

A PRESCRIPTIVE COST MODEL FOR DEMAND SHAPING: AN APPLICATION FOR TARGET COSTING

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ABSTRACT

Costing tools and traditional cost models are used primarily to calculate costs. However, these models would be more relevant if used as decision-making support tools. That is, they should allow ex-ante rather than ex-post analyses. Nevertheless, cost models tend to follow a linear logic of resources-activities-products (e.g. as it is the case of Activity Based Costing) when uncertainty, variability and dynamics of the current market demand cost models that help decision makers to define which resources are needed to satisfy market needs (e.g. as it is the case of Target Costing), i.e. in a reverse logic. Such models can be designated prescriptive cost models and require significant computational resources to attend the complexity of the problems for which they can be applied. The prescriptive analysis intends to recommend actions based on specified or desired results and it is the most evolved stage of business analytics, far beyond descriptive and predictive approaches. This paper presents and discusses a prescriptive cost model applied in the context of Target Costing. The relevance and validity of this approach are discussed and several opportunities for further work are presented.

INTRODUCTION

Traditional costing systems do not meet precisely the information that managers need to make decisions, i.e., in many cases occurs an inappropriate or even arbitrary distribution of resources consumed by different cost objects. (Aderobal, 1997; Banker & Johnston, 1993; Baykasoglu & Kaplanoglu, 2008; Ben-Arieh & Qian, 2003; Qian & Ben-Arieh, 2008). For Benjamin et al. (2009) full cost systems allocate all the manufacturing costs to products, and logically will be used apportionments criteria for, and therein lies errors compromising them as effective control instruments. Even if the manager try to apply the best criterion of apportionment, there will always be a strong arbitrary component, which distorts the results reported in terms of cost objects

In this context, the allocation of resources to the products is made, oftentimes, by the use of volume allocation bases (e.g. units produced) that is biased considerably in production environments characterized by highly complex processes and high diversity in terms of products. Because of the problems and limitations of traditional costing systems the Activity Based Costing (ABC) emerged in the 80's - Cooper & Kaplan (1988). ABC differs from traditional costing, by the way costs are accumulated. ABC focuses on activities as cost generators, while traditional costing focuses on products as the cost generators. In an ABC system, cost drivers make it possible to allocate resources to activities and then to cost objects. They may be divided in cost drivers of first and second stages or levels. First stage cost drivers are those that allocate resources to the activities, and second stage those that assign the costs of activities to cost objects.

The use of ABC provided a more efficient and effective management of resources, including a more strategic vision on the costing process, to which started to consider not just the view but also the assignment process view (Turney, 1989). The first one is focused on the costing process: resources-activities-products and the second perspective on the analysis of activities and cost drivers. However, , ABC systems also have limitations and problems. In particular, problems related to its complexity (of design and implementation). Indeed, it may be difficult to apply due to the high number of internal controls, it requires constant review, and has high design and implementation costs, among other aspects.

Kaplan (1984), the ABC is a system in which it is assumed that "products consume activities and activities consume resources." Cost models tend to follow a logic resource-activity-product (e.g. as it is the case of Activity Based Costing) when uncertainty, variability and dynamics of the current market demand cost models able or appropriated to recognize which resources are needed to respond to the market, i.e. from a reverse logic.

In fact, a general rule, both Traditional cost systems as ABC focus control and management costs of the products after manufacturing. Indeed, costing tools and traditional cost models have been used essentially to calculate costs through and allocation procedure. However, cost models can and should be used as tools to support decision making. That is, they should support ex-ante analyses rather than ex-post analyses.

These cost models focused on an ex-ante analysis can be designated prescriptive cost models. Prescriptive analysis recommends actions based on desired results and is one of the business analytics stages, which also includes the descriptive and predictive analysis.

Business analytics refers to the ways in which organizations can use data to gain insights about their business or about the market and make better decisions. Business analytics is applied in operations, marketing, finance, and strategic planning among other functions.

In predictive analytics it is common to use statistical techniques, data mining and machine learning on historical data analysis in order to make predictions about future trends. Finally, the prescriptive analysis goes beyond the predictive but drawing on a similar logic: a prescriptive model aims to predict possible consequences of different choices and recommends the best paths to follow (van Barneveld, Arnold, & Campbell, 2012).

Therefore, with the application of prescriptive cost models the organization can visualize and plan what will be needed in order to produce a particular product, achieving a more efficient and cost effective strategy regarding the best use of resources by departments, activities and products. In the study of Moturu, Johnson & Liu (2010), they used a prescriptive cost model that allowed “the possibility of using a combination of over-sampling and under-sampling together with classification algorithms for the creation of predictive models that can forecast high-cost patients.”

Prescriptive cost models require significant computational resources considering the complexity of the problems to which they can be applied. Moturu, Johnson & Liu (2010). Cost formulas can be built for large quantities of data and in such cases, data mining techniques can be - Krishnaswamy, & Zaslavsky Loke (2000).

Prescriptive cost models allow treating various problems that can be applied in different contexts as process distributed data mining (DDM) - Krishnaswamy, Loke & Zaslavsky (2000); resources supply and demand - Salafatinos, (1996); stochastic optimization problems - Bertsimas & Kallus (2014); predictive risk modelling for forecasting costs - Moturu, Johnson & Liu (2010).

Target Costing (TC) can be It considered a prescriptive cost model, which has an ex-ante perspective in addressing costs and is focused on the adequacy of the company's resources to the conditions, needs, preferences or requirements of the market. In TC, the maximum allowable cost (i.e. target cost) is determined by the equation $TC = TP - M$ where TP is the price accepted by the market (i.e. target price) and M the margin assumed or required by the company for that product.

In TC, the target cost is determined as a function of market conditions and other restrictions namely, the desired margin for the product. In fact, TC is an excellent example of the importance of a cost management approach that establishes a connection between products-

activities-resources i.e. an inverse logic of traditional costing systems.

In this paper, we present a prescriptive cost model that can be used to define and optimize resources, according to the market conditions. The prescriptive cost model is presented and an application to the case of Target Costing is discussed. The case shows possible applications of prescriptive cost models and offers some discussion on these models. At the end of the paper, we discuss the results and opportunities for further work. Thus this article begins with an introduction and a presentation of the main concepts necessary for a proper understanding of the assumptions, development and application of prescriptive cost models. Subsequently, the results of its application to TC are presented and discussed. Finally, the concluding remarks are outlined.

PRESCRIPTIVE COST MODELS

Consumers have become more demanding in terms of quality, usability and functionality of the products along with the fierce competition, meant that prices were set by the market, and consequently being the reference to define the costs and the profit margin for the survival of the organization. Because of these changes, costing tools and cost models need to go further the traditional computation of costs.

Business Analytics

Business analytics can be put into practice through three different phases of analysis 1) descriptive, which uses business intelligence and data mining to ask: “What has happened?”; 2) predictive, which uses statistical models and forecasts to ask: “What could happen?” and, finally, the most sophisticated of these approaches, 3) prescriptive, which uses optimization and simulation to ask: “What should we do?” (IBM, 2013).

These three approaches are build upon each other being the descriptive analysis the simpler one and the prescriptive the most advanced. They share the goals of improving facilities and operations with capabilities that help to achieve a better understanding of the events or actions, uncover relationships in data, developing what-if scenarios and simplifying business decisions. (IBM, 2013).

According to Eckersen (2007) business intelligence reveals relationships and patterns within large volumes of data and can be used to predict behavior and events. Predictive analysis is forward-looking, using past events to predict the future. (IBM, 2010).

Predictive analytics is a process that serves all business levels and acts as a connector between the collected data, and intelligent action that can be taken as a result of the analysis, and decision making. The model reflects the data that should be collected, reported and analyzed, not only to make sense of them, but also to take action.

Prescriptive Approach and Cost Models

The Prescriptive Analytics explore a set of possible actions and suggests actions based on descriptive and predictive analysis of complex data. Although the final decision is made by the decision maker (e.g. managers), prescriptive analytics can provide reliable solutions for important business questions as well as resolve operational problems.

It is a strategic process that supports real-time demand and future supply. It is a dynamic method that can increase revenue and reduce costs with the participation of all stakeholders in the supply chain. (SAS, 2013). Through the collection of information related to production and business processes, major operational data can be accessed, stored and analyzed to track the performance of production processes. This data can provide valuable information and forecasting. It can be also used to assess consumer sentiment or the performance of the product on the market. Furthermore, it can provide information about customer demand and help define alternatives for modeling demand in order to improve profitability.

Prescriptive cost models supports decision making based on ex-ante analyses, i.e., helping managers and companies to react quickly in order to be able to shape proactively desired results. It results in analytical solutions that provide a reliable way for the production of effective and efficient solutions for business needs and strategic and operational problems. To perform an application of a prescriptive cost models it is necessary to use mathematical cost models or a kind of mathematical representation. Typically, these models are mathematical algorithms or parametric equations which can be used to model first and estimate after the cost of a product and/or service, activities and resources needed to reach in an optimized way a certain objective (function) constrained by a set of relevant conditions.

Among the studies that can be classified as prescriptive cost models, some are particularly elucidative. Salafatinos (1996) states that cost management systems should turn decision makers able to predict the economic consequences of their actions. His method was used to model the relationship between resource supply and demand for resources, allowing decisions based their expected economic consequences. Managers can prescriptive cost models to compute more accurate profitability measures in order to assess the proposed courses of action. Lenders, on the other hand, can use such models to assess credit quality and investors to determine the potential return under uncertainty conditions. In fact, the standard by which cost systems should be judged largely depends on the exact translation of management actions in quantified statements of condition and performance. A cost system that does not meet this standard is deficient.

Applications

Currently, there are several cost modeling techniques applied in organizations to achieve minimize arbitrariness in the allocation of costs to products. Among the estimation techniques most used, Asiedy & Gu (2010) highlight the Bottom-Up models which are associated to the collection of all information about product cost that is available, identifying also information related to the components, e.g. size and functions; those estimates are aggregated to produce an overall estimate. The bottom-up approach relies on the analysis of detailed engineering plans and calculations to determine the cost (Curran et al., 2004). Analogous techniques use cost comparison according to the similarity and differentiation of similar products. According to Curran et al. (2004) it is one of the best established methods to compute efficiently the cost of products. Furthermore, parametric approaches are associated to the use of probabilistic relations between the features and the costs of the products. A cost estimate using a parametric model is based on predictions; for example, using regression analysis based on historical cost and technical information (Asiedy & Gu, 2010).

The assessment, measurement and control of production costs is an important issue in industrial engineering and management, and the use of mathematical models in the cost management context is highlighted increasingly. For example, for Curran, Raghunathan & Price (2004) these applications are used to assist in the cost estimates, business analysis and planning, project management, profitability analysis, etc. Datta & Roy (2010) add that they can be used to support in procurement contracts. Agyapong-Kodua, Wahid & Weston (2011) state that cost modeling techniques have been used in scientific research and practical applications in order to support projects in cost evaluation, life cycle analysis and evaluation of economic viability or investment appraisal. Research and studies that have been applying mathematical cost models, tried to solve several types of problems. Some of these problems are:

- Problems of reciprocal allocation (Aderobal, 1997; Boons, 1998; Itami & Kaplan, 1980; Tijss & Driessen, 1986). Reciprocal allocation means a way to distribute indirect costs by the production in a logical manner, such as products or customers.
- Cost drivers optimization (Babad & Balachandran, 1993; Banker & Johnston, 1993; Datar, Kekre, Mukhopadhyay, & Srinivasan, 1993; Dopuch, 1993; Senechal & Tahon, 1998; Tsai, 1996). A cost driver is an event, associated to an activity, that results in the consumption of firm's resources. Since the number of events performed in a firm is often vast, it may not be cost-effective to use a distinct and different cost driver for each activity. Thus, many activities may be grouped into a single driver to trace the costs of all the grouped activities for a product or service.

- Allocation errors (Cardinaels & Labro, 2008; Datar & Gupta, 1994; Xu, Zheng, Du, Chu, & Wu, 2014). According to these studies, there are generally three types of errors: aggregation error (AE) specification error (SE) and measurement error (ME).
- Homogeneity problems (Gervais, Levant, & Ducrocq, 2010; Levant & Zimnovitch, 2013). Homogeneity problems are found if activities that use the same cost driver have different cost behaviors.

Typically, research applications are made through simulations and case studies.

Prescriptive Cost Models for Demand Shaping

The demand shaping perspective is beyond price and substitute products optimization. It is used to reduce and eliminate anomalies in the supply chain that were previously detected.

The demand-shaping process is characterized by a production distribution model developed with available demand and supply data. Demand shaping is a management strategy where a company uses tactics such as price incentives, cost modifications and product substitutions to entice customers to purchase specific items. Demand shaping is designed to help the company to influence demand of a certain product in order to match its planned supply.

Demand shaping may become an integral part of sales and operations planning. Tactically, it complements the demand and supply planning process by closing the loop through execution. While companies use forecasting to plan for customer demand, they should use demand shaping to reduce the gap between their expectations and actual customer demand. The target costing model can be regarded as a demand shaping approach, because its principles are complementary, i.e. using the market analysis to see what customers want and at what price companies should offer them. For Koonce et al., (2007) an organization, in order to remain profitable, should be able to deliver products that are competitively priced and of a certain quality standard. Therefore, accurate estimates of the cost of a new product is imperative to any company that competes in today's marketplace and the important role of product development in cost management is undeniable (Tornberg, Jamsen & Paranko, 2002).

A good estimate provides an organization with valuable information regarding the cost of products and processes during the design phase. Furthermore, it allows the organization to consider alternate product designs, or decide whether to make or buy a part Winchell (1989).

According Dietrich et al. (2012) demand shaping is the ability to sense changing demand patterns, evaluate and optimize an enterprise supply plan to best support market demand and opportunity, and execute a number of demand shaping actions to "steer" demand to align with an optimized plan. The authors applied a suite of mathematical optimization models that allowed on

demand up selling, alternative-selling and down-selling to better integrate the supply chain horizontally, connecting the interaction of customers, business partners and sales teams to procurement and manufacturing capabilities of a firm.

TARGET COSTING

Target Costing (TC) is a comprehensive management process that starts with the premise that prices are established in the marketplace based on customer requirements and competitive alternatives or as a result of management decisions; to prompt markets that firms are in business to be profitable, grow, and provide a return to their shareholders, and, as a result, that allowable costs and investments are driven by prices (Pazarceviren & Celayi, 2013).

The current evolution of competitive markets requires a shorter shelf life of products, emphasizing the design and development phase of the product life cycle. Thus, it became more important to analyze product costs since the design and development phase (Ben-Arieh and Qian, 2003). That is, with a good cost control at this stage, the organization can make efficient and effective decisions.

Target Costing is a strategic cost management practice focused on profit planning applied in the early phases of a product, i.e. research, development and engineering of the product, guided by the market price. It defines the maximum acceptable cost of a new product, in order to achieve a reasonable return, satisfying customers and respecting the long term business plan of the company. It takes into consideration the entire product life cycle and involves the whole organizational structure and the company's value chain.

Target Costing is a long-term comprehensive management system that can be implemented in various stages of product development including; product concept, product planning, and product design. Through inter departmental integration, target costing can accomplish the goals of developing a new product with its functionality, quality, and price acceptable to consumers (Lin, Huan, 2009).

TC is built on some principles such as: cost must be guided by price, i.e., the cost is given by the market price and not by other way; focus on the consumer; focus on design, where it says that the costs should be optimized prior to product entry into the production process; involvement of the company as a whole; orientation to a life cycle costing approach, considering that relevant costs are not only the initial cost or acquisition cost, but the total cost of use or ownership; and the involvement of the value chain.

Target costing is regarded as an activity that aims to reduce the costs of the product during its whole life cycle and to satisfy customer requests such as rapidity, quality and reliability, with the way of examining all of the presented alternatives to reduce the cost of planning, research and development of a new product (Pazarceviren & Celayir, 2013).

A need exists for more complete and robust cost models, which should provide effective support for more consistent decision making. Prescriptive cost models can be tools used to assist management in decision making. More particularly, the application of TC models can demonstrate what the market wants and what price is willing to pay. With this information, organizations can analyze the feasibility of their production processes, resources allocate and more important, they may be able to optimize and redefine capability and resource usage. In this sense, the purpose of the Target Costing is to ensure adequate profits through simultaneous planning of profit and cost.

COST MODEL

A more generic is presented first and an adaption of such model to the problem of TC is presented afterwards.

A Generic Model for the Computation of Product Cost

For the production of the cost equations presented in the model, there are some steps that must be followed. First, the costs are calculated for activity, according to the distribution of resources to the various activities using the selected resource drivers. In the second stage, the activity costs are allocated to cost objects (products). Thus, this model relies on the two-stage approach of an ABC system.

The calculation of the activity costs considers an Resource matrix of n lines (number of resources), where the element r_j is the total amount of resource n . On the other hand, in the matrix for the activities, the a_i element represents the amount of the costs attributed to the activity i ; r_{ij} represents the technical relation between resources and activities, i.e. de cost driver. In this model, cost drivers are normalized, i.e. de sum of each column in the coefficient matrix equals 1. The same logic for the allocation of activity costs, to the cost objects (e.g. products) resulting in p_k and using the activity-product coefficient matrix of a_{ik} elements (Equations 1 and 2).

$$\begin{bmatrix} r_{11} & \dots & r_{1j} \\ \vdots & & \vdots \\ r_{i1} & \dots & r_{ij} \end{bmatrix} * \begin{bmatrix} r_j \end{bmatrix} = \begin{bmatrix} a_i \end{bmatrix} \quad (1)$$

$$\begin{bmatrix} a_{11} & \dots & a_{1k} \\ \vdots & & \vdots \\ a_{k1} & \dots & a_{ki} \end{bmatrix} * \begin{bmatrix} a_i \end{bmatrix} = \begin{bmatrix} p_k \end{bmatrix} \quad (2)$$

The cost equations represented by these matrixes show the flexibility and the potential application range which can be used to calculate and relate product costs, margins,

consumption patterns of resources and activities, etc. On the other hand, cost equations turn simpler the association between resources and cost objects.

$$R = \sum_{j=1}^J R_j ; A = \sum_{i=1}^I A_i ; P = \sum_{k=1}^K P_k \quad (3)$$

$$A_i = \sum_{j=1}^J r_{ij} \times R_j ; P_k = \sum_{j=1}^J \sum_{i=1}^I a_{ki} \times r_{ij} \times R_j \quad (4)$$

$$\text{If } x_{kj} = \sum_{i=1}^I a_{ki} \times r_{ij} \text{ then} \\ P_k = \sum_{j=1}^J x_{kj} \times R_j \quad (5)$$

$$\sum_{k=1}^K x_{ki} = 1, \forall i ; \\ \sum_{i=1}^I r_{ij} = 1, \forall j ; \sum_{k=1}^K a_{ki} = 1, \forall i \quad (6)$$

Substituting activity costs in product cost equations, by their equivalent cost equations, we can present product cost equations in terms of resources consumption instead of activities. Such model can be represented as follows.

$$\begin{bmatrix} x_{11} & \dots & x_{1j} \\ \vdots & & \vdots \\ x_{k1} & \dots & x_{kj} \end{bmatrix} * \begin{bmatrix} R_1 \\ \vdots \\ R_j \\ R_K \end{bmatrix} = \begin{bmatrix} P_1 \\ \vdots \\ P_K \end{bmatrix} \quad (7)$$

If prices and margins are included, this model can be extended as it is explained below.

$$\begin{bmatrix} x_{11} & \dots & x_{1j} \\ \vdots & & \vdots \\ x_{k1} & \dots & x_{kj} \end{bmatrix} * \begin{bmatrix} R_1 \\ \vdots \\ R_j \\ R_K \end{bmatrix} * \begin{bmatrix} \frac{1}{Q_{P_1}} \\ \vdots \\ \frac{1}{Q_K} \end{bmatrix} * \begin{bmatrix} -1 \\ \vdots \\ -1 \end{bmatrix} + \begin{bmatrix} Price_{P_1} \\ \vdots \\ Price_{P_K} \end{bmatrix} = \begin{bmatrix} Margin_{P_1} \\ \vdots \\ Margin_{P_K} \end{bmatrix} \quad (8)$$

Prescriptive Cost Model for TC

The generic formulation of TC typically presented as:

$$Target Cost = Target Price - Margin \quad (9)$$

$$TC = TP - M$$

Where,

TC = the maximum allowable cost

TP = the target price accepted by the customer

M = profit margin

Whereas there is the production of K products, TC configuration would be of following form:

$$\sum_{k=1}^K TC_{p_k} = \sum_{k=1}^K TP_{p_k} - \sum_{k=1}^K M_{p_k} \quad (10)$$

This equation can be presented through the following matrices.

$$\begin{bmatrix} TC_{P_1} \\ \vdots \\ TC_{P_K} \end{bmatrix} = \begin{bmatrix} TP_{P_1} \\ \vdots \\ TP_{P_K} \end{bmatrix} - \begin{bmatrix} M_{P_1} \\ \vdots \\ M_{P_K} \end{bmatrix} \quad (11)$$

Considering Equation 7 the previous representation can be expressed as:

$$\begin{bmatrix} x_{11} & \dots & x_{1J} \\ \vdots & & \vdots \\ x_{K1} & \dots & x_{KJ} \end{bmatrix} * \begin{bmatrix} R_1 \\ \vdots \\ R_J \end{bmatrix} = \begin{bmatrix} TP_1 \\ \vdots \\ TP_K \end{bmatrix} - \begin{bmatrix} M_{P_1} \\ \vdots \\ M_{P_K} \end{bmatrix} \quad (12)$$

Where the left-side of the equation represents the product costs or the target costs. In a reverse order to traditional costing systems, this model works on the philosophy of TC, i.e. product-activity-feature. With this system it is possible to define how much resource will be required to perform a given production. Therefore, this model can provide the definition of the sale price and profit margin.

APPLICATION

Case description

Company A produces two products P₁ and P₂ using two types of resources R₁ and R₂. The actual conditions are the following:

P₁ = 1.000 units
P₂ = 500 units

Unitary Costs of R₁ and R₂ = 0,24 m.u. per hour.

1 unity of P₁ needs 6 min of R₁, P₂ needs 48 min of R₁
1 unity of P₁ needs 30 min of R₂, P₂ needs 60 min of R₂

The actual production process conditions require 500h of R₁ and 1.000h R₂. Furthermore, in order to be able to respond adequately to the market and also to have a good use of the resources, a preliminary market study was made to collect information on the market conditions. The strategic plan and long term objectives of the firm were also taken into consideration.

It was verified that the product target price and respective margins should be:

TP₁ = 0,15 m.u.
TP₂ = 0,40 m.u.
M_{P1} = 20%
M_{P2} = 10%

Application of the prescriptive TC model

The Target Costing approach and the prescriptive cost model can be applied following a sequence of steps. Firstly, we need to compute the maximum allowable cost (i.e. target cost) taken into account prices and margins. Secondly, it is necessary to check if the actual conditions result in costs that not exceed those target costs. The application of TC implies that such objective is not obtained through the actual conditions.

This is an important moment of our model because at this point the decision maker is challenged to reduce costs and needs to develop a plan to do it and compare the alternatives producing feasible cost reduction objectives and cutting cost plans. These plans are of extreme relevance because they need to be convincing when this cost reduction effort is pushed to the operational level and to suppliers.

Three generic alternatives can be hypothesized here. A more common and straightforward approach is focused on reduce resources involved. A second one, is focused on the optimization of process. A third approach implies a balanced use of the previous two.

The case presented before will be used to illustrate each one of these approaches.

1) Computation of the TC

Applying Equation 11 we can compute the TC or maximum allowable cost.

$$\begin{bmatrix} TC_{P_1} \\ TC_{P_K} \end{bmatrix} = \begin{bmatrix} 0,15 \\ 0,40 \end{bmatrix} - \begin{bmatrix} 0,03 \\ 0,04 \end{bmatrix} = \begin{bmatrix} 0,12 \\ 0,36 \end{bmatrix}$$

2) Computation of the actual cost

The information presented before permits to elaborate the coefficients matrix. The cost of the products is the result of the multiplication of that matrix by the vector of resources as explained through Equation 7.

$$\begin{bmatrix} 0,2 & 0,5 \\ 0,8 & 0,5 \end{bmatrix} * \begin{bmatrix} 120 \\ 240 \end{bmatrix} = \begin{bmatrix} 144 \\ 216 \end{bmatrix}$$

Unitary Costs of P₁ (1.000 units) and P₂ (500 units) are higher than the TC, indeed 0,144 > 0,12 and 0,432 > 0,36, respectively (values in m.u). This means that it is necessary to reduce costs in the resources directly (e.g. buying cheaper materials and other inputs or paying less to workers), optimizing the existent process (e.g. using less materials or less resources per unit produced), or reducing the unused capacity or even waste and non-

value added activities. All these possibilities deserve specific studies, simulations and discussion.

3) Reducing (the cost of the) resources

In this case, we consider the objective of attaining the TC thus, resources should satisfy the following equations system:

$$\begin{cases} 0,2R_1 + 0,5R_2 = 120 \\ 0,8R_1 + 0,5R_2 = 180 \end{cases} \Leftrightarrow \begin{cases} R_1 = 100 \\ R_2 = 200 \end{cases}$$

Note that we are using the total cost of products 1 and 2 (i.e. TC x quantity). The result shows that we can accomplish the TC using the same technical conditions (represented in the coefficients matrix) if the cost of resources 1 and 2 are reduced to 100 and 200 m.u., respectively (i.e. from 360 to 300 m.u., 1/6 of reduction, around 17%). In general, this level of reduction is feasible in target costing exercises. But, probably, it can be achievable if a direct reduction in resources costs is complemented with gains in the efficiency of the production process.

4) Improving efficiency and reduce conversion costs

In this case resources have equivalent cost drivers (0,24 m.u.) thus, it will be possible to achieve the desired reduction of 60 m.u. improving the efficiency on the consumption of resource 1, resource 2 or both combined if a global reduction of 250 hours in the use of the two resources is achieved. And this reduction can be designed relaxing the cardinal rule in TC, i.e. the constraint that imposes to not exceed the maximum allowable cost. In these cases may be acceptable to assume a bundle or global TC to avoid that restriction. For example, in this case, assuming that it is not possible or recommended to reduce costs of resource 1 and that the 250h can be reduced in a equivalent way in the production of both products, the final unitary costs will be 0,114 and 0,372 m.u. for products 1 and 2, respectively.

$$\begin{bmatrix} 100 & 375 \\ 400 & 375 \end{bmatrix}, \begin{bmatrix} 120 \\ 180 \end{bmatrix} = \begin{bmatrix} 114 \\ 186 \end{bmatrix}$$

In this case, the coefficient matrix presents non-normalized cost drivers to show in a easier manner the information about the volume of resource used (in hours) – the normalized matrix is a similar one where each element is obtained from the division of these by the sum of each column.

This means that a bundle or global TC can substitute individual TC.

5) Combined and constrained solutions

An alternative to the two previous approaches is to reduce the quantity and price of the resources simultaneously.

Furthermore, a more realistic approach should consider some constraints that will limit the feasible solutions and that will impose several challenges. Capacity issues, demand restrictions, technical limitations, etc. should be considered. These situations ask for more elaborated mathematical models which should be explored in other research paper.

A general trade-off exists between the level of reduction obtained in terms of resources' price versus the quantity of resources (gains of efficiency). If λ is the fraction of the cost reduction that should be made through a better efficiency of the process – i.e. internally, $(1 - \lambda)$ is the remaining effort to be made through price reductions – i.e. externally, i.e.

$$\text{Cost Reduction} = \lambda (\text{Cost} - \text{TC}) + (1 - \lambda)(\text{Cost} - \text{TC})$$

DISCUSSION AND CONCLUSIONS

Target Costing is used as a strategic tool for cost management in the product development stage. The technique considers that the possibility of the company to modify the product in that project period significantly increases the degree of possibilities to reduce costs.

Therefore, it is necessary to identify, in advance, which target price is accepted by the market. In this context, the present study examined the effectiveness of the TC method as a strategic tool in the context of prescriptive cost models.

The prescriptive analysis intends to recommend actions based on specified or desired results and it is the most evolved stage of business analytics, far beyond descriptive and predictive approaches.

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