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Procedia Manufacturing 13 (2017) 932–939

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

Manufacturing Engineering Society International Conference 2017, MESIC 2017, 28-30 June 2017, Vigo (Pontevedra), Spain

The implementation of an Activity-Based Costing (ABC) system in a manufacturing company

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Abstract

Nowadays companies face strong competition at a global level, so there is a lot of pressure to increase productivity and lower production costs. Thus, obtaining a method of estimating the costs of the various products produced in the same company in a rigorous and precise way has turned into a really strategic objective [1]. To address this issue, the ABC methodology has been proposed, which establishes that resources are consumed by the activities and these are consumed by the products and services. The distribution of resources by activities and the subsequent allocation to the products is done through cost drivers [2]. The goal of this work is to re-port the main results obtained with the implementation of an industrial cost model based on the ABC principles in a Portuguese coffee production company that fits with the organization's reality and reflecting the way how it operate on a day-to-day basis, in an accurate and reliable way, providing useful and relevant information.

Peer-review under responsibility of the scientific committee of the Manufacturing Engineering Society International Conference 2017.

Keywords: ABC costing, ABC methodology, cost accounting, implementation of a costing system, industrial costing.

1. Introduction

The business environment in which today's companies are inserted has undergone enormous changes over the last decades caused by deregulation, increased global competitiveness, reduced costs associated with information, demand

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2351-9789 © 2017 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the Manufacturing Engineering Society International Conference 2017.
10.1016/j.promfg.2017.09.162

for greater diversity of products, among others. The development of new technologies, essentially linked to automation and information systems, has led to significant advances, which have had repercussions on the various organizations that make up the business fabric, affecting virtually all the departments and their areas of intervention. Companies no longer compete locally only and have come to deal with competition from companies located on other continents, embedded in distinct realities and diverse business environments. These changes have forced these organizations to implement ever more sophisticated costing systems [3].

Important decision-making within an organization, such as the placing of new products on the market or the continuation or termination of the marketing of other products or services, as well as the design and definition of the selling price, will have to be supported by reliable information regarding to their industrial cost and profitability [4]. Customer satisfaction is a key prerequisite for the viability of companies and organizations. However, customer satisfaction must be ensured by meeting their expectations, but the selling price of the product will always have to be higher than its production cost. This is a requirement that companies can-not abdicate [5]. As a consequence of the profound changes that have taken place over the last few years, there is strong pressure in the organizations to increase productivity at reduced prices, so that to obtain a method of estimating the costs of the various products produced in the same company in a rigorously and accurately way has become a strategic objective [2].

However, the mere knowledge of the costs of a particular product may not be sufficient for a company to remain competitive. There is a need to constantly improve their processes by detailing how the various activities within the company are developed in order to increase efficiency and effectiveness, which will lead to more competitive and higher quality products and services [6]. On the other hand, the selection of the costing method more appropriate to the reality of each organization can be a complex task [7], and the misallocation of indirect fixed costs, as it occur in some traditional costing systems, leads to obtaining incorrect industrial costs and may lead to misallocated management decisions [8]. The Activity-Based Costing (ABC) method has been seen as a useful tool to achieve a costing system more efficient, since it identifies and analyses the production activities that lead to the product object of the cost [9].

The main goal of this work is to describe the implementation of and the results obtained with an industrial cost model based on the ABC principles in a Portuguese coffee production company, that fits with the organization's reality and that reflects the way how it operates on a day-to-day basis, in an accurate and reliable way, providing useful and relevant information for the decision-making process. Although this company produces different coffee-type products, this study analysis the particular case of the cost associated with producing the product "coffee capsule" using the ABC method. The implementation of a modern costing system is of particular relevance to this company, taking into account the following aspects:

- The production of a large number of diverse products occurs in the same industrial unit, which are directed to different distribution channels;
- The production process involves a set of activities common to the various manufactured products, with their own specificities and different production requirements, with varying degrees of difficulty;
- The different production activities share human resources, equipment and raw materials during several stages, and at a given moment the separation of production from the various products involves changes (in some cases abrupt) that translate into different costs per unit of output. In this sense, the difficulty in reflecting these costs on the different products at the time of their allocation is not an easy task for most so-called "traditional" systems.
- The company has two distinct business areas - the production of coffee and derivative products and the marketing of wines and other beverages - which share facilities (such as warehouses) and employees, as well as the difficulty of strictly affecting the associated costs to each product.

2. Methodology

This section provides a brief overview of the ACB methodology, describes the industrial company used as a case study, and the implementation process of the ABC methodology in the company.

2.1. The ABC methodology

The activity-based costing (ABC) methodology was developed by Cooper and Kaplan [10, 11] as a way to address the problem of the increasing share that indirect fixed costs have on a product's cost structure, derived from the process of industrialization and automatization of the production processes.

ABC costing systems estimate the costs of resources used or spent in a given process, consisting of a set of activities, to produce products or services. In this system, it is assumed that resources are consumed by the activities needed to produce the products or services. In a first phase the resources are allocated to the activities, and in a second phase the activities are allocated to the products. This allocation is made in both cases through cost drivers. Cooper and Kaplan [12] argue that two reporting systems should coexist within a company: the traditional financial reporting system that periodically provides information about the cost of the activities provided by the company in each period, and the ABC costing system, which provides information about the quantity and estimates the cost of the activities effectively used in a given period.

In a nutshell, ABC is a method for measuring the cost and performance of activities and cost objects. In this sense, it is based on three basic premises: products require activities, activities consume resources and resources cost money. Resources are associated with activities through resource drivers and, in turn, activities are indexed to cost objects through activity drivers. From the perspective of the process, it is allowed to analyze the causes of the costs associated with the activities, as well as the measure of their performance, and from the point of view of management represents an added value [13].

2.2. Case study

The study was conducted in a Portuguese company that produces roasted coffee, and was focused on a specific area: the production of coffee in capsule. This study concentrated on all aspects of this new sector of activity in the company: acquisition of new industrial equipment, manufacturing processes and methods, raw materials and subsidiary products, contracted services, direct labor, to mention only the most important.

The company is dedicated to two distinct areas of activity: the production and marketing of roasted coffees and the marketing of alcoholic beverages, namely wines, Port wine, sparkling wines and others. The company's two business areas have similar sales volumes. The marketing and distribution of the various products is present throughout the national territory and islands. On the other hand, this company is part of a broader business group, with companies and facilities in the Iberian Peninsula and in the American continent. The headquarters of the group and most of its companies are in the same place where this work was developed.

The production of coffees is carried out in facilities that are separated from the rest of the company's activity. However, the terminal part of the production process, such as the dispatch of merchandise, shares employees, equipment and facilities with the marketing and distribution of beverages.

The production of coffees involves different formats and its commercialization is done through several channels, both in the national market and in the foreign market. In the national market the sale of the products is directed essentially to 2 channels: a) HORECA (stands for Hotels, Restaurants and Cafes) and b) Mod-ern distribution (a term used in the company to designate the sales made to the retail companies of the large distribution, which offer their products normally in large areas). Commercialization in the foreign market is carried out through distributors.

As noted above, the product "capsules" represents only a small part of the coffee-based products produced in the company's industrial facilities. The production of coffees is not the only activity developed by the company (there is still the distribution of beverages), so there are resources that are shared not only between activities in the same area, but also between different business units. In this way, the evaluation of the activities related to the production of a given product are even more important in order to better evaluate the associated costs and the "weight" they represent for the organization.

A set of activities were identified as main activities (MA) by their importance and influence in the production process of the capsule production. For these activities, a direct/linear relationship with the product was verified. This reason of linearity is verified not only at the level of costs but also at the qualitative level and the intrinsic constitution of the final product. The activities represented in Table1 are those included in the capsules manufacturing flowchart.

Table 1. Identification of the main activities of coffee capsules production.

Code	Main Activity	Local / Zone
MA1	Green coffee reception	Green coffee warehouse 2
MA2	Green coffee storage	Green coffee warehouse 1 and 2
MA3	Densimetric treatment	Densimetric treatment room
MA4	Blending	Roasting room
MA5	Roasting	Roasting room
MA6	Grinding	Grinding room
MA7	Degassing	Ground coffee room
MA8	Packaging/encapsulation	Capsules packaging room
MA9	Semi-finished packaging	Capsules packaging room
MA10	Placement in cardboard sales unit	Capsules packaging room
MA11	Final Packaging	Capsules packaging room
AP12	Expedition	Final product warehouse

These activities are developed in the industrial building of the company and, in most situations, there is a physical separation of each activity site, as can be seen in the previous table (Table 1). A considerable part of these activities is common to all coffee products produced in the company, which corresponds to activities between MA1 (reception of green coffee) and MA5 (roasting). In fact, after the roasting stage, there is a separation of the way forward for each product that will culminate in the following 6 groups of products that are presented in Table 2. Because they are activities that lead to the obtaining of products whose base constitution in their combination is coffee and constitute all the activity of the industrial unit of this company, were called complementary activities (AC).

Table 2. The different products produced in the industrial building.

Code	Activity	Distribution Chanel
CA1	Bulk coffee packaging	HORECA + Domestic + Export
CA2	Coffee Packaging HORECA channel	HORECA + "Vending"
CA3	Coffee POD packaging	Domestic + Export
CA4	Coffee 250g packaging	Domestic + Export
CA5	Coffee sachets Packing	HORECA + Export
CA6	Coffee capsule packaging	Domestic + Export

Thus, up to the point of separation (MA5), the activities developed are shared by all coffee products produced in the company, and their execution uses the same resources, both at the level of facilities, equipment and labor.

On the other hand, there is a set of activities of wide scope and common to several organizational processes, which, despite not having an importance of the same order of magnitude of the previously identified group, interfere and influence the production process. This group includes activities such as purchasing, receiving materials, maintenance and management and quality control. These activities were designated as secondary activities (SA), see Table 3.

Table 3. Secondary activities developed in the company.

Code	Secondary Activity
SA1	Green coffee purchase
SA2	Subsidiary Products Purchase
SA3	Reception of subsidiary products
SA4	Maintenance
SA5	Cleaning and sanitation
SA6	Quality Management and Quality Control

The production of coffee capsules activity is the result of a set of activities that are upstream of the production process, and which are developed by suppliers where the resources of this company are used. These activities include the production (injection) of plastic capsules that will be used in the industrial coffee manufacturing process. The moulds used in this activity belong to the coffee manufacturing company.

On the other hand, there was a set of actions that led to the development of the coffee capsule, as well as the entire process of requesting and maintaining industrial property, which involved and continue to resort to entities outside the organization. Thus, it is necessary to frame these activities and consider them in the allocation of the respective costs. This group of activities, because they took place outside the company's industrial facilities, was called external activities (EA).

Table 4. Activities developed outside the company.

Code	External Activity
EA1	Research and development of the capsule
EA2	Industrial Property Protection
EA3	Capsule production

2.3. Implementation of the ABC methodology in the company

First phase: the allocation of resources to activities

The work began with the survey of all the main, secondary and external activities involved in the production of capsule coffee. This survey contemplated all the tasks that are performed in each activity. After this sur-vey, the identification of all the resources that were consumed in each activity was made: industrial building, labor and industrial equipment.

The costs associated with the industrial building are summed to the value of the rental of the building, electrical energy, insurance and maintenance. The rent paid annually for the facilities was easy to quantify and allocated to each activity according to the area occupied by each activity developed in the company in a global way and in the industrial building in particular.

The energy consumed by the installations relates to the energy consumption of lighting and common infra-structures such as elevators and hoists and social areas. The energy consumption of the equipment was as-associated with each one according to its electrical power and was not considered in the costs of the industrial building. It was considered the overall maintenance related to the industrial building, such as repair and intervention in infrastructures (paintings, paving, etc.). The maintenance associated with each equipment was counted individually and allocated to the respective equipment.

As far as insurance is concerned, the company has a wide range of insurance policies ranging from the civil responsibility of each employee, business activity / lost profits, facilities, stocks, etc. On a case-by-case basis, the insurance was allocated in order to better reflect its allocation to the insured object. Briefly, environ-mental insurance was totally affected by the industrial building, since the greatest environmental risks (gas emissions and waste generation) were generated here, civil liability insurance was divided by the total number of employees of the company and attributed to the number of employees to industrial activity. Finally, it was quantified the consumption of water verified in the industrial building and its imputation to each activity was made according to its occupied area, since in the industrial process there is no water consumption.

The costs associated with the labor consumed in each task of each activity (main and secondary) took into account the time consumed by each job / function, based on the measurements made. The calculation of the labor costs took into account, taxes, social security, subsidies (Christmas and Holidays) and actual working time. A working year of 11 months and 20 working days was considered. The same rules were applied to the main and secondary activities.

In the case of equipment, its estimated value was considered in relation to the expected depreciation (calculated according to the applicable legal requirement as well as the expected life expectancy for the same equipment), costs related to repairs or relevant interventions carried out and consumed energy. From these values it was possible to identify the hourly cost of using each equipment. Thus, by quantifying the time of use of each equipment assigned to each activity, it was possible to allocate the respective cost.

The production of capsules also includes a set of activities that are developed outside the facilities through outsourcing and which are limited to activities developed in the field of R & D, industrial property (industrial patent submission and maintenance), as well as costs associated with moulds which are found on the premises of the supplier of empty capsules. Since these fixed costs are specific to the activity of capsule production, and do not absorb internal resources of the organization, those resources are easily identified and allocated to the coffee production capsules activity. In this way, these were allocated to the specific activity of coffee capsules production: MA7-degassing to MA12 - expedition. In this way, it was possible to clearly identify the resources used only in the coffee capsules production.

The allocation of resources to the respective activities where they are consumed was done through the resource drivers (Fig. 1).

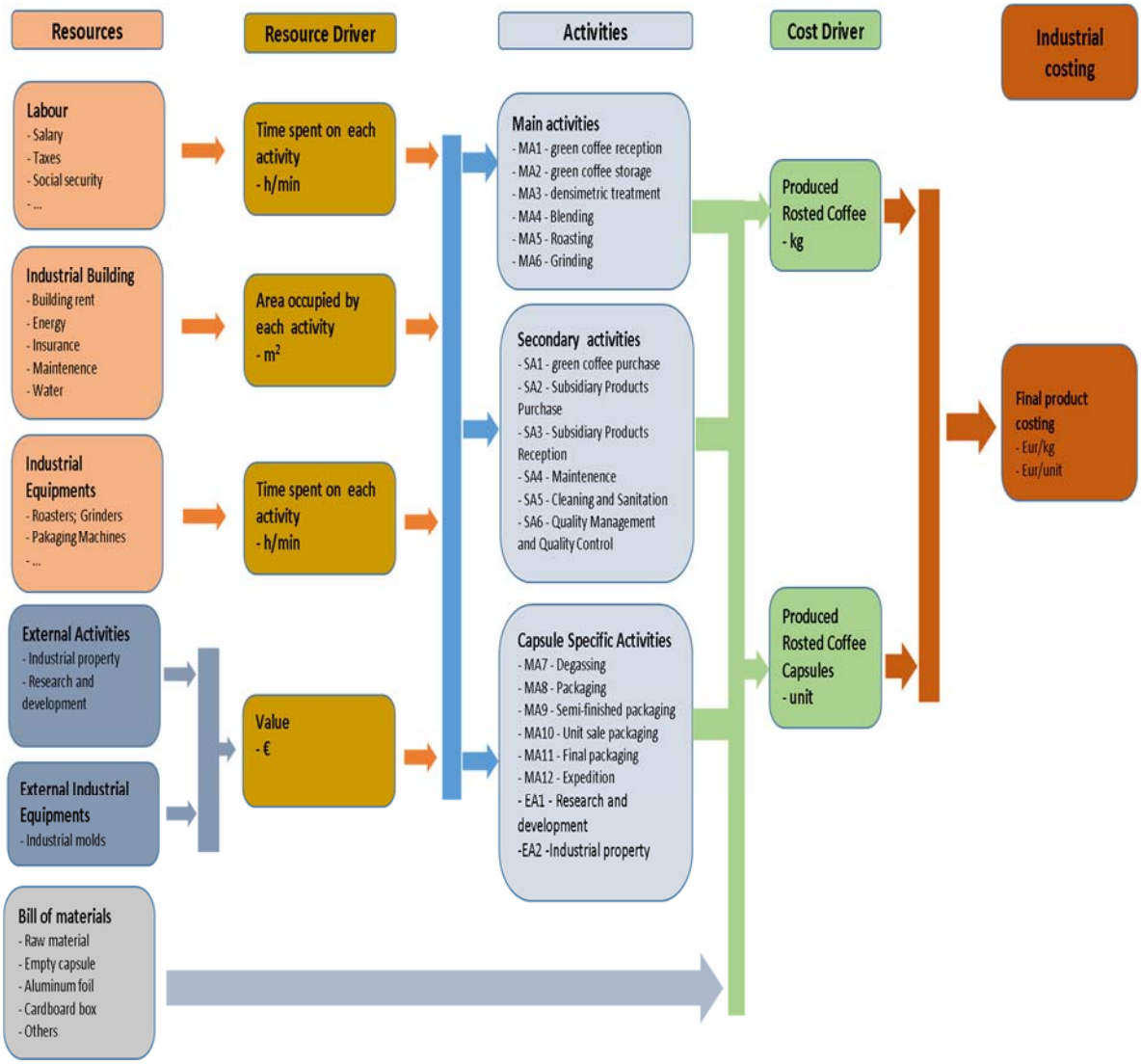

Fig. 1. The ABC implementation flow chart.

Second phase: the allocation of activities to products and the definition of industrial cost

Once the resources were allocated to the activities those were allocated to the product capsules in its various aspects. It was used for the driver activity: produced roasted coffee (kg) and produced coffee capsules (units). The calculation of the industrial cost of the product is finalized with the introduction of the values associated with the bill of materials of the products concerned. Fig. 1 shows very briefly how the resources were allocated to the activities, as well as their allocation to the industrial product.

In a brief summary, all the activities involved in the production of coffee capsules were identified, as well all the resources that are consumed in these activities. The distribution of the resources through the activities was done over previously identified cost drivers. In a second phase, activities were attributed to the products through the cost drivers of the activities that directly and linearly reflect their consumption. Finally, the total cost of the product was calculated according to the activities consumed and the respective bill of materials (Fig. 2).

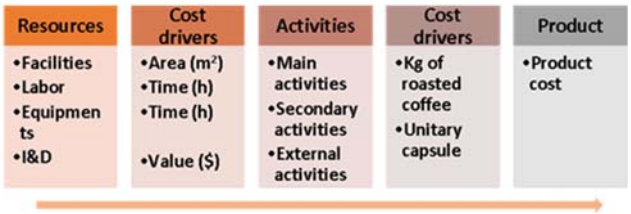

Fig. 2. The ABC implementation methodology used in this work.

3. Results

The work carried out allowed the analysis of the distribution of general manufacturing expenses by the different main activities, as can be observed in Fig. 3. This way, it is possible to reflect about the relevance of each activity in the cost structure of the final product. As can be seen, MA8 (23.8%) and MA9 (18.5%) activities represent the highest share of the distribution.

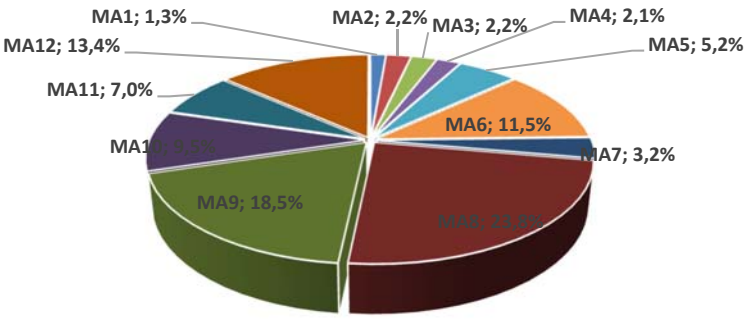

Fig. 3. Main activities distribution.

This work allowed to obtain the industrial costing of the coffee product in capsules in its different variants. Because each of the activities involved in the production of the coffee capsules has been analyzed in detail, a large amount of relevant information has been obtained for the various components of the cost of the industrial product. In Fig. 4 it is possible to observe the contribution of the various activities involved in the production of capsules, whether they are specific, secondary or major, for the final cost of the product. On the other hand, as regards the bill of materials, it is possible to distinguish individually the costs with the raw material, packaging materials and empty capsule. As can be seen, the largest cost components are the green coffee (28.9%), empty capsule (28.7%), and packaging materials (24.8%).

Relevant information about the distribution of packaging materials was obtained, either by the weight they represent versus the overall costs (Fig. 4), and within this group the relevance of the cost associated with the empty capsule (Fig. 5), which represents more than 50% of the total cost of the packaging materials.

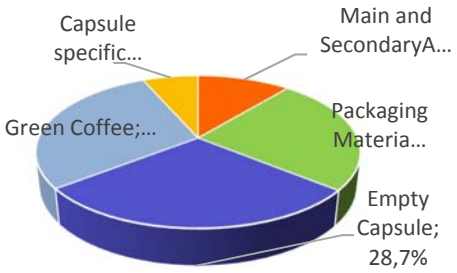

Fig. 4. Global coffee capsule cost distribution.

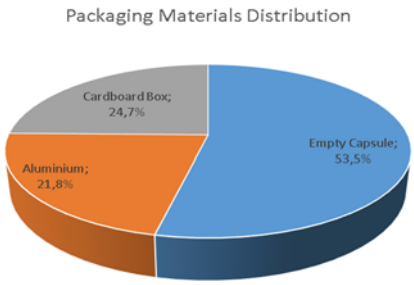

Fig. 5. Coffee capsule packaging materials distribution.

4. Conclusions

The analysis of the various activities involved in the coffee production process of a Portuguese company, from the perspective of the ABC methodology, allowed obtaining, analyzing and reflecting about a set of information of high importance for the organization. The work carried out has exposed the changes verified in the company over the last years, regarding the diversification and complexity of the products and activities involved in the production process.

Overall, this work contributed to a better knowledge of the company, providing a greater degree of detail about how the company's industrial activity develops. The ABC costing system provides relevant and useful information for the decision-making process in various domains, such as the definition of cost and sales prices of products, the identification of processes where greater effort is needed to improve or adapt them to the new realities and needs and the restructuring of some areas of the industrial unit. Moreover, in the industrial costing model developed in this work, a set of specificities in the distribution of general manufacturing expenses was taken into account, namely at the level of the specific allocation to each activity of the resources consumed. Thus, a high level of detail and specificity of the information is obtained, allowing a broad analysis of the various components of the cost of the product under analysis.

In this company, several products are produced simultaneously that share a wide range of resources. There-fore, the correct allocation of those resources to the various products can be complex and ineffective. The implementation of the ABC costing system led to the obtaining of a wide set of information, with high detail, relevance and usefulness, which indicates that this is a costing system that adapts to the needs of this company.

Acknowledgements

This work has been supported by COMPETE: POCI-01-0145-FEDER-007043 and FCT – Fundação para a Ciência e Tecnologia within the Project Scope: UID/CEC/00319/2013.

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