REDUCE COSTS IN THE MODERN MANUFACTURING ENVIRONMENT: CASE STUDY WITH IMPLEMENTATION OF TARGET COSTING AND ε -CONSTRAINT METHOD

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Abstract

This article investigates the role of target costing and ε -constraint method for reducing costs in the modern manufacturing environment that characterized by an intensification of global competition and rapid progress of information and manufacturing technology. It is based on case study in an Algerienne manufacturing company. In this study it was found that target costing and ε -constraint method together provide considerable advantages to users of these practices in reducing of costs.

Keywords: Cost, modern manufacturing environment, target costing, □-constraint

Introduction

The traditional cost management systems have become not effective to meet the challenges posed by the prevailing variables in the modern manufacturing environment. Consequently, new technologies of cost management have emerged such as activity-based costing, target costing and life cycle costing.

Target costing plays a critical role in managing costs because once a product is designed, most of its costs are committed (R.Cooper, R.Slagmulder, 1997). It is a structured approach to establish the cost at which a firm must manufacture a proposed product with specified functionality and quality to generate the desired profitability over its life-cycle at its anticipated selling price (W.Roman, M.Michael, 2005). The target costing begins with the target price, which is in general determined by market research or observation. A desired per unit profit is then simply subtracted from the target price to obtain the target cost (T.Filomena et al, 2009).

In this article an attempt will be made to provide a model of ε -constraints as a tool to help achieve the target cost at a Algerienne zinc company. This company have recently faced the problem of high costs, due to poor cost management, besides problems in the production process.

This paper is organized as follows: Section 2 discusses modern manufacturing environment. Section 3, concepts of target costing. In Section 4, the ε -constraints method is described , while in Section 5 the model of ε –constraints is applied to help achieve the target cost in a Algerienne zinc company. The conclusion of the article are presented in Section 6.

Modern manufacturing environment

The Prevailing variables in the modern manufacturing environment are the global competition, information technology and manufacturing technology, which we present next.

Global competition

The current era is characterized with a large number of multinational companies and partnership agreements, besides the regional economic integration and joining the World Trade Organization, These factors led to an increase entanglement between countries and create an economic environment characterized by rapidly changing and the intensification of global competition.

Information technology

Information technology refers to all forms of technology applied to processing, storing, and transmitting information in electronic form. The physical equipment used for this purpose includes computers, communications equipment and networks, fax machines, and even electronic pocket organizers (C.Henry et al, 2000).

Manufacturing technology

Total quality management

Total quality management is a management philosophy that fosters an organisational culture committed to customer satisfaction through continuous improvement (A.brunhosa and P.Moura, 2008).

Just in time

JIT philosophy appeared for the first time in Japan by Toyota Motor Corporation in the period (1950/1960) and culminated in the eighties of the twentieth century. This philosophy stems from the fact that the Japanese environment characterized by shortness of space and lack of natural resources as well as the love of teamwork and privacy of culture and tradition.

Schonberger was one of the first authors to extensively study this revolution in detail, and defined the Just-In-Time manufacturing system thus: "The JIT idea is simple: Produce and deliver finished goods just in time to be sold, sub-assemblies just in time to be assembled into finished goods, fabricated parts just in time to go into sub-assemblies, and purchased materials just in time to be transformed into fabricated parts" (D.Power and A.Sohel, 2000).

Flexible Manufacturing Systems

Flexible manufacturing systems have emerged in response to the requirements of modern production environment characterized by abundance and diversity of products with a focus on high quality and low cost, in a market characterized by complex and intense competition.

FMS is called flexible due to the reason that it is capable of processing a variety of different part styles simultaneously at the workstation and quantities of production can be adjusted in response to changing demand patterns (H.K. Shivanand et al, 2006). Browne defines FMS as an integrated computer controlled system with automated material handling devices and CNC machine-tools and which can be used to simultaneously process a medium-sized volume of a variety of parts (A.M. El-Tamimi et al, 2011).

Lean Manufacturing

The term Lean Manufacturing emerged in the late twentieth century, It is considered one of the most modern manufacturing systems that have achieved impressive results for organizations to reduce waste, and It is also behind the dazzling success of Japan after the challenge faced to rebuild its economy after World War II. Many thinkers administrators use this term as a synonym for the phrase Toyota productive system.

Lean means manufacturing without waste. Waste ("muda" in Japanese) has seven types: waste from over production, waste of waiting time, transportation waste, inventory waste, processing waste, waste of motion, and waste from product defects (N.Azian et al, 2013). Womack and Jones define waste as any human activity which absorbs resources but creates no value (A.Natasya et al, 2013).

Target Costing

Roots of target costing

Target costing received its roots from Western world thinking. A retrograde approch for determining product costs, which is one of the most important features of target costing, can be found as early as the begining of the last century at Ford in the united states and in the development of the Volkswagen Beetle in Germany in the 1930s (M.A.Sarokolaee et al, 2012).

The first use of target costing in Japan known as « genkakikaku » occured at Toyota in 1963s, and became popular in the English-language literature in the 1990s. Lorino stated that over 80% of large companies in the assembly industries had already applied TC in Japan at the beginning of 1990 (H.Yazdifar et al, 2012).

Concept of target costing

Target costing is defined as a structured approach to determine the life cycle cost at which a proposed product with specified functionality and quality must be produced to generate the desired level of profitability over its life cycle when sold at its anticipated selling price (R.Cooper, R.Slagmulder, 1997). it is a disciplined process for determining and realizing a total cost at which a proposed product with specified functionality must be produced to generate the desired profitability at its anticipated selling price in the future (M.Bradford et al, 2004).

Target costing is introduced as a technique that aims to manage product costs throughout the design stage (Y.Zengin, E.Ada, 2010). It is a ‘‘reverse costing’’methodology, in which an estimation of the attainable selling price and the required profit margin are used to determine the allowable cost for a new product (Dekker and Smidt, 2003). At this simple equation lies the heart of target costing :

Target cost = Target selling price – Target profit margin

This equation describe several characteristics of target costing. The selling price is set only after considering customer requirements and competitive offerings, the target profit is derived after evaluating the company’s strategy, shareholder expectations and other matters, the resulting cost targets are achieved by focusing on product and process design and by making continuous improvement throughout the product’s life–cycle (W.Swemson et al, 2005). Target costing makes cost an input to the design process, not an outcome of it. By estimating the selling price of a proposed product and subtracting the target profit margin, the cost at which the product must be manufactured can be identified (R.Cooper, R.Slagmulder, 1997).

According to Monden, a target costing system has two objectives (U.Ibusuki, P.Caminski, 2007):

1. Reduce the cost of new products so that the level of required profit could be guaranteed, simultaneously satisfying the levels of quality, development time and price demanded by the market.

2. Motivate all the employees to achieve the target profit during the new product development, turning target-costing into an activity of profit

administration for the whole company, using the creativity of employees from several departments to draw up alternative plans that allow higher cost reductions.

Tools of target costing

The techniques and tools that facilitate an effective and efficient target costing process are :

Reverse Engineering

Reverse engineering is now widely used in numerous applications, such as manufacturing, industrial design, and jewelry design and reproduction (V.Raja et al, 2008). Gannod and Cheng defined RE as, " the process of constructing high level representations from lower level instantiations of an existing system " (G.Gannod and B.Cheng, 1996).

Value Engineering

Value Engineering (VE) is a methodology that is known and accepted in the industrial sector. It is an organized process with an impressive history of improving value and quality. The VE process identifies opportunities to remove unnecessary costs while assuring that quality, reliability, performance, and other critical factors will meet or exceed the customer's expectations (A.Dellisola, 1997).

Quality Function Deployment

Quality Function Deployment, or QFD as it is commonly known, is a process that provides structure to the development cycle (J.Bossert, 1991). According to a recent definition by the American Supplier Institute (ASI), QFD constitutes a system for translating customer requirements into appropriate company requirements at every stage, from research through production design and development, to manufacture, distribution, installation and marketing, sales and services (F.Franceschini, 2002).

ε - constraint method

The ε -constraints method is proposed by Chankong and Haimes in 1983. It is another solution technique to multi-objective optimization.

Assume the following Multi-Objective Mathematical Programming (MOMP) problem:

$$\text{Max } (f_1(x); f_2(x); \ldots ; f_p(x))$$
St
$$x \in S;$$

where x is the vector of decision variables, $f_1(x), \ldots, f_p(x)$ are the p objective functions and S is the feasible region.

In the e-constraint method we optimize one of the objective functions using the other objective functions as constraints, incorporating them in the constraint part of the model as shown below (G.Mavrotas,2009) :

Max $f1(x)$
St
$f2(x) \geq e2$;
$f3(x) \geq e3$;
. . .
$fp(x) \geq ep$;
x ϵ S.

Case study

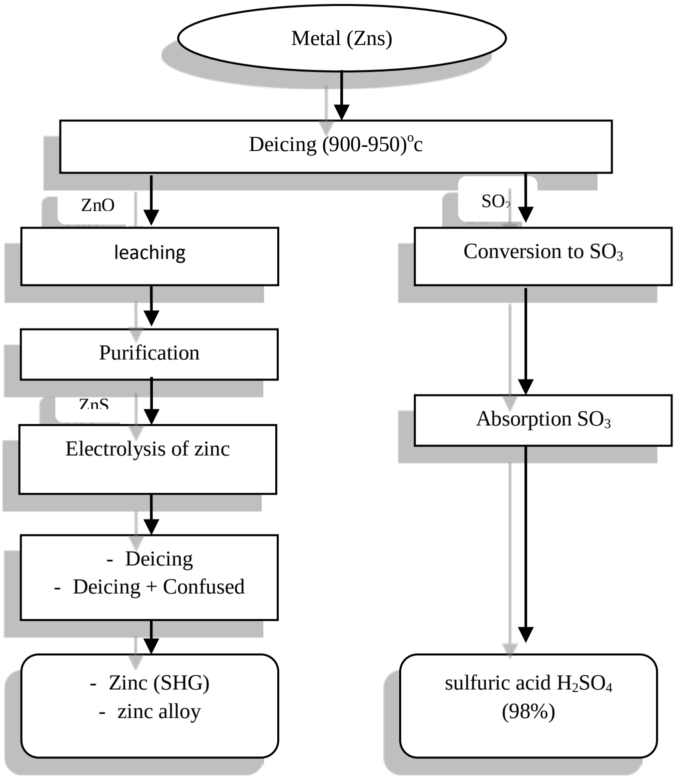
The case study was developed that based on an idea proposed of applying The ε -constraints method as a tool to help achieve the target cost.

ALZINC is an algerian zinc company, situated in the Northwest region of Algeria, registered in the Lodon Metal Exchange (LME), it is able to produce the special high grade zinc (SHG) with 99.9995% Zn purity, specific zinc, Zamac and sulfuric acid.

The first step to understand the problem was mapping the industrial process, as illustrated in Fig.1.

Fig.1.illustrate the eight most important unitary operations related to the zinc, zinc alloy and sulfuric acid production processes.

Figure1: zinc (SHG), Zinc alloy, sulfuric acid process



ALZINC does not use any method of cost management. In recent years has been suffering from the problem of high costs compared to a steady decline in production.

TC adoption

Table1 illustrate the target cost for each product.

Table 1:Target cost calculation

	Target selling price	Target profit margin	Target cost
Zinc(SHG)	184299.44	73719.776	110579.664
specific zinc	169680.95	64840.475	104840.475
Zamac	203984.37	61195.311	142789.059
sulfuric acid	8843.95	1768.79	7075.16

Reverse Engineering

Reverse engineering allows the company to reach the target cost by taking advantage of the experiences of the industry's leading companies in the world. Therefore, the identification of new methods and technologies used in the production of zinc (SHG) will help the organization to reduce costs of depleting the activities that do not add value, and avoid waste reasons that make the company bear additional costs are indispensable.

Table 2 illustrate the wastes resulting from the use of metal, electricity and zinc powder.

Table 2 :Waste calculation

	objective	real	waste
Metal (T)	15506.246	14877.944	628.302
Electricity (Kwh/T)	4257	4627	370
Zinc powder (kg/T)	95	143.059	48.059

Value Engineering

The application of the method of value engineering can ALZINC of extracting unnecessary costs and improve the quality of its products. Through case study, Unnecessary costs are the costs associated with activities that do not add value to the product, Among these activities : storage, handling, maintenance, distribution, supply to the inside, activities associated with the production process.

Adoption of ε-constraint method :

We will try to give a mathematical formulation of the problem posed in ALZINC company, using the information that we have reached a way of reverse engineering and value engineering in order to reach the target cost.

A ε -constraints method model was developed to solve the multi-objective optimization for a ALZINC. The products are zinc (SHG), specific zinc, Zamac, sulfuric acid. The company seeks to achieve the following objectives :

- Reach the target cost;
- Improve the quality of products;
- Raise zinc extraction rate.

Available resource constraints are:

- Quantity of production;
- Electricity;
- Zinc powder.

Decision variables

X_1 : Quantity of zinc (SHG)

X_2 : Quantity of specific zinc

X_3 : Quantity of Zamac

X_4 : Quantity of sulfuric acid

Goal Z_1 : Minimize the total cost

$$\text{Min } Z_1 = 110579.664\, X_1 + 104840.475 X_2 + 142789.059\, X_3 + 7075.16\, X_4 \quad (1)$$

Goal Z_2 :Maximize the quality of products

$$\text{Max } Z_2 = 0.99995\, X_1 \quad (2)$$

Goal Z_3 : Maximize the zinc extraction rate

$$\text{Max } Z_3 = 2.08 X_1 + 1.99X_2 + 1.76 X_3 \quad (3)$$

Eq (4) is the constraint of Production capacity available to the ALZINC

$$X_1+X_2+X_3 <=36850 \quad (4)$$

Eq (5) is the constraint of total electricity power available

$$9407.97X_1+9407.97X_2+9407.97X_3+235.64X_4<=353600000 \quad (5)$$

Eq (6) is the constraint of zinc powder

$$0.095X_1+0.095X_2+0.095X_3<=2582 \quad (6)$$

Eq (7) is the constraint of specific zinc quantity

$$0.9564X_2 >= 5000 \quad (7)$$

Eq (8) is the constraint of Zamac quantity

$$0.9442X_3 >= 5000 \quad (8)$$

Eq (9) is the constraint of sulfuric acid quantity

$$0.96X4 >= 20000 \quad (9)$$

Accordingly, the mathematical model is obtained as follows:

$\text{Min } Z_1 = 110579.664 X_1 + 104840.475X_2 + 142789.059 X_3 + 7075.16 X_4$

$\text{Max } Z_2 = 0.99995 X_1$

$\text{Max } Z_3 = 2.08 X_1 + 1.99X_2 + 1.76 X_3$

Subject to

$X_1+X_2+X_3 <=36850$

$9407.97X_1+9407.97X_2+9407.97X_3+235.64X_4<=353600000$

$0.095X_1+0.095X_2+0.095X_3<=2582$

$0.9564X2>=5000$

$0.9442X3>=5000$

$0.96X4>=20000$

$X_1, X2, X_3, X_4 >= 0$

Under the method of□□ -constraint, will resort to conversion the goal of quality and the goal of extraction rate to the contraints, as follows :

$0.99995X1 >= 15000$

$2.08 X_1 + 1.99X_2 + 1.76 X_3 >= 32000$

The final model becomes :

$\text{Min } Z_1 = 110579.664 X_1 + 104840.475X_2 + 142789.059 X_3 + 7075.16 X_4$

St

$0.99995X1 >= 15000$

$2.08 X_1 + 1.99X_2 + 1.76 X_3 >= 32000$

$X_1+X_2+X_3 <=36850$

$9407.97X_1+9407.97X_2+9407.97X_3+235.64X_4<=353600000$

$0.095X_1+0.095X_2+0.095X_3<=2582$

$0.9564X2>=5000$

0.9442X3>=5000
0.96X4>=20000
X_1, X2, X_3, X_4 >= 0
We'll solve the model with the help of Lindo program.
The solution obtained shown in Table 3

Table 3 :Results for the ε -constraints method model

X_1(T)	X_2(T)	X_3(T)	X_4(T)	Cost (DA)
15000	5227	5295	20833	3.110.414.000

In analyzing Table 1, we can observe that the model results are:

- The company can achieve the target cost by producing 15000 t of zinc (SHG), 5227 t of specific zinc, 5295 t of Zamac and 20833 t of sulfuric acid.
- The total cost is 3.110.414.000 DA.
- This means that the organization can produce larger quantities at lower cost, As shown in Table 4.

Table 4 :Comparison the results between befor and after the application of TC and ε-constraint.

	Without TC and ε-constraint	With TC and ε-constraint
zinc (SHG) (T)	6984	15000
specific zinc(T)	5453	5227
Zamac(T)	610	5295
sulfuric acid(T)	20724	20833
Total cost (DA)	3.342.237.740	3.110.414.000

Conclusion

This paper presents a ε -constraints method to support the company decisions in achieving target cost.

The case study reveal that the incorporation of target costing and ε -constraints method in a work methodology could be interesting, because while the target costing allows the identification of target cost and where cost reduction could be achieved, the ε -constraints method provides useful information for decision makers and offering more reliable and more precise outputs.

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