Application of Lean Accounting for production costs management in lean enterprises: a case study in an auto parts company

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ABSTRACT

The main purpose of this study is to analyse and to compare how the lean manufacturing changes, applied in the production system, are reflected in company´s financial reports. This case study practically compares the traditional accounting reports with the ones purposed by the Lean Accounting (LA) methodology version. The motivation of this case study started with the statement of unit managers of a Lean Manufacturing (LM) company, here called "lean enterprise". They said that one of the greatest challenges, after the modifications in the production system, is the financial demonstration in costs reports. After change the production system from "push" to "pull", the main structure for a cost per unit calculation and fix cost "dilution" are ruined. There is no mass production anymore, "the more, the better" philosophy does not lasts and the encountered results corroborate with the literature in regarding of the need of adapting the cost controlling system in Lean Enterprises.

Keywords: Lean Accounting, value stream costing, cost management.

1 INTRODUCTION

In the latest decades, many companies have been migrate its production system from mass production to the Lean Manufacturing System (Kennedy *et* Widener, 2008).

After adhering to the just-in-time philosophy and implementing lean changes, that dramatically reduce waste and minimize inventory levels, managers have been facing a new challenge: how to

demonstrate financially all earnings and savings generated by the Lean Manufacturing. (Haskin, 2010, Árbulo-López *et* Fortuny-Santos, 2010, Maskell *et al.*, 2011).

From this challenge arises a necessity of interaction between manufacturing and controlling sector. This synergy has been named Lean Accounting (LA) and one of its purposes is to translate the data from shop floor into financial reports that will support business decisions (Slavov *et al.*, 2013).

The aim of this study is to demonstrate if a lean enterprise can keep using the traditional costing method to evaluate its production costs results. Can this traditional model, a system that seeks the lowest unit cost by the dissolution of the fix costs into the highest possible production quantity, still demonstrate the performance of an one-piece-flow oriented system?

2 LITERATURE REVIEW

2.1 ACCOUNTING ROLES IN PRODUCTION SYSTEMS

Since the beginning, the accountancy activity has been evolved to different levels during the history of economics. Going not so far back, before the Industrial Revolution (XVII century), the Accountability was mainly financial, structured to serve the mercantilist and reporting basically the stocks variations and the results of buying and reselling goods. After the Industrial Revolution, the management accounting enhanced its importance in front of the financial accounting and has become more notable and complex, especially regarding the valuation of manufactured inventories and for costs and profits measuring (Martins, 2003).

Padoveze (2010) clarifies that only in the 1960´s, however, the focus of Accounting went from financial to a management level, contributing with information for decision making and providing support for planning, administration and corporate strategy.

In the 1980´s, more than generate information, Accounting started to identify waste, analyze processes and finally, in the middle 1990´s, the first references of added value for customers and shareholders were created.

Atkinson *et al.* (2011) reinforce the importance of the management accounting information and its relevance as source for decision making, improvement and control in organizations.

The responsibility of price definition and market valuation belongs to the Accounting (Lere, 1980), some authors claim that Accounting should be able to suit the needs of different production systems in order to serve their administrators better (Haskin, 2010, Granlund, 2001, Lere, 2001).

The fact is that many authors are converging and agreeing that the Accounting must be adapted and evolve within innovations in production systems (Souza *et al.*, 2003), thus, collaborating with administration and management of production and not imposing paradigms or obstacles.

2.2 COSTING METHODS AND LEAN ACCOUNTING

Regarding the function of Accounting as a managerial tool for supporting business decisions, one relevant debate follows regarding which costing method should be considered more appropriated to each production system (Charles *et* Hansen,2008; Lere, 2001; Pong *et* Mitchel, 2006). While some authors question the real need of a product cost-per-unit (Kaplan et Cooper, 1991), others demonstrate that cost-per-unit is still one of the most important methods for pricing, being widely used by industries (Noble *et* Gruca, 1999, Charles *et* Hansen, 2008).

Cost-per-unit or unit cost is the result of the Absorption Costing Method.

The Absorption Costing is still the most acknowledged by tax authority for balance and income statement (Martins, 2003).

This method, however, was and still is very criticized, mainly because of the apportioning rule, which aims that, somehow, all company´s costs must be inserted into the product cost. This method is assertive to ensure that all costs will be allocated in the company (Meade et al., 2008), but does not produce a clear picture of which costs really belong to the product , what are indirect costs and lost its managerial value when combined with other cost drivers (Vercio, 2008).

Seeking the breaking-even point, the Absorption method indicates the “best cost” as a result from the maximum possible production quantity. The fix costs are “diluted” into the produced quantity, so the higher is the produced volume, the lower is the cost-per-unit. On the other hand, this effect leads to an overproduction and, therefore, induces to inventories increase, what can compromise company´s cash flow (Womack *et al.,* 1992).

This concept must be highlighted as the basis for our case study, since, taking into account that Toyota´s just-in-time system has been seek and copied by many manufactures and one of the main changes is the review of batch sizes and lower inventory levels, it must be understood how the standard cost-per-unit, calculated by Absorption model, behaves in front of this new context.

Advancing with costing methods, other widespread models must be enounced:

- Variable Costing or Direct Costing: this method avoids the arbitrariness of apportionment encountered in the Absorption mode. It considers only the variable cost in the cost unit. The fix costs are allocated as expenses in the company´s final income statement result (Martins, 2003c). Nevertheless, this mode is also not free of criticism. Some authors call the attention to the fact that, in this method, the costs of installed capacity (fix), treated as “unavoidable”, are ignored, what can overestimate products with low profitability (Gietzmann *et* Monahan, 1996).
- Activity Based Costing - ABC: contrary to Absorption, this method split the fix costs and overheads up, allocating them to their real originator batch or product. In other words, each usage of resources is measured and appointed for each activity and the costs are appropriate to the

product only if it consumes the activity (Kaplan *et* Cooper, 1991; Andrade *et al.*,2008). This method has a similarity to this case study approach: the Value Stream Costing (VSC).

The VSC descends from the Lean Accounting (LA) concept.

Lean Accounting is a concept that preaches the adoption of the same assumptions of Toyota´s Production System in the Accounting area, as: creating value by eliminating waste, reducing lead time, material flow, improving quality, saving physical space, etc.

The Lean Accounting term emerged in the late 1990s and started from the observation that the benefits gained with lean implementations were not positively expressed in traditional financial reports. That occurs basically because of the traditional product costing method: Absorption. As mentioned, it was designed to meet the needs of mass production and is not suitable for measuring the cost behavior in the Lean system. (Haskin, 2010, Maskell *et al.*, 2011).

The costing method proposed by LA is called Value Stream Costing, which is the obtained result after the lean enterprise pass through its maturity path. Here, this will be analyzed after two milestones: Value Stream Mapping (VSM), as proposed by Rother *et* Shook (1999), and lean cell implementation.

According to Maskell *et al.* (2011), one of the premises of the VSC is that, in the lean system, the product cost-per-unit is not necessary. This unit cost is irrelevant, once the managerial and financial decision of a sale should be evaluated taking into consideration the added value for the customer, the manufacturing capacity and company's market driver. So, having the production chain available capacity to manufacture the products and the business adds value for the customer or market, the unit cost alone is not the imperative for the decision anymore, but the value stream profit is.

3 RESEARCH METHODOLOGY

This case study was developed in a subsidiary of a large multinational European company from the auto parts industry. The company has 170 plants in 49 countries and has approximately 80,000 employees. The Brazilian subsidiary is located in State of São Paulo, Brazil, counts with approximately 4,000 employees and has, for over 20 years, a strong lean program, leaded by the head office. They are strongly focused on the lean philosophy implementation.

This empirical research used information from free interviews and project data collection.

By the first interview, done 18 months after the lean cell implementation, the Unit manager affirms that most of lean manufacturing projects are non-viable economically. He declares that is widely known at the managerial level that the changes on the production cells "always enhances the product cost". This manager has 27 years in the area, there of 10 years in leader position. He approves and indicates all efforts to the lean development; nevertheless, he reinforces many times the conflict between manufacturing and controlling area when the monthly cost report is distributed.

The second interview was leaded 2 weeks after the first one, Lean Office Chief and Manager attended the meeting. They explained that lean projects are normally evaluated by other indexes than financial, as: WIP rates (Work in Process), Lead Time, handling distances, square meter area, cycle time and OEE. They also agreed that the improvements in these factors are barely translated in the costs and financial reports.

Based on that, this case study will draft comparative tables to measure the deviations between the traditional accounting reports and the figures encountered after lean cell implementation.

4 PROJECT, COSTS AND REPORTS

In the year of 201Y, the lean office proposed a Value Stream Mapping Project for the "Product XX" as per Rother *et* Shook (1999) method. A project team was selected and they track and design the Value Stream Map of "Product Line XX", this work team has identified an potential performance improvement by making some machine layout modifications.

After data collection and workflow analysis, the team presented to the board of directors the following Table 1, contending a data simulation for a line with a different layout and a new mode of operation for the employees.

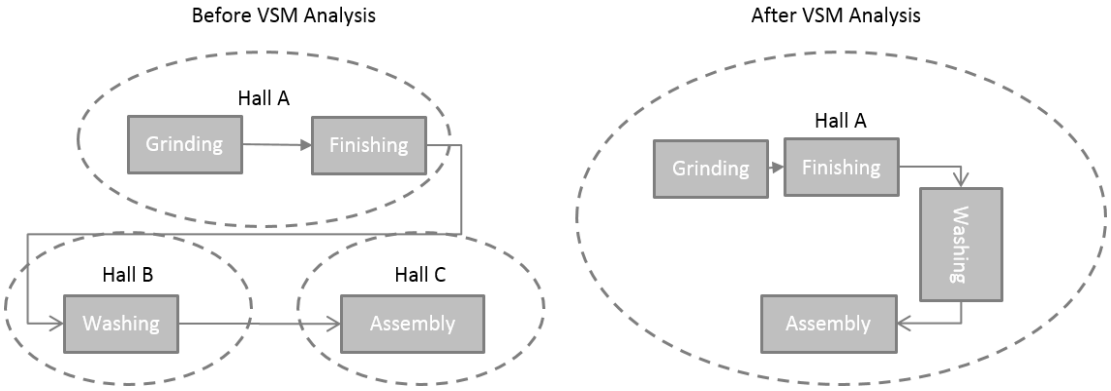
Table 1. Simulated indicators for VSM with layout modification

Indicator		**Current VSM**	**Simulated VSM**	**Δ**
WIP	[pcs]	16.000	5.246	-67%
Lead Time	[days]	1,6	1	-38%
Handling	[m]	2500	55	-98%
Employees		18	10	-44%
Area	[m^2]	213	180	-15%
OEE	[%]	68	80	18%

Source: Compiled from Project Report "Lean Cell XX Implementation"

The directors were convinced that the changes in the shop floor would improve considerably the material flow, product planning, quality and lead-time. In figure 1, it is demonstrate the modification plan, which was, by the end, approved and implemented.

Figure 1. Machinery layout. Single to cell.



Source: The authors own.

Seeing in Table 2, by applying the new concept, many performance indicators have been improved. A cycle time reduction was achieved substituting an upgraded grinding tool in the bottleneck machine.

The handling distance between the machines almost does not exist anymore and the logistic labor to transport the components from one station to another has been practically eliminated. This modification has also influenced, associated to the WIP reduction, the savings in used area.

Due to this new layout, 8 (eight) employees were released to work at other sectors that were in lack of manpower. The company´s policy is not to dismiss any employee, but avoid new hires.

Table 2. Comparative between push (before) and lean concept (after)

Indicators		**Before**				**After**	
		Grinding	**Finishing**	**Washing**	**Assembly**	**Cell XX**	**Δ**
Component	[min/pc]	0,180	0,160	0,160	-	0,168	-16%
Component B	[min/pc]	0,120	0,120	0,007	-		
Final Product	[min/pc]	0,000	0,000	0,000	0,180		
Concept	-	Individial Machines				Cell	-
Employees	-	18				10	-44%
WIP [1]	[pcs]	16.000				6.012	-62%
Batch Size	[pcs]	100.000				25.000	-75%
Lead Time [2]	[days]	1,6				0,8	-50%
Handling	[m]	2500				60	-98%
OEE [3]	[%]	68				76	12%
Area	[m^2]	213				180	-15%

Source: Compiled from Project Report "Lean Cell XX Implementation"

[1]WIP = ΣWIP ÷ Daily Customer Demand

[2]LeadTime = ΣQeueT + ΣSetupT + (Batch Size x ΣCycleT) + ΣWatingT + ΣHandlingT

[3]OEE= Availability x Performance Efficiency x Quality

Going forward with cost analysis, it is necessary to understand the cost per minute structure and how the company analyses its production costs results.

Table 3 shows all allocated costs for machinery and operation cost. Summing not only the production costs, but also all costs from support areas, sales and company´s overhead, the production unit

absorbs costs that are not related to its activity, again, because of the apportionment method. This total amount applied to the machine center cost will be divided by the total available minutes per month, or year, and the cost per minute will be created.

Table 3. Cost per Minute Structure and Operations Costs before Cell Implementation

Cost per Minute Structure	**Component A Grinding**	**Component A Finishing / Washing**	**Component B Grinding / Finishing / Washing**	**Components Assembly**
Customer Service	R$ 90,62	R$ 36,14	R$ 210,72	R$ 143,24
Purchasing	R$ 326,76	R$ 134,16	R$ 502,86	R$ 243,08
Production Cell	R$ 36.616,99	R$ 46.334,69	R$ 65.909,45	R$ 20.111,04
Cell reloading	R$ 2.941,62	R$ 2.157,30	R$ 2.922,54	R$ 1.629,23
Quality Assurance	R$ 3.969,47	R$ 3.046,01	R$ 3.494,02	R$ 2.345,26
Unit Administration	R$ 7.389,99	R$ 4.539,74	R$ 8.201,43	R$ 6.808,85
Accounting	R$ 55,46	R$ 53,88	R$ -	R$ -
Information Systems	R$ 90,62	R$ 9,74	R$ -	R$ 84,41
Design Engineering	R$ 2.227,25	R$ 1.709,11	R$ 1.960,48	R$ 1.315,92
Technical Support	R$ 7.249,21	R$ 1.041,83	R$ 8.914,12	R$ 205,02
Area	R$ 202,48	R$ 75,92	R$ 263,03	R$ 32.082,19
Overhead	R$ 1.972,67	R$ 783,36	R$ 2.617,69	R$ 2.607,39
Total Cost	**R$ 63.133,15**	**R$ 59.921,88**	**R$ 94.996,33**	**R$ 67.575,65**
Available Time [min/month]	28.762	37.710	33.988	41.662
Cost per minute	R$ 2,20	R$ 1,59	R$ 2,80	R$ 1,62
Setup [min]	300	200	400	70
Cycle Time [min]	0,180	0,160	0,120	0,180
Batch Size	100.000	100.000	100.000	100.000
Operation Cost per unit	**R$ 0,40**	**R$ 0,26**	**R$ 0,35**	**R$ 0,29**

Source: Compiled from Project Report “Lean Cell XX Implementation”

Before “Cell XX” creation, the total of process cost, given by the sum of all operations costs, was R$ 1,30. Here it was not considered neither raw material, nor process cost for previous operations, because those were not modified by the new concept. Maskell et al. (2011), denominate the process cost as conversion cost. The conversion cost encompasses the costs for all necessary operations to convert the raw material into finished product. In this case study, the process costs of operations that are not related to cell project were ignored.

Further, in Table 4, the conversion costs of new cell were calculated. As showed bellow, the total cost of cell is lower than the individual machines, the difference is explained by the employee reduction,

from 18 to 10. The cell concept allowed 1 employee operate more than one machine during the shift. The employees act circling the cell and operate multi tasks.

Table 4. Individual Machines and Cell Total Costs and Manufacturing Costs

Cost per Minute Structure	**Individual Machines**	**Cell**
Customer Service	R$ 480,72	R$ 480,72
Purchasing	R$ 1.206,86	R$ 1.206,86
Production Cell	R$ 168.972,18	R$ 151.325,95
Cell reloading	R$ 9.650,69	R$ 9.650,69
Quality Assurance	R$ 12.854,77	R$ 12.854,77
Unit Administration	R$ 26.940,01	R$ 26.940,01
Accounting	R$ 109,34	R$ 109,34
Information Systems	R$ 184,76	R$ 184,76
Design Engineering	R$ 7.212,76	R$ 7.212,76
Technical Support	R$ 17.410,19	R$ 17.410,19
Area	R$ 32.623,62	R$ 27.569,26
Overhead	R$ 7.981,11	R$ 7.981,11
Total Cost	**R$ 285.627,01**	**R$ 262.926,41**
Available Time [min/month]	see Table 2	32.832
Cost $_{\text{per minute}}$	see Table 2	R$ 8,008
Setup	see Table 2	400
Cycle Time	see Table 2	0,168
Batch Size	100.000	25.000
Process Cost $_{\text{per unit}}$	**R$ 1,30**	**R$ 1,474**

Source: Compiled from Project Report "Lean Cell XX Implementation"

Here it is important to highlight that, even with the cycle time reduction demonstrated in Table 2, the final calculated conversion cost per unit has increased. It was caused because of the batch size effect. Before the cell implementation, the batch size was 100.000 pieces. After value stream analysis the work team defined that the batch size should be reduced. The main reason for this reduction was that the lead time to process the whole lot was too long and, in the reality, the 100.000 pieces were never running together in the workflow. Very often, when a quality failure was identified in the middle of the process, the whole batch, that was not flowing sequentially, had to be inspected. Also, chasing the one-piece-flow of lean thinking premise, the team reduced 75% of the batch size, what generated the cost increase of R$ 0,474 / piece.

The batch size is direct related to the cost per unit. Equation 1 explains this relation:

$$Costperunit = \left(\left(\frac{SetupTime}{BatchSize} \right) + Cicletime \right) \times Costper\,\text{min}$$

According to Maskell *et al.* (2011), the average cost per unit would be R$ 2,856 / piece instead, in other words, R$ 285.627,01 divided by 100,000 produced pieces. Thus, a priori, some managers would

consider this cost unfeasible for the business. That is why the Lean Accounting affirms that this simplistic cost per unit analysis is a wrong view for cost management and should not to be used by lean enterprises.

Evidencing the literature, even when the total production cost has been reduced in 7,9%, the company has not use the cost per unit measurement to decide for cell implementation. Company knows this effect, but when the time goes by and many lean cells are implemented, the company loses its overview, because the financial reports became completely distorted.

Therefore, the claim for a different approach in cost reports for lean adopters is confirmed. The alternative for the cost view is necessary for the productive system evolution.

Table 5 will presents the results exhibited as the Lean Account suggestion for Financial demonstration and shows that, to enable the complete business management overview, sales revenue and inventory level must be included in the sentence.

Table 5. Financial Statement for Value Stream Mapping according to Lean Accounting

	Before Lean	After Lean	Improvement
Sales Revenue	R$ 1.158.750,00	R$ 1.158.750,00	R$ -
Conversion Costs	R$ 285.627,01	R$ 262.926,41	-R$ 22.700,60
Material Costs	R$ 627.000,00	R$ 627.000,00	R$ -
Value Stream Profit	**R$ 246.122,99**	**R$ 276.804,70**	**R$ -**
ROS	21%	23%	2%
Inventory	R$ 121.104,00	R$ 45.504,83	-R$ 75.599,17
Average Cost $_{\text{per Unit}}$[1]	**R$ 9,13**	**R$ 8,90**	**-R$ 0,23**

Source: The authors own

1 Average Cost per Unit = (Conversion Costs + Material Costs) ÷ 100,000 pcs (produced)

Table 5 clearly reflects the inventory reduction. The stocks variance were treated separately, differently from Table 6 that exposes the current company´s report with inventory variance carried into unit production credit and leads to a controversial impact: wondrously, the inventory increase affects positively the production costs performance.

Table 6. Current Financial Statement. Behavior of Inventory Variation
Source: The authors own

Inventory	Reduction	Increase
(=)Production Credit[1]	R$ 912.627,01	R$ 912.627,01
(±) Δ Inventory	-R$ 75.599,17	R$ 75.599,17
(=) Total Unit Credit[2]	R$ 837.027,83	R$ 988.226,18
(+)Processes Costs	R$ 285.627,01	R$ 285.628,01
(+) Material Costs	R$ 627.000,00	R$ 627.000,00
(=) Total Costs	**R$ 912.627,01**	**R$ 912.628,01**
(=) Production Cost Deviation	**-8,3%**	**8,3%**

1 Production Credit = Cost per unit x delivered quantity at Expedition
2 Unit Credit = Delivering Credit +/- change of stock

Hence, more than apply the lean method, the enterprise must be aware about the informational impact of the figures on its managers actions and decisions.

5 CONCLUSION

The analyzed figures combined with the unit management reports confirmed the literature proposition regarding the necessity of an accounting system adaptation. As support for management decisions and actions in lean enterprises, the Accounting must evolve to accompany the changes, not only on the shop floor, but also in company´s strategy.

Since this studied was realized in association with a private company, the access to information and staff was limited, not allowing the verification of the real raw material, selling price values and the apportionment rules. Company provided those values after multiply them by an unknown factor, not higher than 10%, for an approximate calculation. The authors consider that the results of the research were not jeopardize by this lack of information.

Nevertheless, seeking the evolution of the lean culture spread, it is suggested to other researchers to verify if companies that adopted lean manufacturing system are also encountering this kind of incompatibility in their accounting management, how those divergences are handled and if they are aware about the existence of Lean Accounting and Value Stream Costing as a management tool.

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