at Completions Methods in Construction Projects. International Conference on Construction and Project Management. IPEDR, IACSIT Press, Singapore. 15. |
| **264.** | National Academy of Engineering, The Competitive Status of the U.S. Auto Industry (Washington, DC: National Research Council, 1982); |
| **265.** | Nayab, N (2010), *Why should you use JIT*, Available at <http://people.brunel.ac.uk/~mastjjb/jeb/or/jit.html>. |
| **266.** | Neagu, C., V. Zaharia (2017), *An informal review regarding the abc method in cost engineering discipline,* Conference Proceedings of the Academy of Romanian Scientists, PRODUCTICA Scientific Session, ISSN 2067-2160 Volume 9, Number 1/2017, p.4. |
| **267.** | Neely, A. (2006). *Business performance measurement*. Cambridge: Cambridge University Press. |
| **268.** | Negruţ, C. (2003), *Resursele Electronice şi Managementul Informațional al Organizațiilor*, Editura Mirton, Timişoara, |
| **269.** | Neish W. (2011), *Management Accounting*, McGraw-Hill, New York, |
| **270.** | Niazi, Adnan Dai, Jian S. Balabani, Stavroula Seneviratne Lakmal 2006 Product Cost Estimation: Technique Classification and Methodology Review. Seuring, S., 2002 b. Supply Chain Costing. in: Franz, K.P.,Kaj ¨ uter, P. (Eds.), Kostenmanagement-Wertsteigerung durchsystematische Kostensteuer- ung2nd ed., Schaffer Poeschl, Stuttgart, pp.5–27. |
| **271.** | Nicholson, J., & Rohrbach, J. (2010). *Cost accounting*, by J. Lee Nicholson and John F.D. Rohrbach. New York: Ronald Press. |
| **272.** | Nicolescu O. (2001) - *Management comparat*, Editura Economica, București, |
| **273.** | Nicolescu, O. (2001), *Managementul Intreprinderilor Mici și Mijlocii*, Editura Economica, Bucureşti, |
| **274.** | Nigam B.M. Lall and I.C. Jain (2017) *Cost Accounting Principles* and Practice - PHI Learning Private Limited 14 Ashish K. Bhattacharyya Principles and Practice of Cost Accounting- PHI Learning Private Limited |
| **275.** | Nigam, B.M. Lall & I.C. Jain (2012) *Cost Accounting Principles and Practice;* Prentice Hall of India, M-97, Connaught Circus, New Delhi-110 001. |

| | |
|---|---|
| **276.** | O'Brien, M.J. & Pantouvakis, J.P. (1993), A new approach to the development of computer-aided estimating systems for the construction industry, Construction Management and Economics, 11 (1), p 30. |
| **277.** | Ochieng, J. (2016). *Market orientation, rural out-migration, crop production and household food security* (p. 92). New York: Taylor and Francis. |
| **278.** | Ofileanu Dimi, *Implementarea contabilității Lean în industria încălțămintei,* ISBN: 978-606-17-1609-8, Editura Casa Cărții de Știință, Cluj Napoca, 2020, (https://www.casacartii.ro/editura/carte/implementarea-contabilitatii-lean-in-industria-incaltamintei/) |
| **279.** | Olariu C. (1975), *Conducerea întreprinderii prin costuri*, Editura Facla, Timişoara, p.59 |
| **280.** | Olariu C., (1971) *Studiu costurilor. Teoria, calculaţia şi informaţia costurilor*, Editura Didactică și Pedagogică, Bucureşti, p. 32 |
| **281.** | Olaru, O., Constanța C. (2001) *Management și negociere în afaceri internaționale*, București, |
| **282.** | Oliver, V., (2010). 301 Smart Answers to Tough Business Etiquette Questions. Skyhorse Publishing: New York USA. |
| **283.** | Oncu, Marius - *Ce sunt bunurile de capital și ce tratament li se aplică din perspectiva TVA* **https://www.profit.ro/taxe-si-consultanta/analiza-ce-sunt-bunurile-de-capital-si-ce-tratament-li-se-aplica-din-perspectiva-tva-exemplu-de-ajustare-a-tva-17023367** |
| **284.** | Oprea D. și alții (2002), *Sisteme Informaționale pentru manageri*, Ed. Polirom, București, |
| **285.** | Oprea O., Cârstea Gh. (2002*), Management accounting and costs calculation,* Genicod Publising, Bucureşti. |
| **286.** | Oprea, C. (2001), *The costs calculation*, Tribuna Economica Publising, Bucureşti, |
| **287.** | Ordinul Ministerului de Finanţe nr. 1826/200, |
| **288.** | Ostrenga, M. et al., (1997). Guia da Ernst & Young para gestao total dos custos. 13rd ed. Rio de Janeiro: Record. |
| **289.** | Ostring P. (2014), *Profit-focused Supplier Management: How to Identify Risks,* ed. Amacom, New York, |
| **290.** | Ozdamar, L., Birbil, S.I., 1998. Hybrid heuristic for the capacitated lot sizing and loading problem with setup times and overtime decisions. European Journal of Operational Research 110, 525–547. |
| **291.** | Pandey I.M. (2006): *Management Accounting; Vikas Publishing House*, P Ltd. A-22, Sector 4, Noida – 201 301 6. |
| **292.** | Pearce, D., Atkinson, G., et Mourato, S. (2006). *Analyse coûts-bénéfices et environnement: développements récents.* Éditions OCDE. Disponible à l'URL: http://www.sourceocde. org/environnement/9789264010062. 21 |
| **293.** | Peng M. (2014), *Global strategy*, (p.82) South Western Strategy, USA., |
| **294.** | Pennanen A., Ballard G. and Haahtela Y., (2011). Target costing and designing to targets in construction. Journal of Financial Management of Property and Construction. 16 (1), p 52-63. |
| **295.** | Perera, A D A J. & Imriyas, K. (2004). An integrated construction project cost information system using MS Access and MS Project. Construction Management and Economics, 22 (2), p. 203. |
| **296.** | **Petra Menn1, Reiner Leidl, Rolf Holle,** *A lifetime Markov model for the economic evaluation of chronic obstructive pulmonary disease - https://pubmed.ncbi.nlm.nih.gov/22799876/* accesat 5 mai 2021 |
| **297.** | Petrescu, S., (2004*) Diagnostic economic-financiar.* Metodologie. Studii de caz, Editura Sedcom Libris, Iași, |
| **298.** | Petrescu, S., *Analiză și diagnostic financiar contabil.* Ghid teoretico-aplicativ, Editura CECCAR, Bucureşti, |
| **299.** | Petrescu, S., Mihalciuc, C.C. (2006), *Diagnosticul financiar privind performanţa întreprinderii. Aspecte teoretice și aplicative de contabilitate și analiză financiară*, Editura Universităţii Suceava, |
| **300.** | Petrovic, D., Roy, R., Petrovic, R., 1998. Modelling and simulation of a supply chain in an uncertain environment. European Journal of Operational Research 109, 299–309. Pfohl, |
| **301.** | Pfister, J. (2009). *Managing organizational culture for effective internal control* (p. 158). Heidelberg: Physica. |
| **302.** | Phaobunjong, K. and Popescu, C.M., (2003). Parametric cost estimating model for buildings. AACE International Transactions, 2003. |
| **303.** | Picoș, C. (1979). Normarea tehnică pentru prelucrări prin așchiere (p. 103). București: Editura Tehnică. |
| **304.** | Plossl, G. W., (1990). Cost accounting in manufacturing: dawn of a new era, Production Planning and Control. Taylor & Francis. |
| **305.** | Plowman, B. (2017). *Activity-based management: Improving processes and profitability*. Routledge. |
| **306.** | Podolchak, N., & Chepil, B. (2015). Optimization of administrative management costs. *Economics, Entrepreneuship, Management*, *2* (1), 53-58. http://dx.doi.org/10.23939/eem2015.01.053 |
| **307.** | Pool, R. (2017). *New directions in assessing performance potential of individuals and groups*. New York: Simon & Schuster. |
| **308.** | Popa, C., & Duduman, G. (2016). *Aplicarea metodelor de producție in management.* Economic, 16 (1), 23. http://dx.doi.org/10.4316/bf.2016.003 |
| **309.** | Popa, I. (1999) *Management internațional, București,* Editura Economica, |
| **310.** | Popham, K., (1996). Cost estimating using historical costs. Transactions of AACE International, 1996. |
| **311.** | Porter, M. E., M. Sakakibara and H. Takeuchi. 2000. Can Japan Compete? (Perseus). |
| **312.** | Preece C,Moodley K., Smith P. (2003), *Construction, bussiness development, meeting new chalanges, seeking opportunity*, (p.165) Elsevier, Oxford, |
| **313.** | Proceedings of the FISITA 2012 World Automotive Congress. (2013). Berlin. |
| **314.** | Proff, H., 2000. Hybrid strategies as a strategic challenge—the case of the German automotive industry. Omega 28, 541–553. Sabri, E.H., |

| | |
|---|---|
| **315.** | Progettointeramna.it, P. (2018). *energia*. *Progettointeramna.it*. Retrieved 5 February 2018, from http://www.progettointeramna.it/energia.htm |
| **316.** | Project Management Institute. (2000). Guide to the Project Management Body of |
| **317.** | Project Management Institute. (2008). Guide to the Project Management Body of Integrated Cost Management System For Delivering Construction Projects Knowledge Guide (PMBOK), 4th edition, New York: Project Management Institute |
| **318.** | Qazi, A., Quigley, J., Dickson, A., & Kirytopoulos, K., (2016). Project Complexity and Risk Management (ProCRiM): Towards modelling project complexity driven risk paths in construction projects. International Journal of Project Management. 34 (7), p 1183-1198. |
| **319.** | Qiu, L. D. & Wang, S., (2011). BOT projects: Incentives and efficiency. Journal of Development Economics. 94 (1), p 127-138. |
| **320.** | Raz, T. and Elnathan, D. (1999). Activity based costing for projects. International Journal of Project Management, 17 (1), p 61-67. |
| **321.** | Reich, Y., (1994). Layered models of research methodologies. Artificial Intelligence for Engineering, Design, Analysis and Manufacturing, 1994. 8 (4), p 261-262. |
| **322.** | Riggs, T., & Bonk, M. (2008). *Everyday finance*. Detroit: Gale Cengage Learning. |
| **323.** | Ristea, M și colectiv (1997), *Contabilitatea întreprinderii*, vol. I, Editura Mărgăritar, București, |
| **324.** | Robson, C., (2011). Real world research: a resource for users of social research methods in applied settings. 3rd ed. Chichester: John Wiley. |
| **325.** | Roll-Hansen, N., (2009). Why the distinction between basic (theoretical) and applied (practical) research is important in the politics of science. The London School of Economics and Political Science. London, |
| **326.** | Russell, D., Patel, A., & Wilkinson-Riddle, G. (2002). *Cost accounting* (p. 43). Harlow: Pearson Higher Education. |
| **327.** | Rutherford, Thomas R. (1997) Workplace Productivity, American Military Engineer Magazine. Smith, Dana K. (1997) “Installation Life-cycle Management”, Journal of Computing in Civil Engineering, Vol. II, No. 2. |
| **328.** | Ryan B. (2004), *Finance and Accounting for business*, (p.38) Thomson Learning, London, |
| **329.** | S.P. Jain & K.L. Narang (2002): *Cost and Management Accounting*; Kalyani Publishers, 23, Daryaganj, New Delhi-110 002.. |
| **330.** | Sabou F (2004) *The main indicators used in direct-costing method*, Contabilitatea, expertiza și auditul afacerilor nr.10, CECCAR Publising, București, ISSN 1454-9263, |
| **331.** | Sabou F. (2007) *Management accounting*, Risoprint Publising, Cluj-Napoca, |
| **332.** | Sabou F. (2007) *Standard-cost method, direct costing method — modem methods of management accounting*, Studia Universitatis „Vasile Goldiş” Arad, Economic Sciences Series, ISSN 158-2339, |
| **333.** | Saha. G.C., & Theingi. (2009). Service quality, satisfaction, and behavioural intentions, (p.41) *Managing Service Quality, 19 (3),* |
| **334.** | Sahlman, W. A. (1999), Stevenson, H. H., Roberts, M. J. & Bhide, A. *"The Entrepreneurial Venture"* 2nd Edition, (p.31) Harvard Business School Press, |
| **335.** | Sakurai, M. 1989. Target costing and how to use it. Journal of Cost Management (Summer): 39-50. |
| **336.** | Sakurai, M. 1995. Past and future of Japanese management accounting. Journal of Cost Management (Fall): 21-30. |
| **337.** | Salem, O., Solomon J., Genaidy, A., and Minkarah, I., (2006). Lean Construction: From Theory to Implementation, Journal of Management in Engineering ASCE. 22 (4). |
| **338.** | Samid, G. (1997), Activity-Based Cost Management: Making It Work. Cost Engineering. 39 (10). |
| **339.** | Samuelson, Paul A., and William D. Nordhaus (2004). Economics, 18th ed., pp. 5-6 & [end] Glossary of Terms, "Normative vs. positive economics." |
| **340.** | Sanders, A. (1971). *Production ratios—measuring the basic factors of productivity.* Production Engineer, 50 (3), 107. http://dx.doi.org/10.1049/tpe.1971.0019 |
| **341.** | Saravi, M. E., Newnes, L. B., Mileham, A. R. & Goh Y. M., (2008). Estimating cost at the conceptual design stage to optimize design in terms of performance and cost. In the proceedings of the 15th ISPE International Conference on Concurrent Engineering. |
| **342.** | Sasacki, N. (1981) *Management and Industrial Structure in Japan*, New York, |
| **343.** | Saunders M., Adrian Thornhill, A., & Lewis P., (2009). Research Methods for Business. Students Paperback |
| **344.** | Saunders, M., Lewis, P. & Thornhill, A., (2012) Research Methods for Business Students. 6th ed. Pearson Education Limited. |
| **345.** | Saxena V.K. & C.D. Vashist (2003): *Cost and Management Accounting;* Sultan Chand & Sons, 23, Daryaganj New Delhi -110 002. |
| **346.** | Schaltegger, S and M. Wagner 2006: *Managing the Business Case of Sustainability*, |
| **347.** | Scheduling of flexible flow lines in an automobile assembly plant. European Journal of Operational Research. 97, 2 (1997), pp. 348-362. DOI: 10.1016/S0377-2217 (96) 00203-2 |
| **348.** | Schiopu, D. (2007). *Contribuţii privind organizarea și implementarea managementului prin costuri în organizaţiile industriale*. Europe’S Journal Of Ecomomy, 3 (1). |
| **349.** | Schmidlin N. (2014), *The art of company valuation and financial statement analysis*, (p.65) Willey, London, |
| **350.** | Schmidt, M. (2008) The Sankey diagram in energy and material flow management. // Journal of industrial ecology. 12, 1 (2008), pp. 82-94. DOI: 10.1111/j.1530-9290.2008.00004.x |
| **351.** | Schmuck, Richard., (1997). Practical action research for change. Arlington Heights. Skylight Training and Publishing. |
| **352.** | Scully, J., & Fawcett, S. E. (1993). Comparative Logistics and Production Costs for Global Manufacturing Strategy, International Journal of Operation & Production Management, p.62-78 |

| | |
|---|---|
| **353.** | Seba T. https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/591a2e4be6f2e1c13df930c5/1509063152647/RethinkX+Report_051517.pdf |
| **354.** | Seidman, L., Skancke, S., & Seidman, L. (1991). *Productivity, the American advantage.* New York: Simon & Schuster. |
| **355.** | Sen, Amartya K. (1970), Collective Choice and Social Welfare, pp. 61, 63-64). |
| **356.** | Sergio and, A. and Conte, I., (2002). Lean Construction: From Theory To Practice Proceedings IGLC-10, August 2002. Gramado, Brazil. |
| **357.** | Shanthikumar, J.G., Sargent, R.G., 1983. A unifying view of simulation/analytic models and modeling. Operations Research 31 (6), 1030–1052. |
| **358.** | Shapiro, J.F., Singhal, V.M., Wagner, S.N., 1993. Optimizing the value chain. Interfaces 22 (March/April), 65–73. |
| **359.** | Sheffield, Greenleaf. Simpson, Timothy W. Maier, Jonathan R.A., Mistree, Farrokh 2001 Product platform design: method and application. 35 (42) ´´X´´ Financial Policies & Procedures 2013 |
| **360.** | Shen, C., & Huang, Y. (2011). *Effects of earnings management on bank cost of debt.* Accounting & Finance, 53 (1), 265-300. http://dx.doi.org/10.1111/j.1467-629x.2011.00455.x |
| **361.** | Shields, Patricia and Rangarjan, N., (2013). A Playbook for Research Methods: Integrating Conceptual Frameworks and Project Management. Stillwater. New Forums Press. |
| **362.** | ShilInglaw, G., (1989). Managerial cost accounting: present and future. Journal of Management Accounting Research. 1, p 33-46. |
| **363.** | Shobrys, D.E., White, D.C., 2000. Planning, scheduling, and control systems: Why can they not work together? Computers and Chemical Engineering 24, 163–173. |
| **364.** | Siegel, J., Shim, J., Hartman, S., & Siegel, J. (1998). *Schaum's quick guide to business formulas.* New York, N.Y.: McGraw-Hill. |
| **365.** | SIEMENS Gamesa, Renewable Energy, Products and services, Onshore, Wind turbine SG 6.6-155, https://www.siemensgamesa.com/en-int/products-and-services/onshore/wind-turbine-sg-5-8-155 accesat 15 ianuarie 2021 |
| **366.** | Simpson, L., (2011). Estimates - a black art: how do you determine if a project is feasible before moving forward with the process design and construction phases? Chem. Information. 49 (2), p 19 (1). |
| **367.** | Singh, A. (2007). Approximate Estimating Method for Typical Buildings. Cost Engineering. 49 (8). |
| **368.** | Sinha A. P. and J. H. May, “Evaluating and tuning predictive data mining models using receiver operating characteristic curves,” Journal of Management Information Systems, vol. 21, no. 3, pp. 249–280, 2004. |
| **369.** | Sîrbu C. (2008), S*trategii de creştere a competitivităţii bazate pe analiza costurilor*, Editura Europlus, Galați, p.37. |
| **370.** | Smith, D., & De Swardt, J. (1967). Some Thoughts on the Concepts of “Operator's Earnings” and “Gross Profit”. Agrekon, 6 (3), 17-21. http://dx.doi.org/10.1080/03031853.1967.9525052 |
| **371.** | Smith, J., (2000). Cost Planning of Buildings Construction. Management and Economics. 18 (4). |
| **372.** | Smith-Daniels, V.L., Ritzman, L.P., 1988. A model for lot sizing and sequencing in process industry. International Journal of Production Research 26 (4), 647–674. |
| **373.** | Spătaru, L. (2014), *Analiza economico-financiară, instrument al managementului întreprinderilor,* Editura Economică, Bucureşti, |
| **374.** | Spear, S. and H. K. Bowen. 1999. Decoding the DNA of the Toyota production system. Harvard Business Review (September-October): 97-106. |
| **375.** | Spiţă, C. (2007). *Managementul prin costuri al unei firme.* Books Abroad, 46 (3), 471. http://dx.doi.org/10.2307/4026373 |
| **376.** | Spreadsheets in Education (eJSiE) 2015;8. |
| **377.** | Stan, S. (2003), *Evaluarea întreprinderii*, Editura Iroval, Bucureşti, |
| **378.** | Standard AACE International Recommended Practice No. 10S-90 COST ENGINEERING TERMINOLOGY TCM Framework: General Reference, Association for the Advancement of Cost Engineering International, 2010, Pg 35. |
| **379.** | State highway cost allocation studies. (2008). Washington, D.C. |
| **380.** | Stav J. B. and Engh E. Learning Object Farms Supporting Learning Activities in Welding Sciences, Proceedings from the EUROJOIN conference (2006) (ISBN: 84-934316-0-5), page 623- 626, Santiago de Compostilla, Spain. |
| **381.** | Sterr, T.; Ott, T. The industrial region as a promising unit for eco-industrial development - Reflections, practical experience and establishment of innovative instruments to support industrial ecology. // Journal of Cleaner Production. 12, 8 (2004), pp. 947-965. DOI: 10.1016/j.jclepro.2004.02.029 |
| **382.** | Stevens, G., 1999. The role of logistics and IT in the European enterprise. In: Hadjiconstantinou, E. (Ed.). Quick Response in the Supply Chain. Springer, Berlin. |
| **383.** | Sun, C. (2013*). Intelligence science and big data engineering* (p. 174). Berlin: Springer. |
| **384.** | Sutherland, J., (1999). Project cost estimating for major renovation projects, AACE International Transactions, 1999. |
| **385.** | Svensson, G., 2000. A conceptual framework for the analysis of vulnerability in supply chains. International Journal of Physical Distribution & Logistics Management 30 (9), 731–749. |
| **386.** | Tabără N. (2005), *Modernizarea contabilității și controlului de gestiune*, Editura TipoMoldova, Iași, 2006, pp. 5-6 Simmons T., Dynamic Costing A.B.C for a New Generation, Accoutancy S.A, p.27-29 |
| **387.** | Tabără, N. (2006), Horomnea, E., Toma, C., *Conturile anuale în procesul decizional.* Elemente de contabilitate, analiză financiară şi evaluarea performanţelor întreprinderii, Editura CECCAR, Bucureşti, |
| **388.** | Takeuchi, H. 1981. Productivity: Learning from the Japanese. California Management Review (Summer): 5-18. |

| | |
|---|---|
| **389.** | Tanaka, T. 1993. Target costing at Toyota. Journal of Cost Management (Spring): 4-11. |
| **390.** | Tanaka, T. 1994. Kaizen budgeting: Toyota's cost-control system under TQC. Journal of Cost Management (Fall): 56-62. |
| **391.** | Taylor, David H. (2005) "Value chain analysis: an approach to supply chain improvement in agri-food chains", International Journal of Physical Distribution & Logistics Management, Vol. 35 No. 10,pp.744 761. |
| **392.** | Teixeira, R., Koufteros, X. A., Peng, X. D. (2012). *"Organizational Structure, Integration, and Manufacturing Performance: a Conceptual Model and Propositions"* (p.190). Journal of Operations and Supply Chain Management. |
| **393.** | The European Aluminum Association (EAA). Sustainability of the European Aluminum Industry. Available online: http://www.alueurope.eu/wpcontent/uploads/2011/08/Sustainability_Report_Sum.pdf |
| **394.** | Thomas, D.J., Griffin, P.M., 1996. Coordinated supply chain management. European Journal of Operational Research 94, 1–15. |
| **395.** | Thompson, P., & Markow, M. (1996). *Collecting and managing cost data for bridge management systems* (p. 303). Washington, D.C.: Transportation Research Board. |
| **396.** | Thrun, W. (2003). *Maximizing profit.* New York: Productivity Press. |
| **397.** | Tofan, C. (2016). Metode de asistare a deciziilor prin costuri cu ajutorul tehnologiilor informatice. Estfalia, 3-6. http://dx.doi.org/10.2139/ssrn.238438 |
| **398.** | Tosh J, Wailoo A. Review of Software for Decision Modelling.. DSU Report 2008. |
| **399.** | Treeage Software Inc. Products - TreeAge Software. 2016. |
| **400.** | Treeage Software Inc. TreeAge Pro 2016 User’s Manual. 2016. |
| **401.** | Tufano, P. (1998). Agency Costs of Corporate Risk Management. *Financial Management, 27* (1), 67. http://dx.doi.org/10.2307/3666152 |
| **402.** | Tüfekçi, M. Hinge *Modular Design, Optimization and Production Prototype for Light Commercial Vehicle,* GHG Emissions, Report Laboratory for Energy and the Environment; Report No. LFEE 2008-05 RP; |
| **403.** | U.S. Automobiles by 2035; Laboratory for Energy and Environment, Massachusetts Institute of Technology |
| **404.** | U.S. Energy Information Administration, International Energy Outlook 2013. Available online: http://www.eia.gov/forecasts/ieo/pdf/0484 (2013).pdf (accessed on 15 March 2014). |
| **405.** | Uherek, E.; Halenka, T.; Borken-Kleefeld, J.; Balkanski, Y.; Berntsen, T.; Borrego, C.; Gauss, M.; Hoor, P.; Juda-Rezler, K.; Lelieveld, J.; et al. Transport impacts on atmosphere and climate: Land transport. consumption. Int. J. LCA Case Stud. Light-Weight. Veh. 2006, 12, 58–64. [CrossRef] |
| **406.** | Ungureanu, C.A.; Das, S.; Jawahir, I.S. Life-cycle cost analysis: Aluminum versus steel in passenger cars. |
| **407.** | Unknown. A Pilot Study of Value of Information Analysis to Support Research Recommendations for the National Institute for Health and Clinical Excellence.pdf. |
| **408.** | Usenik, J. (2008). *A fuzzy model of power supply system control =*. Londra: Routledge. |
| **409.** | van Goor, H.C., A.R., 2000. Supply chain management and management accounting: a case study of activity based costing. International Journal of Logistics: Research and Applications 3 (1), 41–52. |
| **410.** | van Loggerenberg, B., & Cucchiaro, S. (1981). *Productivity measurement and the bottom lin*e. National Productivity Review, 1 (1), 87-99. http://dx.doi.org/10.1002/npr.4040010111 |
| **411.** | Varian, Hal R.: (2003) *Intermediate Microeconomics* - A Modern Approach. 6th edition. New York / London: W.W. Norton & Company |
| **412.** | Walter, Nicholson: (2004) *Intermediate Microeconomics and Its Application with Economic Applications* Card, New York / London: W.W. Norton & Company |
| **413.** | Wang Y., King G. (2008), *Software Engineering Processes: Principles and Applications,* ed.CRC Press, New York, |
| **414.** | Wang, P. C.; Lee, Y. M.; Chen, C. Y. Estimation of resource productivity and efficiency: An extended evaluation of sustainability related to material flow. // Sustainability (Switzerland). 6, 9 (2014), pp. 6070-6087.DOI: 10.3390/su6096070 |
| **415.** | Ward, T. (1967). *Management concepts. Management Decision*, 1 (4), 38-38. http://dx.doi.org/10.1108/eb000817 |
| **416.** | Warren M. (2000), *Economic Analysis for Property and business*, (p.203) Butterworth, London, |
| **417.** | Weber, C. (1966). *The evolution of direct costing* (p. 63). Urbana, Ill.: Willey. |
| **418.** | Wei, J., Krajewsky, L., 2000. A model for comparing supply chain schedule integration approaches. International Journal of Production Research 38 (9), 2099–2123. Wu, D.J., 2001. Software agents for knowledge management: Coordination in multi-agent supply chains and auctions. Experts Systems with applications 20, 51–64. |
| **419.** | Wheelwright, S.C. 1981. Japan - Where operations really are strategic. Harvard Business Review (July-August): 67-74. |
| **420.** | Wight, L. (1932). The fundamentals of process cost accounting. London: Sir I. Pitman & Sons, Ltd. |
| **421.** | Wong, Stanley (1987). “*Positive economics*," The New Palgrave: A Dictionary of Economics, v. 3, pp. 920–21. |
| **422.** | Yenokyan, K., Seater, J., & Arabshahi, M. (2014). *Economic growth with trade in factors of production. International Economic Review*, 55 (1), 223-254. http://dx.doi.org/10.1111/iere.12047 |
| **423.** | Zülch, G., Jagdev, H., & Stock, P. (2005). *Integrating human aspects in production management* (p. 33). New York: Kluwer Academic Publishers. |

*Rethinking Transportation 2020-2030. The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries -*

https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/591a2e4be6f2e1c13df930c5/1509063152647/RethinkX+Report_051517.pdf accesat 14 aprilie 2021
**Figure nr. 3. Etapele metodei GP** (Concluzii proprii în urma studierii bibliografiei. Sursa: Inventories, https://slidetodoc.com/inventories-www-assignment-point-com-inventories-after-studying/, accesat 16 octombrie 2021
Support Services for the Office of Naval Research for the Legislative Affairs Office - Solicitation Number: 05-0002-02
https://web.archive.org/web/20060722155057/http:/www.onr.navy.mil/02/matoc/05_09/solicitations/docs/05-0002-02.pdf, accesat 4 august 2021, wayback machine