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REGULAR PAPER

Lean production: mistakes and limitations of accounting systems inside the SME sector

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Abstract

Purpose – Implementation of lean production introduces the problem of what kind of management accounting to use. The purpose of this paper is to analyse aberrations that are typically created when traditional accounting is used in a lean organisation. Furthermore, the purpose is to discuss whether activity-based costing (ABC) and value stream accounting are suitable for lean production. These three accounting systems are compared under the particular conditions of a small-to medium-sized enterprise (SME) that is in an early stage of lean implementation.

Design/methodology/approach – The paper is based on a case study carried out within a SME illustrated by three examples. In the first and second examples the SME analyses how the introduction of improvements, by the means of lean production, can lead to cost product mistakes when traditional accounting calculations are used. The second example deals with a comparison benchmark between traditional accounting and ABC. The third example analyses value stream accounting as an alternative to ABC and discusses the implications and limits for the SME.

Findings – The results of the examples show first, the possible mistakes introduced by traditional accounting, and second, how the costing of a manufacturing lot varies when using traditional accounting and ABC. In addition, the results illustrate the interrelationships between lean production, ABC and value stream accounting. In particular, ABC seems to introduce some difficulties in terms of IT automation, and there are difficulties with value stream accounting because it requires a particular value stream-based organisation not particularly suitable for this SME.

Research limitations/implications – The generalisability of the research findings is limited because of the use of a case study within a SME in which lean production is in an early stage of application and has a particular flexible organisation. This implies a need for further studies on other SMEs in different organisational situations.

Practical implications – The implications are useful for SMEs that are implementing lean production and are thinking of a changeover from traditional accounting. The results can guide SMEs in the selection of the most effective accounting system considering particular factors such as the state of lean implementation, whether the organisation is value stream oriented or type of products manufactured.

Originality/value – The paper discusses for the first time the implications of ABC and in particular of Value Stream Accounting inside a SME that is implementing Lean Production.

Keywords Small to medium-sized enterprises, Lean production, Accounting systems, Activity-based costing, Lean accounting, Value stream accounting, Traditional accounting

Paper type Case study

Introduction

The market scenario has changed dramatically over the past 20 years and many companies, including small- to medium-sized enterprises (SMEs), have gradually abandoned "mass production" to implement "lean production" or "lean thinking"

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(Womack *et al.*, 1991). Mass production was implemented in a market in which product demand was high and customisation low and consequently companies preferred to program big lots of different code products. We are now in an era of strong personalisation of products/services, more dynamic design and research (Goleman *et al.*, 2001), more expensive resources, and above all customers who often determine product price. This market has led to a complete turnover of productive paradigms (Bicheno *et al.*, 1997). In such a scenario, companies of all sizes are forced to analyse and reduce costs and waste across all processes and, in particular, in production processes. Lean production helps companies to find and eliminate seven types of waste (Ohno, 1988) that increase product costs:

(1) overproduction;
(2) inventory;
(3) extra processing steps;
(4) motion;
(5) defects;
(6) waiting; and
(7) transportation.

These wastes also increase process lead time and reduce value-added for customers (Hines and Rich, 1997). In order to implement lean production, companies normally use effectiveness teams called "Kaizen teams" (the English translation is "continuous improvement" teams) during "Kaizen events" or workshops (Manos, 2007). Savings created by the application of Kaizen events or other improvement projects obviously have to be measured in economical-financial terms (George, 2002). Such savings become visible at the close of the fiscal year (Dauphinais and Colin, 1998) when general accounting is able to highlight the improvement in earnings before interest and tax; however, they are often not so visible at micro, day-by-day and monthly levels. This problem has its roots in the methods of traditional cost accounting based on the division of costs into direct and indirect costs, and on the use of cost centres (Johnson, 1978). Furthermore, traditional accounting makes it difficult to see financial savings such as work-in-process (WIP) reduction in the short term. The less the WIP the shorter the lead time and consequently the more the cash flow (Spearman and Zazanis, 1992).

Since the 1990s a new accounting system, activity-based costing (ABC) (Cooper and Kaplan, 1991) has attempted to overcome the limits of traditional accounting. ABC usually includes activity-based management (ABM) in which processes and activities are continually put in discussion in the short and medium term to achieve more value-added and better financial results. According to Cooper and Kaplan (1991), ABC is an accounting system that allows businesses to gather data about their operating costs. Costs are assigned to specific processes such as marketing, engineering or production. The processes are divided into activities and for each activity managers have to determine a cost driver. The activities are associated with different products or services. In this way, the ABC method enables companies to understand which products and services are increasing their profitability, and which are contributing to losses.

Several authors have studied these principles. Roztocki and LaScola Needy (1988) analysed how ABC can measure the economic and financial results of operations. Cagwin and Bouwman (2002) argued and demonstrated the relationship between ABM

and the possibility of improving financial aspects in the short term. While Gosselin (2006) after having listed techniques inside ABC highlighted how it can be used for measuring value-added inside processes.

In the past few years, lean accounting (Kennedy and Huntzinger, 2005) based on the concept of value stream or value stream accounting (Baggaley and Maskell, 2003a, b, parts I, II), seems to be the new frontier of accounting systems that are specifically dedicated to lean production. Because value stream accounting is based on the principle of value stream organisation it is by its nature focused on a continuous cutting down of wastes, and helps managers plan for the short as well as the long term (Cooper and Maskell, 2008). As shown in the next sections, value stream mapping (VSM) is a very powerful tool that makes waste in processes immediately apparent. VSM also increases economic and financial performances in the short and long term (Rother and Shook, 2003).

Many companies that are implementing lean production are investigating what the most suitable accounting system for lean production would be (Cooper and Maskell, 2008). There are several articles about applications of ABC inside companies that have implemented lean production (Cooper, 1995; Kim and Ballard, 2001; Ittner *et al.*, 2002; Pohlen and Coleman, 2005) and the results analysed and discussed seem to show a positive relationship between the two systems. Other authors investigated value stream accounting especially in large companies with repetitive and high quantity products, and demonstrated that it is particular suitable for organisations that have processes based on value stream (Maskell, 2000; Baggaley and Maskell, 2003a, b, parts I, II; Maskell and Kennedy, 2007; Huntzinger, 2007). However, there is a lack of literature concerning value stream accounting inside SMEs. SMEs often need a tailored methodology and to consider flexible target areas (Deep *et al.*, 2008). In view of this, this research based on a SME case study has two main objectives:

(1) Evaluating what kind of mistakes traditional accounting can introduce within lean production projects.

(2) Understanding whether ABC and value stream accounting are suitable or unsuitable for SMEs that have embraced lean production.

In this way, the results of this research will be a useful source of information for the SME sector when implementing lean production.

Research methodology

The research employed an empirical approach within a SME case study. It was based on accounting data from the operations of a plant in mechanical production. The plant employs approximately 200 staff of whom 140 fall under the direct workforce with a turnover of €45 million per year. The company has an 8-hour shift per day and the labour cost in production is from €10 to €18 per hour depending on the skills of the worker. Its production is divided into four product families plus a large number of personalised products for single customers. In particular, the company manufactures rotary shaft seals and o-rings and it is a so-called "tier 1", insofar as it supplies directly to the customers. The company has been implementing lean production for one year in order to reduce wastes such as WIP and improve processes.

However, the company has not yet reached a "mature" stage of application. For example, the value stream process redesign is incomplete and wastes are still high.

Indeed starting from an estimated amount of €500,000 WIP per month, it is now around €400,000 per month. The researcher spent one day per week in the company as an observer over a period of six months. The senior management of the company suspected that the implemented traditional accounting led to mistakes regarding the cost of products and was not suitable for lean production. For instance, using the traditional accounting, a product family designed ten years ago and still in production seemed to have the same cost as a new product with a similar production cycle. However, because it was a new product it was affected by high design and marketing costs. How was this possible? Furthermore, when lean improvements reduced transportation costs this sometimes was difficult to detect in the product cost. These and others situations rang alarm bells that led senior management to evaluate and compare different accounting systems.

The research stages can be summarised as:

- Analysis of traditional accounting system and the possible introduction of mistakes. In this stage by the means of the two first examples, it is shown how, after the introduction of lean improvements, traditional accounting can lead to cost product calculation mistakes. In particular, the second example directly compares the cost product calculations using traditional accounting and ABC after a lean reorganisation inside a cell.
- Comparison between the ABC calculations and the possibility to introduce value stream accounting. In this stage, starting from the results of ABC calculations that help to understand how the cost of product is structured, it is discussed whether or not value stream accounting can be implemented in this SME. In particular it is analysed and discussed whether a value stream organisation can be applied in this SME and if the cost of product results can be similar to the ABC ones.

The company compared and analysed the cost of product results in order to evaluate what kind of accounting system was the best for its own situation and should have substituted the current based on traditional accounting.

The limitation of this research is the lack of generalisability of the results that is typical of a case study approach (Bryman, 1988).

Traditional accounting

Traditional accounting is normally linked to mass production (Kaplan, 1983), which is still in use in particular markets (Gamble *et al.*, 2004), that is based on the principle of the increasing production lot antithetical to lean organisation (Shingo, 1989). Indeed, in the mass production the use of big lots typically led to the achievement of the following targets:

- customer service by means of high supply levels;
- high margins given by the maximum exploitation of machines (Hounshell, 1984);
- detailed calculations related to the "actual" costs for each cost centre;
- pursuit of standard product costs (Collins, 2001); and
- low indirect costs directly proportioned to the amount of workforce necessary to make the product.

By producing big lots, it is obvious that the percentage of direct costs, particularly workforce, becomes very high compared to indirect ones or overheads. In a market

in which the request for different products was limited and the demand was high, only a few production set-ups were required. In addition, design and research and development were limited and, most importantly, inventories required less capital due to a general lower cost of production.

Organisations that use traditional accounting identify their cost centres based on departments, lines, groups of machines, cells and so on, to which they initially charge the direct workforce dedicated to those centres, the amortisation of machines, the raw materials and the semi-finished goods (Johnson and Kaplan, 1987). Through this first accounting operation a considerable part of the whole costs is immediately allotted and the overheads, the indirect costs of little value, are left out: design and development, marketing, maintenance, materials handling, quality, supplier management and so on. In traditional accounting, the omitted indirect costs are therefore allocated to the cost centres according to the direct workforce of the centre by means of formulae such as:

$$\frac{(\textit{Total amount of overheads} \times \textit{Direct labour hours of the centre})}{\textit{Total direct labour}}$$

Therefore, the higher the number of hours of direct workforce that are absorbed by the cost centre, the higher the overhead costs that are allocated (Argyris and Kaplan, 1994); this is the paradigm of traditional accounting. Dividing by the number of products of the output period of the cost centre, the average cost of the product or lot can be obtained as a reference point for traditional accounting in order to make decisions on price lists, make or buy, budget and so on. However, this accounting system can lead to aberrations as shown in the analysed case study. Several studies have demonstrated how traditional accounting provides information that is inaccurate and even detrimental to continuous improvement initiatives. Kaplan in the 1980s presented some empirical case studies on the subject (Kaplan, 1986). Johnson and Kaplan (1987) discussed traditional accounting mistakes in a book for practitioners and presented several case studies from large companies. Cooper and Kaplan (1991, 1988) correlated these issues with profitability management and argued that traditional accounting can lead to incorrect strategic decisions. Glover (1993) stated that an accounting method other than the traditional system was necessary for successful improvements related to quality management. Drury and Tayles (1994) investigated the subject through a survey on the UK's manufacturing industry, concluding that traditional accounting was receiving criticism from many companies and that these latter were looking for different accounting systems. Whereas Abdel-Maksoud *et al.* (2005) tried to analyse relationships between accounting systems and non-financial performance arguing that contemporary management accounting practices try to take performance into more consideration than in the past.

Activity-based costing

The ABC system brings into question traditional accounting based on cost centres and on the charging of indirect costs by means of direct workforce. The principle is simple and revolutionary at the same time: according to ABC there are no indirect costs. All costs are direct in relation to processes/activities, and in order to calculate the cost of a product accountants have to add up the costs directly absorbed through the passage of processes (Cooper, 1992). Marketing, design and development, purchases, logistics, maintenance and quality generate direct costs, as much as production and its cost

centres do. Essentially, the cost centre becomes the process. Such reasoning is easier to explain than to put into practice (Covey, 1991). In fact, it implies, for example, that designers have to register every day how many hours planning they have dedicated to a product/service. All costs become direct by means of the cost "driver" concept: this is the leading factor directly linked to the cost of the activity. For example, the number of handled products can be the driver of the transport activity. Consequently, to analyse the cost of a lot, or of products handled in a specific period, the number of these products has to be multiplied by the unit driver cost. By means of this outline, the cost driver arrives at the cost of the product by adding up the costs of all the activities of the processes concerned with that product, beginning with research and development, design, marketing and so on (Karlsson and Åhlström, 1996). The ABC accounting system seems complex because:

- It is necessary to realise a detailed mapping by dividing the processes into activities and in some organisations a product "goes through" hundreds of activities.
- For every activity it is necessary to identify the correct driver and its standard unit value.
- It is necessary to register in a software or paper report the number of drivers in a specific period of time for each activity.

In the early 1990s and 2000s, ABC seemed to be achievable when considering the increasing capillary diffusion of PC networks, bar code decoders, Wi-Fi and so on. By means of these systems, many calculations related to activities can be computerised (Groover, 2008). For example, the use of bar code systems makes knowing how many products with a specific code a conveyor has handled in a day relatively easy. In fact, although theoretically interesting, ABC has turned out to be complicated and difficult to apply. Moreover, managers and software developers who were culturally used to traditional accounting systems have often rejected it. Today, companies are talking a great deal about lean production and Six Sigma (Chowdhury, 2001) but industrial accounting (at least the official one) is sometimes still stuck at the calculation of mass production.

Lean accounting – value stream accounting

A review of the literature shows that it lacks a clear explanation of what lean accounting is. Lean accounting is normally based on process reengineering using the VSM tool and organisation based on value streams. For some authors, especially practitioners, it is considered a breakthrough (Maskell and Baggaley, 2000; Huntzinger, 2007). VSM is one of the most important lean production tools for mapping processes. According to Rother and Shook (2003, p. 4):

> Value Stream Mapping (VSM) is a tool that helps to see and understand the flow of material and information as a product makes its way through the value stream [...] is the simplest way [...] to see value, and, especially the sources of wastes.

VSM uses codified icons such as a process/activity box, in which important data concerning cycle time (C/T) and changeover time (C/O) are entered. Value stream accounting, similar to ABC, tries to avoid calculations of overheads: all costs become direct in respect of the value stream (Maskell, 2000; Maskell and Kennedy, 2007).

The centre of gravity of this accounting system is therefore the extended value stream organisation, from design to shipping.

The highest level of marginality in the sale of products/services is obtained by the continuous reduction of lead times and by the acceleration of order-to-cash (Hines *et al.*, 1998). Beginning from this logic it does not make much sense to talk about overhead costs or standard costs. This latter aspect becomes a target to reach that is typically related to the budget, especially in traditional accounting. The reduction of costs by means of traditional accounting mostly occurs by reducing the time of direct workforce (Bossidy and Charan, 2002) because the indirect costs item represents a melting pot that cannot be investigated. From this reasoning emerge standard C/Ts and the consequent standard costs as an attempt to maximise the use of resources and to bring down the product cost.

Such reasoning is more than logical in the era of big lots and low indirect costs, but today wastes are mostly included in many indirect costs, and C/T has to be especially conceived to line up with takt-time. No less important is the fact that intense use of standard costs/times implies the specialisation of productive roles according to the Tayloristic model (Lindbeck and Snower, 2000), and clearly this is the antithesis to the need of flexibility that is necessary in the trade-off of cells/processes. This point underlines that it is necessary to unhinge the concept of standard cost in order to focus on value stream and on the stream speed, because it is not usually possible to reduce process wastes by means of the standard cost.

Mistakes introduced by traditional accounting: first example

Many authors have demonstrated the weakness of the traditional accounting system in manufacturing operations (Zuk *et al.*, 1990; Greenwood and Reeve, 1992; Cooper and Kaplan, 1998; Adler *et al.*, 2000; Brimson, 2007).

The SME analysed in the case study has been using traditional accounting since the 1990s. Computations are based on a complex hardware and software system installed in a dedicated UNIX server and upgraded to Euro currency in 2000.

This first example shows in a simple way how improvements achieved by lean in some cases can lead to aberrations in cost of product calculations. Two working lines, A and B, dedicated to two different families of products, work as cost centres. The cost of a lot of products (about the same amount and demand in a week) from both lines is calculated according to Table I.

Cost centre A	Cost centre B
Cost of semi-finished products and raw materials = €30	Cost of semi-finished products and raw materials = €28
Cost of direct workforce = €160	Cost of direct workforce = €120
Plants amortisation = €10	Plants amortisation = €12
Overhead share = (amount of indirect costs of the period*direct workforce time in the centre)/total amount of direct workforce = (€560*16 h)/28 h = €320	Overhead share = (amount of indirect costs of the period*direct workforce time in the centre)/Total amount of direct workforce = (€560*12 h)/28 h = €240
Total cost of lot A = €520	Total cost lot of lot B = €400

Table I.
Cost of a lot using traditional accounting

The cost of semi-finished products and raw materials are directly taken from the supplier invoices. The cost of the direct workforce is the number of hours dedicated to the production of the products (A or B) multiplied by the hourly cost estimated to be around €10. For each product there are two direct operators involved: 16 hours in centre A and 12 hours in centre B. Amortisations of the plants are related to one week's work, the time consumed for producing the lot. The overhead of the period (one week) or indirect costs are allocated by the direct workforce time and include marketing, design and development, accounting, IT, supply chain management, quality management, shipping and warehouse management and post-sales.

Apparently, the lot of product A is more expensive because it requires more direct workforce and consequently absorbs higher indirect costs. Moreover, the industrial accountant of the company highlighted that the families of products A and B had been designed ten years earlier with similar design costs, that marketing did not require any particular efforts such as fairs, promotions and so on for either of the two products, and that quality performances in terms of reworks and wastes were very close. The conclusions could be that the calculations in Table I are realistic because indirect costs seem to subdivide to the same extent on the processes concerning the two families of products A.

Later, a Kaizen event took place in order to cut down transportation costs. Kaizen activity (Brunet and New, 2003) is based on worker participation in small group in order to reduce wastes and improve processes. Distinctive features of a Kaizen event are execution rapidity as well as intervention rapidity when a problem arises (Manos, 2007). The Kaizen event was successful and the cost of transportation, which is a part of the €560 of indirect costs of the period, was cut back by about €10. The €10 reduction was not equally distributed between the lines: line A gained €9 of transportation cost saving whereas line B gained €1. Indeed line B was affected by fewer transportations than line A. Looking at the calculations in the penultimate row of Table I and considering that the total amount of direct workforce is the same (28 hours), the €10 saving was equally distributed. In this way the cost of products would be wrong and products of line B benefit by improvements as much as products of line A. The industrial accountant took note of the situation and stated that he would make the costs of the conveyors direct in relation to cost centres.

As can be seen in the next section ABC considers all direct costs in respect to the activities of the processes.

Wrong decision made by traditional accounting: a second example

This second example shows more clearly how traditional accounting can introduce distortions in the results and consequently in decisions related to lean improvement projects. In this second case, the company, at the beginning, analysed a process using VSM. Figure 1 shows the results of this analysis. The flow starts with a first activity in which a 250-product lot is prepared taking 2 minutes per product. Then the lot is moved onto a first-in-first-out conveyor towards a second activity, a visual inspection, and so on. The triangle in the middle of the map is the inventory symbol. This means that products are stored in a warehouse between visual inspections and welding. This is due to the fact that welding is dedicated to several part-numbers, and consequently there is usually a delay before the 250-product is processed.

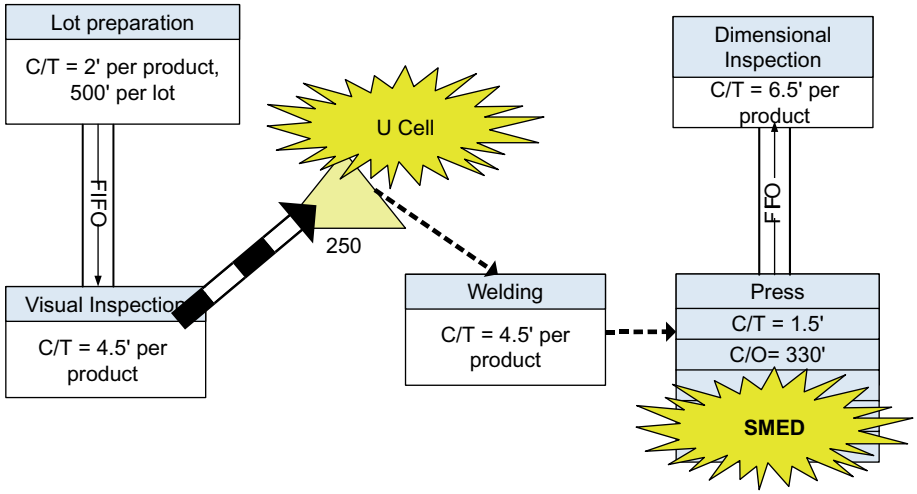

Figure 1.
VSM before the Kaizen event (as-is)

The first-in-first-out conveyor constitutes an inventory as well. Indeed the visual inspection activity is slower than the earlier one. The press uses 1.5 minutes for each product but the C/O lasts about 330 minutes. The map in Figure 1 is called VSM "as-is" because it depicts the initial situation before the improvements. The "clouds" represent possible Kaizen events for improving the situation. In this case, a U-cell design and a single minute of exchange of die (SMED) could help the company to reduce the lot size. The operator places him or herself inside a "U" so that everything can be reached and the operator works one piece at a time, reducing lot size (Monden, 1998). SMED reduces the set-up time or C/O that allows further reduction in lot size. Figure 2 shows the VSM "future-state" or how the process should be at the end of Kaizen events. The lot size decreases from 250 to 25 and the welding machine is now entirely dedicated to the product, consequently there is no more WIP before welding.

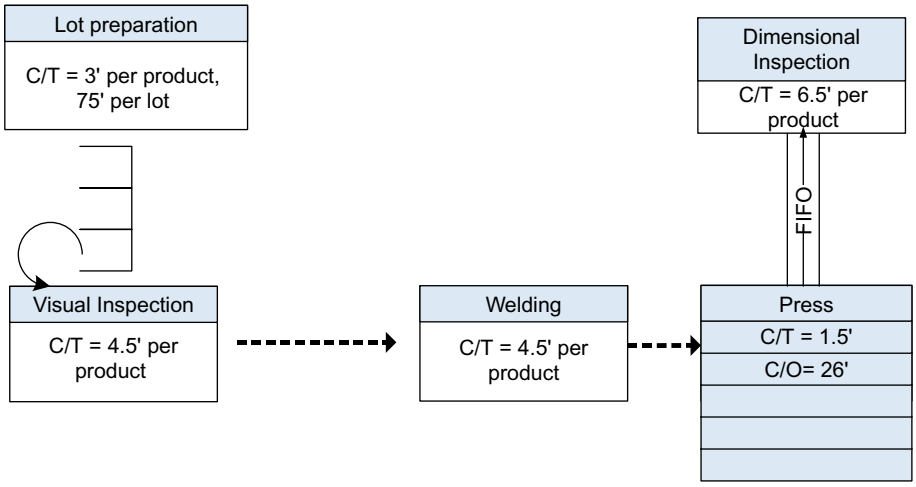

Figure 2.
VSM after the Kaizen event (future-state)

A so-called "supermarket" (Monden, 1998) can be noticed; it reduces WIP between lot preparation and visual inspection activities. Indeed inside the supermarket the operator can load up to 75 products (three lots of 25 each). The conveyor could instead store up to 1,500 products.

Figure 3 shows the improvements obtained after a change in the layout by means of "U"-shaped cell and the SMED application on the press. Operators involved in the cell are the same five of the earlier situation.

Some activities with no added value, highlighted in grey, have been eliminated; set-up times of the press have been drastically reduced from 330 to 26 minutes, but the time for the preparation of the lots has been increased by 1 minute for every single product.

Activities Worksheet

Area: Plant 1								Part number: T147							
Process: T147 cells								Kaizen Team: n°23 (Continuous improvement)							
Before (date):								After (date):							
Work	Movement	Transport	Waiting	Inspection	Activity	Time	Distance	Work	Movement	Transport	Waiting	Inspection	Activity	Time	Distannce
○	◎	●	▼	◈	Movement towards preparation	2'	30	○	◎	●	▼	◈	Movement towards preparation	2'	30
○	◎	●	▼	◈	Lot preparation	2'[a]		○	◎	●	▼	◈	Lot preparation	3'[a]	
○	◎	●	▼	◈	Visual Inspection	4.5'[a]		○	◎	●	▼	◈	Visual Inspection	4.5[a]	
○	◎	●	▼	◈	Movement towards buffer	3'	15	○	◎	●	▼	◈	Welding	4.5[a]	
○	◎	●	▼	◈	Movement from buffer to welding	2'	15	○	◎	●	▼	◈	Press Set-up	26'	
○	◎	●	▼	◈	Welding	4.5[a]		○	◎	●	▼	◈	Press	1.5[a]	
○	◎	●	▼	◈	Movement towards press	2'	10	○	◎	●	▼	◈	Dimensional Inspection	6.5[a]	
○	◎	●	▼	◈	Press Set-up	330'		○	◎	●	▼	◈			
○	◎	●	▼	◈	Press	1.5[a]		○	◎	●	▼	◈			
○	◎	●	▼	◈	Dimensional Inspection	6.5[a]		○	◎	●	▼	◈			
* average time per product															

Figure 3.
Activity analysis worksheet

Note: [a] average time per product

The results achieved through the Kaizen events were analysed by the means of the report in Table II. The calculation logic is the same as that used in Table I.

The report showed that, despite the efforts made by a team of six people for more than one week, the costs for the product had increased; an utter failure. Certainly, the sum of all C/Ts had increased by 1 minute and, consequently, the cost for active workforce had increased from €3.8 to €4, but where was the achieved reduction of set-up times highlighted? And the reduction of inventories and space used by the cell? As already repeated several times, the traditional accounting system is based on the division of the melting pot of indirect costs by means of proportional parts of direct workforce. In the firm mentioned in the example, set-up activities are dealt with by a group of employees who are not considered direct (not directly connected to the C/T). Even after the Kaizen activity, their salary was obviously included in the indirect costs and there was no way to highlight the advantages derived by reducing their time dedicated to the set-ups by 304 minutes. The calculations were checked a second time and redone using ABC systems (Table III).

The calculations are entirely made using the ABC system. First of all the company has been divided into processes: marketing, design and development, accounting and IT and so on until production. Some authors (Johnson and Kaplan, 1987; Tornberg *et al.*, 2002) argued that modelling the organisation into processes is fundamental.

Each process should be divided into activities; for instance marketing process is divided into activities such as "offers" and "order entry". For each activity ABC needs a

Before Kaizen workshop	After Kaizen workshop
Unit cost of the semi-finished product = €35	Unit cost of the semi-finished product = €35
Cost of direct workforce (minutes of working*cost of the workforce) = 19*0.2 = 3.8	Cost of direct workforce (minutes of working*cost of the workforce) = 20*0.2 = €4
Overhead share (amount of indirect costs of the period*direct workforce time in the centre)/total amount of direct workforce = €18.02	Overhead share (amount of indirect costs of the period*direct workforce time in the centre)/total amount of direct workforce = €18.03
Plants amortisation share = €2.07	Plants amortisation share = €2.07
Total cost of the product = 57.94	Total cost of the product = 58.01

Table II. Calculation based on traditional accounting system before and after Kaizen event

Id	Before workshop	After workshop
1	Unit cost of the semi-finished products (invoice) = 35	Unit cost of the semi-finished products (invoice) = 35
2	Cost of marketing process = 0.20	Cost of marketing process = 0.20
3	Cost of design and development process = 2.10	Cost of design and development process = 2.10
4	Cost of accounting and IT process = 2.62	Cost of accounting and IT process = 2.62
5	Cost of supply chain management = 3.65	Cost of supply chain management = 3.65
6	Cost of quality management = 0.10	Cost of quality management = 0.10
7	Cost of shipping and warehouse management = 0.90	Cost of shipping and warehouse management = 0.90
8	Cost of service and post-sales process = 5.10	Cost of service and post-sales process = 5.10
9	Cost of the cell = 3.67	Cost of the cell = 3.57
10	Plant amortisation share = €2.07	Plant amortisation share = €2.07
	Total cost of the product = €55.41	Total cost of the product = €55.31

Table III. Recalculation of the cost product using ABC before and after the workshop

cost driver; for offers, for example, this is "number of offers". Lastly the cost of the activity in the period is the multiplication of the cost driver by the number of offers made.

The revised results are shown in Table IV. The unit cost of products decreases by €10 cents after the Kaizen event has been applied to the cell. Apart from the unit cost of semi-finished goods, an invoice coming from a supplier, and plant amortisations, each process has been divided among the activities that concern the product, and the driver has been determined with its cost. By splitting the "cell cost" line that is highlighted in grey, the accounting reasoning that led to the demonstration of the €10 cents saving can be analysed in detail. In addition, Table IV highlights the improvements determined by the Kaizen team in terms of elimination of activities with no added value (Senge, 2006).

The highlighted lines in the last column of Table IV, named "cost of the lot (after)", represent the activities that have been eliminated after the event, that are at zero cost. For example, the second line named "lot preparation" presents the minutes of labour as drivers. Consequently, the unit value of 1 minute of labour (€0.25) in the third column is multiplied by the 500 minutes that are required to prepare the lot (Figure 1). Because the activities of the cell were linked to the lots, the industrial accountant had to calculate the costs related to the lots in order to eventually obtain, in the final line, the product's unitary cost by dividing by the number of products of the lot: first 250, then 25. The ABC in Table IV shows precisely the benefits obtained both through the elimination of activities with little or no added value and through the reduction of set-up time of the press.

Value stream activities (highlighted in grey the eliminated activities)	Cost driver	Cost of the lot (before)	Cost of the lot (after)
Movement towards preparation	No. of handled lots	0.25 (× 1) = 0.25	0.25 (× 1) = 0.25
Lot preparation	No. of prepared products	0.25 (× 500) = 125	0.25 (× 75) = 18.75
Visual inspection	No. of inspected products	0.6 (× 250) = 150	0.6 (× 25) = 15
Movement towards buffer	No. of manual movements	0.1 (× 250) = 25	0
Movement from buffer to welding	No. of manual movements	0.2 (× 250) = 50	0
Welding	No. of welded products	0.6 (× 250) = 150	0.6 (× 25) = 15
Movement towards press	No. of handled lots	0.30 (× 1) = 0.30	0
Press set-up	Workforce minutes	0.2 (× 330) = 66	0.2 (× 26) = 5,2
Press	No. of pressed products	0.8 (× 250) = 200	0.8 (× 25) = 20
Dimensional inspection	No. of inspected products	0.6 (× 250) = 150	0.6 (× 25) = 15
		Cost of the lot = 916.55 unit cost of the product = 3.67	Cost of the lot = 89.2 unit cost of the product = 3.57

Table IV.
Details of the costs within the cell using ABC

Analysis and discussion about the possibility of implementing value stream accounting

Value stream accounting inherits ABC principles in that it does not distinguish between direct and indirect costs. All costs are direct in relation to the value stream, as much as in ABC all costs become direct in relation to the processes that influence the realisation of the product/service (Maskell and Baggaley, 2000). However, whereas in ABC it is necessary to divide the processes into activities, determine activity drivers and the unitary driver cost in order to eventually add up all the costs of process activities, value stream accounting implies a further simplification in the calculation. ABC has received some criticism concerning difficulties in its implementation (Gosselin, 2006; Kaplan and Anderson, 2007) and this was the reason why the company decided to compare it with value stream accounting. The company after managing the second example noticed that it had to do a huge process analysis, finding activities, their drivers and above all introduce widespread electronic data gathering. For instance an ABC system should automatically register each transportation of the conveyors in order to calculate this activity cost. This is not impossible but for the company it entailed a big change-over from the hardware system dedicated to the traditional accounting.

The first issue to consider when analysing value stream accounting as a possible alternative to ABC is value stream organisation. Maskell and Baggaley (2000) dealt with the subject claiming that first of all the organisation should be based on specific value streams. According to Maskell and Baggaley (2003, p. 142, part II), in large companies costs and expenses associated with non-stream value activities should not be allocated to the value stream because: "non-value stream costs are inevitably small because most of the work of the organisation will be associated with value streams".

However, because of their nature SMEs are sometimes not able to dedicate staff to a single value stream or product family, and consequently non-value stream costs might be not so small. This is especially so for the sales force, designers and supply chain managers (Siqueira and Cosh, 2008), and they are inevitably dedicated to several value streams, as in this case study. Indeed, going over Table III the industrial accountant immediately understood that processes and staff from row 2 to 8 were dedicated to at least four value streams at the same time. Only the cell in the ninth row was entirely dedicated to a unique value stream along with the cost of semi-finished products in row 1. The industrial accountant tried to sort out the problem by allocating the costs dedicated to processes from row 2 to 8 to the four value streams using methods different from ABC drivers. But this allocation should have been made using formulas derived from traditional accounting, introducing up to 17 per cent of difference from the ABC calculations. In addition, it was even difficult to dedicate the cost of the machines in the tenth row to a single value stream. Indeed it is not easy to transfer and dedicate big machines called "monumental" systems, such as presses and ovens, to a single value stream.

Table V shows the ratio between value stream costs and non-value stream costs within Table III.

It is clear how non-value stream costs are not so irrelevant with respect to value stream costs. Finally the analysis and discussion above demonstrate that in this SME non-value stream costs are not so small.

Another consideration, quality costs, was presented more clearly for analysis in Table III. At the beginning of the lean journey, defectiveness is usually high

(Monden and Hamada, 1991; Monden and Lee, 1993). Consequently, costs related to quality such as quality inspections, laboratories, reworks, scraps and so on can be relevant (Johnson, 2006) and, as in this case study, increase non-value costs. In the same way, wastes such as inventories, motion and transportation affect the cost of shipping and warehouse management, and once more they were not in the value stream. These aspects have been discussed by several authors (Maskell, 2000; Maskell and Kennedy, 2007; Huntzinger, 2007; Kennedy and Widener, 2008) who claimed that such value stream external costs should be as low as possible.

Furthermore, SME flexibility sometimes leads to the production of a few unique products that are very personalised and difficult to classify in the existing product families. This is for instance the situation in this case study. However, according to Huntzinger (2007, p. 253): "only the cost for the product family, value stream product, or component family should be tracked in value stream accounting".

Therefore, implementing value stream accounting in this SME and similar, it would be impossible to calculate the cost of such external products.

Summarising the above analysis, this case study shows that:

- Staff must be allocated to the value stream as much as possible otherwise it is necessary to divide staff costs among different value streams and/or processes, as happens in ABC accounting, to the detriment of accounting simplicity; indeed only the staff inside the cell in the ninth row of Table III was entirely dedicated to value stream.
- In connection to the previous point, the value stream organisation obviously has to be extended to design and development, marketing, accounting and IT, supply chain management, quality management, shipping and warehouse management processes, with staff dedicated to the product-codes of the value stream. There must therefore be designers, sale managers, buyers and so on dedicated only to the products of the value stream, and not the classical marketing managers divided by geographical areas, designers dedicated to several products and other particular organisational situations.
- Inventories included in the value stream have to be low otherwise it becomes necessary to turn to the calculation of their handling.
- There must be no so-called "monumental" systems such as presses, ovens, big processing machines that serve more codes otherwise it becomes necessary to calculate the amortisation share.

Table V.
Reclassification of the costs in Table IV by non-value stream and value stream

Before workshop	After workshop
Value stream costs (sum of the rows nos 1 and 9)	Value stream costs (sum of the rows nos 1 and 9)
35 + 3.67 = 38.67	35 + 3.57 = 38.57
Non-value stream costs (sum of the rows nos 2, 3, 4, 5, 6, 7, 8, 10)	Non-value stream costs (sum of the rows nos 2, 3, 4, 5, 6, 7, 8, 10)
0.20 + 2.10 + 2.62 + 3.65 +	0.20 + 2.10 + 2.62 + 3.65 + 0.10 +
0.10 + 0.90 + 5.10 + 2.07 = 16.74	0.90 + 5.10 + 2.07 = 16.74
Ratio value stream costs/non-value stream costs	Ratio value stream costs/non-value stream costs
38.67/16.74 = 2.31	38.57/16.74 = 2.30
Total cost of the product = €55.41	Total cost of the product = €55.31

- Costs related to quality (quality management, quality inspection, laboratories, etc.) have to be low and the processes have to be kept under control, that is with low defectiveness, otherwise it becomes necessary to calculate the amounts of quality costs, including cost of poor quality.
- All the products should be divided into value streams including very personalised and/or unique products.

Taking into account all the limits discussed above, this SME considered value stream accounting a specific system for firms whose processes are already stabilised by lean improvements, and with an organisation that is strongly aimed at the value stream. Too many approximations would have given wrong product cost calculations. Consequently, ABC has been judged the best accounting system even if about half a million euros has been spent on process analysis, identification of cost-drivers, servers, PCs, personal digital assistants, software, data-warehouses and many other IT tools. This strong automation that uses IT processes has led to more red tape; people are supposed to fill in screens for every transaction inside a process with little slowing down of the work. However, for senior managers and the industrial accountant once this situation becomes a habit no one will grumble about it.

Conclusions

The SME analysed by the means of these three examples has clearly shown that:

- Traditional accounting can lead to mistakes in cost of product calculations because of the process of overhead sharing based on direct workforce time. In the second example even a Kaizen event risked being rejected.
- ABC seems to work well with lean organisations because an accountant can immediately understand all the impacts of Kaizen activities on product costs. The second example shows how ABC reveals the improvement carried out by a Kaizen team.
- ABC is not as easy to implement as other accounting systems. Automation and software are supposed to be implemented pervasively.
- Value stream accounting requires that all the costs become direct in relation to the value streams. When this condition is verified then value stream accounting becomes accurate and extremely simple in its calculations. However, the third example shows how this is not always possible in this SME.

Discussion of value stream accounting in the case study has revealed that its accuracy depends, first of all, on the maturity of implementation of lean tools. Normally, when a company starts implementing lean, wastes such as defectiveness, transportations and inventories are relevant and affect activities that cannot be easily transformed into direct costs for the value streams. However, even when lean is well-implemented and wastes reduced there are other issues that cannot be overcome. Value stream has to be extended to the design of product and process, marketing, quality, purchases, shipping and so on. In this SME, however, it is practically impossible to find staff and machines entirely dedicated to a single value stream.

Last, but not least, all the products should be classified into value streams. However, this SME, along with many others, manages a small quantity of very personalised products that cannot be included in any existing value streams.

ABC was the best accounting system for the SME and value stream accounting was not considered such a breakthrough. However, the price that has to be paid with ABC is a huge implementation of IT throughout the company with the consequence of more red tape.

Agenda for future research

The results of this paper point to interesting future directions of research. First, academics should investigate and define what exactly is lean accounting. There are few academic papers on lean accounting (Maskell, 2000; Kennedy and Huntzinger, 2005; Johnson, 2006; Kennedy and Widener, 2008) and the relationship between lean accounting and value stream accounting is unclear. Is it really based on value stream organisation or can it be implemented using techniques derived from ABC? This SME case study proves, for instance, that lean accounting based solely on value streams is not suitable for companies in the early stages of lean production implementation with staff who are not entirely dedicated to a value stream because of the size and non-repetitive production. Is this finding due to the particular conditions of the case study or can it be generalised? Practitioners, in this way, could carry out similar case studies and academic researchers could investigate using surveys and quantitative research. Lastly, practitioners and academics should investigate the difficulties in implementing ABC within SMEs. The huge requirement to invest in IT within processes, and the consequence of more red tape, could become antithetical to the concept of lean and ultimately a new source of waste.

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