Costing a Product by Old and New Techniques: Different Wines for Different Occasions

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Abstract The aim of this paper is to compare and contrast four different costing systems: Full costing, Activity-based Costing (ABC), Time-driven Activity-based Costing (TDABC) and Value Stream Costing (VSC). Companies around the world use different costing techniques for a variety of reasons and a particular plant may wonder which approach would fit better its needs. Since TDABC and VSC are new techniques, there are not many references in literature and not many companies have implemented them. For this reason, the comparison is done by means of a case study. Results given by the four methods may be more or less similar depending on the structure and organization of both the process and the company.

Keywords: Time-driven activity-based costing; lean manufacturing; value stream costing.

1 Introduction

The need of companies for precise information on costs is out of question because an adequate knowledge about costs is a key factor to assure the profitability of businesses. In some industries, the selling price of their products is fixed by their customers and manufacturers cannot influence prices: the only one variable that

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they can act upon is the manufacturing cost. This is especially important in the environment of international economic crisis that companies are currently facing.

Besides, the costing system has to be able of capturing the effects on cost of the efforts placed on improving processes.

In practice, different cost-accounting methods are applied: traditional costing systems such as full costing, more recent approaches like Activity-based Costing (ABC), or 21th Century wannabes like Time-driven Activity-based Costing (TDABC) or Value Stream Costing (VSC). Karmarkar et al. (1990) state that the reasons why companies use one or another costing system are not well known, but they, empirically, appear related to the manufacturing process (complexity, layout, number of products, and so on).

In this paper, we try to shed light on that question by means of a comparison among four cost-accounting methods (Full costing, ABC, TDABC and VSC) in a case study. Different comparisons between accounting methods can be found in Balakrishnan et al. (2012) and Li et al. (2012, but there is no other previous comparison among these four costing methods in literature.

2 Research Methodology: a Case Study

In order to facilitate the assessment on the major or minor complexity of application and the goodness of their results, we introduce a practical case that depicts the main differences among Full Costing, ABC, TDABC and VSC.

We know of companies, in Spain, that have evolved from full costing to ABC and even TDABC (Ruiz de Arbulo et al., 2013a) but we do not know of any company that has implemented VSC so far. For this reason the research approach could not be a massive survey. When little is known about an issue, a case study is indicated due to its exploratory nature (Voss et al., 2002).

Our example is constructed on a case study in previous literature (Ruiz de Arbulo and Fortuny-Santos, 2011) and it is complete enough to appreciate the techniques used by the different costing systems but also short enough for an easy comprehension.

Table 1 Average time and production schedule for each product type. Number of parts in each type of knob

	Knob A	Knob B	Knob C	
Time (seconds)	140	100	80	
Quantity (knobs /month)	2,000	2,000	1,000	5,000

Table 1(continued) Average time and production schedule for each product type. Number of parts in each type of knob

Parts	Knob A	Knob B	Knob C	Cost per part (€)
Part 1	1	1	1	0.25
Part 2	0	1	1	1.00
Part 3	1	0	1	1.20
Part 4	0	0	0	0.80
Part 5	0	1	0	0.60

The company manufactures and sells plastic parts for the automotive sector. The manufactured products are booth locking knobs used to open the booth of the car. The manufacturing process has three phases: Injection molding, painting and assembly but here only the assembly process is considered. This process is performed in a U-shaped cell where three different types of knobs (A, B, and C) are assembled. Table 1 shows the production schedule and the standard time (derived from work study) to assemble each knob. Knobs are made up of several parts (numbered 1 to 5), depending on the model (Table 1). In consequence, the cost of materials is different for every model.

3 Computing the Full Cost of the Products

Full Costing classifies manufacturing costs as either direct or indirect. Direct costs are traced to manufactured products considering the consumption of each product. Indirect costs (overhead) are assigned using a two-stage allocation process:

- •In the first stage, resources are allocated to cost centers (cost pools) and costs accumulated in auxiliary departments are assigned to main departments on the basis of the usage that main departments have of auxiliary departments.
- •In a second stage, overheads are allocated to products. Usually volume-based cost drivers are used.

In our example, direct labor hours would be the common allocation basis (Table 2 shows how indirect costs are allocated). This would entail that a greater proportion of costs would be allocated to products with bigger labor content. The overhead assigned to those products subsidizes (Cooper and Kaplan, 1988) the assumed profitability of the rest of products. Table 3 shows the resulting cost of the products. While products A and C are not much different, their costs are different because more overhead is allocated to knob A than to knob C.

Table 2 Allocation of costs in the auxiliary departments

	Material handling	Quality control
Cost pool (€/month)	3,000.00	4,000.00
Standard labor hours per month	155.56	155.56
Unit cost (€/LH)	19.29	25.71

Costs will be unreliable whenever the allocation basis is unrelated to the nature of the cost (in our case, there is no relation between quality inspection or replenishment and the time needed for assembly of one product). Errors will be greater in companies where overhead is greater than direct labor and material costs. This distortion may lead to decisions such as considering knob A unprofitable. Distortion caused by the allocation of indirect costs has been criticized since the 1980s (Cooper and Kaplan, 1988). For this reason, ABC appeared as a model that might overcome the pitfalls of traditional cost accounting.

Table 3 Costing products using full costing (including overhead allocation)

Manufacturing costs	Knob A	Knob B	Knob C
Raw material (€)	2,900.00	3,700.00	2,450.00
Direct labor €)	12,444.44	8,888.89	3,555.56
Handling (€)	1,500.00	1,071.43	428.57
Quality control (€)	2,000.00	1,428.57	571.43
Manufacturing costs (€)	18,844.44	15,088.89	7,005.56
Manufactured units	2,000.00	2,000.00	1,000.00
Unit Cost (€/knob)	9.42	7.54	7.01

4 Computing the Cost with ABC

The philosophy of ABC relies on the idea of performing "activities". Resources are assigned to activities and then activities to products. Manufacturing and some non-manufacturing activities can be assigned to products (or other object costs such as orders or clients) if there is a logic cause-effect relationship.

The process was examined in detail. People from different departments were interviewed in order to obtain information on their tasks and the time spent in each one. That allowed the definition of several activities. The cost of an activity includes all types of resources necessary to perform the activity (Table 4). Data refer to one month.

Table 4 Costing activities using ABC: From resources to activities

Activity	Part of time [1]	Activity cost	Cost Driver	Number of drivers	Cost per driver
Taking parts to/from the assembly cell	15%	3,000 €	Number of times replenished	160[2]	18,75 € / replacement
Assembly	100%	24,960 €	labor-hours	156	160 € / LH
Quality control	12.5%	4,000 €	Assembled units	5,000	0,8 € / unit

[1]Proportion of their working time spent in this cell by people devoted to replenishment, assembly or quality control (the rest of their time is devoted to other tasks or departments). [2]The parts of knob A are replaced 10 times per month (50 times, knob B; 100 times, knob C).

From the information in tables 1 and 4, we compute the costs of the different models of knobs (Table 5).

Now, the costs of products A and B are similar and C is the most expensive. However, due to the detail it requires, ABC is difficult to apply (especially in large companies) and, while the time figures indicated in table 4 are exact, in practice they would be estimated and therefore they might carry a certain error. Besides, an "activity" is just a cost pool and therefore, another way of allocating overhead to products.

Table 5 Costing products using ABC: From activities to object costs

Costs	Knob A	Knob B	Knob C
Material cost (€)	2,900.00	3,700.00	2,450.00
Direct labor (€)	12,444.44	8,888.89	3,555.56
Replenishment (€)	187.50	937.50	1.875.00
Quality control (€)	1,600.00	1,600.00	800.00
Manufacturing cost	17,131.94	15,126.39	8,680.56
Manufactured units	2,000	2,000	1,000
Unit cost (€/knob)	8.57	7.56	8.68

5 Refining the Cost with TDABC

Kaplan and Anderson (2004) developed TDABC. There has been a certain debate whether TDABC is a simplified version of ABC or a completely new approach. In any case, TDABC may be more precise when ABC cannot model processes in detail (or it would be too complicated). The method relies in estimating the cost per time unit of capacity and them modeling tasks by means of time equations. In our example, While ABC considered the replenishing activity equal for all the three knobs, the replenishing process depends on the type of knob considered: For knob A, the time is 15 minutes; for knob B, it is 10 minutes, and finally for knob C, the time is 5 minutes. Equation 1.1 gathers all this information (where X_1 would be 1 for knob A or 0, otherwise. In a similar way, X_2 and X_3 would act for knobs B and C).

$$\text{Replenishment (in minutes)} = 15\ X1 + 10\ X2 + 5\ X3 \quad (1.1)$$

The time for performing the quality control of each knob depends on the number of points that have to be checked. There are 10 points in knob A, 9 in knob B and 8 in knob C. Equation 1.2 gathers all this information (where X is the number of checkpoints: 10 in knob A; 9 in knob B, and 8 in knob C).

$$\text{Time for quality control (in minutes)} = 0.02\ X \quad (1.2)$$

TDABC computes the cost per unit of time (minute) for the “group of resources” in charge of replenishment as shown in table 6. Following Kaplan and Anderson (2004), we consider that on the basis of 40 working-hours per week, the effective capacity is 80% of the theoretical capacity. In a similar way, not shown here, the cost of quality control results to be 4.34 € / min.

Table 6 Estimating the cost per time unit in replenishment

Capacity (per week)	40 h x 0.15 workers =	6.00 labor hours
Effective capacity (4 weeks per month)	0.8 x 6 x 4 =	19.20 labor hours
Total cost of resources		3,000.00 €/month
Cost per minute	3,000 / (19.2 x 60) =	2.60 €/min

According to table 4, the parts of knob A are replaced 10 times in one month, 50 times in knob B and 100 times in knob C. The coefficients in equation 1.1, enable us to determine the time for replacement in each knob and the cost of replacement per unit of product, by multiplying the time devoted to each knob and the cost per unit of time and dividing by the production (units). Similarly (Table 7), using equation 2 we obtain the cost of quality control per unit of product (knob). Finally, we add the cost of replenishment and inspection to the cost of assembly in order to compute the total cost of production of each product in TDABC (Table 8).

Table 7 Estimating the cost per knob (as a function of time) using TDABC

Knob model	Time (minutes) for replacements of material	Unit cost of replacement (€/knob)
Model A	15 x 10 = 150	150 x 2.60 / 2,000 = 0.1953
Model B	10 x 50 = 500	500 x 2.60 / 2,000 = 0.6510
Model C	5 x 100 = 500	500 x 2.60 / 1,000 = 1.3021
Knob model	Time (minutes) for inspection	Unit cost of quality control (€/knob)
Model A	0.20 x 2000 = 400	400 x 4.34 / 2,000 = 0.8681
Model B	0.18 x 2000 = 360	360 x 4.35 / 2,000 = 0.7813
Model C	0.16 x 1000 = 160	160 x 4.34 / 1,000 = 0.6944

Table 8 Computing the total cost per knob using TDABC

Knob model	Material (€/knob)	Replenishment (€/knob)	Assembly (€/knob)	Quality (€/knob)	Total (€/knob)
Model A	1.45	0.1953	(140/3,600) x 160 = 6.22	0.8681	8.74
Model B	1.85	0.6510	(100/3,600) x 160 = 4.44	0.7813	7.73
Model C	2.45	1.3021	(80/3,600) x 160 = 3.55	0.6944	8.00

In our example, TDABC can capture the complexity of the operations easily and better than ABC. This will be valid whenever the time is the right cost driver and if the study is accurate, because the group of resources is nothing else than a cost pool. Considering the shop floor as one single group of resources would have led us to the conclusions in table 3.

6 Computing the cost by value stream

Since full costing motivates non lean behaviors such as overproduction and ABC entails a lot of non-value added tasks, Maskell and Baggaley (2004) created VSC to support lean companies. VSC assigns both direct and indirect costs to a value stream (Table 9) on condition that the company is organized by value streams with few shared resources amongst them, including non-manufacturing departments (Ruiz de Arbulo et al., 2013b). Raw material (2,900 € of material in product A, 3,700 € in product B and 2,450 € in product C in a month), labor, depreciation and other conversion costs are included, while costs outside the value stream are not.

Table 9 Computing the cost of the value stream

Centers	Cost of materials (€/month))	Labor (€/month)	Depreciation costs (€/month)	Other costs (€/month)	Total cost (€/month)
Replacement		1,000.00	1,000.00	1,000.00	3,000.00
Assembly	9,050.00	18,000.00	5,060.00	1,828.88	33,938.88
Quality		3,000.00		1,000.00	4,000.00
Total	9,050.00	22,000.00	6,060.00	3,828.88	40,938.88

VSC is different from other approaches because it focuses on the value stream as a whole and is not interested in isolating the cost of a specific product. Its aim is to see how each step contributes to the cost of the value stream and how continuous improvement activities cut those costs. It is possible to compute the cost of products one by one the basis of the characteristics of the flow of products through the value stream chain. In Table 10, we consider that it would be possible to assemble 4,000 model A knobs in a month (155.6 working hours x 3,600 seconds per hour /140 seconds per knob), 5,600 model B knobs and 7,000 model C knobs. Since costing products with VSC only takes into account one feature of the product, related to the assembly time, results are distorted as in Table 3.

Table 10 Costing each knob with VSC

Knob type	Material (€/unit)	Capacity (units/month)	Conversion cost (€/unit)	Total cost (€/unit)
A	1.45	4,000	31,889/4,000 = 7.97	9.42
B	1.85	5,600	31,889/5,600 = 5.69	7.54
C	2.45	7,000	31,889/7,000 = 4.56	7.01

7 Final Discussion and Concluding Remarks

The aim of this paper is to explore how different accounting systems can model manufacturing processes and supply cost information. Full costing, accepted for reporting purposes, gives an idea of all the necessary costs to make a product in the long run, but overhead allocation distorts costs. ABC is considered a great innovation in the management accounting literature but it is difficult to implement and sustain. It can be very accurate and reveal the causes of costs -although it was not the case in our example-, which can be used for process improvement. TDABC can model processes where time is the right cost drivers. Because the activities of replenishment and quality control depend on the type of product, the cost computed using TDABC is more accurate than the average value obtained using ABC. ABC could be as accurate by using multiple drivers but it would be really complicated. Results show that TDABC is the method that best fits our example. VSC can only be implemented in lean plants. Because it is more concerned with process improvement than with cost measurement, costing products with VSC does not take into account all the characteristics of the products. In the future, this preliminary research will be enriched by a survey on the application of the new accounting approaches in (especially SME) Spanish firms.

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