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## Developing a lean supply chain performance framework in a SME: a perspective based on the balanced scorecard

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### Abstract

To keep ahead of the completion, organizations look for continuous improvement in Supply Chain Management (SCM). Lean paradigm connected to SCM is a strategy based on cost and time reduction to improve the effectiveness. At the operational level, Lean Supply Chain (LSC) is focused on optimizing the processes of all supply chain, searching for simplification, reducing waste and reducing activities that do not add value. A well-defined lean supply chain measurement system increases the chance for success because it enables managers to see areas where supply chain performance can be improved, so they can focus their attention, and obtain higher levels of performance. There are a number of conceptual frameworks and discussions on supply chain performance measurements in the literature, however there is a lack of empirical analysis and case studies on performance metrics and measurements in the supply chain environment of Small and Medium Sized Enterprises (SMEs). This research aims to develop a conceptual framework for managing LSC, integrating both financial and non-financial performance dimensions and so it expands the existent knowledge and provides indication of how LSC performance can be assessed and improved in this and other kinds of organizations. The proposed framework has been implemented in a Portuguese SME operating in the food manufacturing sector. A case study was developed to better understand the suitability of this tool.

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**Keywords:** Supply Chain Management, Lean Supply Chain, Performance, Balanced Scorecard, Analytic Hierarchy Process;

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### 1. Introduction

For many organizations it became clear that evaluating their performance is fundamental in order to achieve an efficient and effective Supply Chain (SC). The lean principles, concepts, tools and techniques expanded throughout the entire SC due to its benefits such as cost reduction, improved quality and flexibility, and just-

in-time deliveries [1]. The added value for the customer and the waste elimination led to an increased importance for the Lean Supply Chain Performance (LSCP) to the different stakeholders. An important aspect of Performance Measurement Systems (PMS), in particular in LSC, refers to the minimization of measures to select in order to make the system effective, easy to use and to analyze [2].

Performance measurement of entities in a SC needs to be considered holistically, reflecting the importance of drivers of strategic future performance. Many methods have been suggested over the years for SCM evaluation of any organization. They comprise a mixture of measures, outcomes and performance drivers, however, it could be questioned whether the most basic issues that drive lean performance are identified. While the Balanced Scorecard (BSC) approach was not specifically designed for the LSC, it does give a good guidance for a company's core measures [3]. Although the link between BSC and SCM has been addressed in the literature [4] a better understanding is needed of how lean performance relates to strategic objectives.

## 2. Supply Chain Performance

Staying competitive in the global economy needs to move forward new management practices in areas such as marketing, design, engineering, manufacturing, finance, accounting and human resources. The challenge is to implement new management tools so that available resources are thoroughly utilized in the production of quality products and services, which in turn enhance organizational competitiveness [5].

The notion of "right supply chain strategy" cannot be generalized. There must be a perfect alignment between supply chain strategy and the characteristics of products or services. This implies a careful evaluation of the performance management system of the SC before it can be generalized to a given sector [6]. The composition of the Supply Chain Performance Measurement System (SCPMS) will be different according to the desired skills of the SC, which explains the importance of developing and improving the performance measurement of SC over time. The reason for the complexity of this procedure derives from the fact that the performance measurements depends on the context.

In particular, in the last decade, several authors attracted attention to the supply chain performance studies with measures of performance in different categories [5]:

- Balanced scorecard perspective.
- Components of performance measures.
- Location of measures in supply chain links.
- Decision making-levels.
- Nature of measures.
- Measurement base.
- Traditional vs. modern measures.

## 3. Lean Supply Chain Performance

The principles, tools and lean techniques have enabled organizations to become more competitive. The benefits of this application motivated managers in the expansion of lean philosophies to the entire SC, involving suppliers, distributors, producers, customers and other stakeholders in lean thinking.

Managers should use a combination of lean techniques throughout the SC in order to improve global performance. A crucial difference between a traditional model of SC and LSC is that the first model focuses on the activities that take raw materials and components through the production process and afterwards to the final customer in an economically fashion and without major complications. On the other hand the model of LSC main focus resides in obtaining value and eliminating waste that occurs along the chain.

Based on the literature, [2] there are three approaches for measuring the lean performance. The first one is based on measuring the degree of implementation of lean tools and techniques, e.g., the identification of the organization leanness degree. The second relates to the measurement of outputs resulting from lean implementation. In this context, dimensions such as cost, quality, delivery, flexibility and continuous improvement deserved special attention. The third approach is a combination of the other two.

The main features of a performance measurement system in a lean context have been classified as follows [8]:

- Supporting the company's strategy - particularly with respect to lead-time; being an important aspect of lean philosophy, its measurement must be easy and frequent.
- Comprising relatively few indicators - at every level of the organization, the number of measures should be small and focused on activities that will add value.
- Focusing on non-financial indicators - all stakeholders in the LSC should seek to eliminate waste and make the physical changes necessary, and this is measured in quantities and not in economic amounts.
- Motivating correct behaviour - in the process of developing the PMS, it is necessary to assess whether the metrics will not cause behaviour contrary to the expectations.
- Being simple and easy to understand - all players in the process should know how to be part of the solution.
- Measuring the process, not people.
- Measuring results against targets - set ambitious but achievable targets and measuring results.
- Avoiding to combine measures of different aspects in the same index.
- Establishing a defined periodicity.
- Showing trend lines - performance charts should show the results and trends for a longer period and not only the current results, that demonstrates continuous improvement.
- Visualizing - if it is worth measuring, it should be presented so that everyone can see what has improved and what needs to be improved.

#### **4. Balanced Scorecard**

This approach has been used extensively in developing a strategic plan that incorporates more realistic goals and initiatives for achieving the outlined goals [9].

The BSC enables managers to have a formalized mechanism that will achieve the balance between financial and nonfinancial results in the short and long term [3] and is also a means to evaluate the performance of an organization through four traditional perspectives: financial, internal business process, customer and learning and growth [9]. Following the identification process, the BSC is applied to these metrics with the intention of evaluating clearly the performance of SC. Each of these perspectives should be translated into corresponding metrics and measures that reflect the strategic objectives. These perspectives should be periodically reviewed and updated as necessary and may even be extended in number [10]. Measures included in the BSC should be monitored over time and integrated explicitly in the strategic processes of the SC [5]. In order to make the BSC a successful approach, organizations should articulate goals for time, quality, performance and services and finally translate these objectives into specific performance measures. It makes no sense for organizations to have only financial measures, but rather a combination of these with operational measures [4].

#### **5. Analytic Hierarchy Process**

The analytic hierarchy process (AHP) is a multi-criteria decision-making tool developed by Saaty [11]. AHP is a systematic procedure to represent elements of any problem in a hierarchical way. Since decision-making in the field of strategy formulation have a great deal of uncertainty associated, managers should be able to express some degree of confidence in their judgments. The hierarchy is structured from the top, usually the main objectives set by management, through the intermediate levels to the lowest level, usually the alternatives. These judgments are then translated into numbers. This method uses pair-wise comparison in the same hierarchy elements in each level using a scale indicating the importance of an element in relation to another. In the context of performance evaluation of SC, the AHP can be the best tool for prioritizing and selecting the best measure of performance in a given situation [12].

## 6. Methodology

This practical application was based on the literature review on SC performance, in particular in what concerns LSCP. In this sense, we identified 70 lean performance measures, taken from 37 articles and books [2], [3], [4], [8], [9], [10], [13]...[43].

Organizations face many challenges in measuring their supply chain performance. In this sense, there have been some attempts to compare metrics in a systematic way, integrating quantitative and qualitative measures and aligning supply chain strategy with the measurement of their performance. In an attempt to address these challenges we propose a framework with the following steps:

1. Strategic alignment.
2. Identification of lean performance measures.
3. Implementing the BSC.
4. Selection of lean performance measures.
5. Measuring process.
6. Assessment of results.
7. Identification of improvement opportunities.

### *Strategic alignment*

Definition of right goals and their alignment with strategy become central to the success of an organization (Fig.1). These objectives will also depend on the type of organization, their conditions and the business area in which it operates.

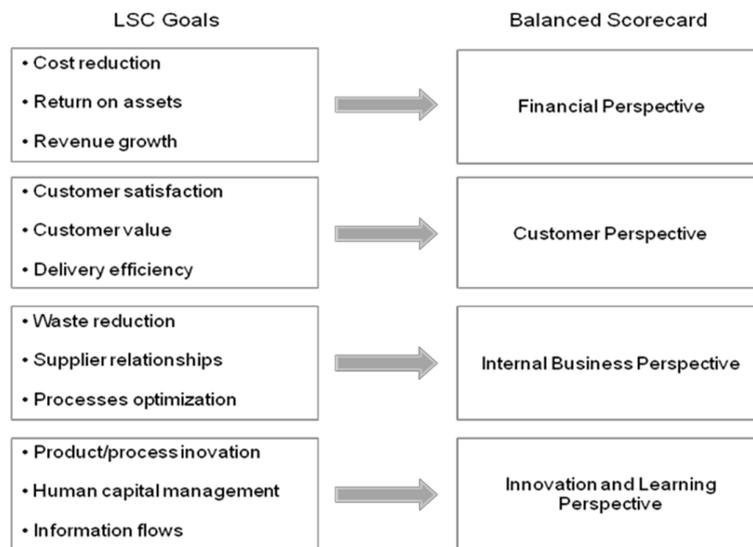


Fig. 1 - Alignment of the LSC goals with the BSC perspectives

### *Identification of lean performance*

The lean performance dimensions to be measured are identified based on the type of business organization and goals set. For the purpose of our study we select the lean performance indicators more referred in the literature. The goal is not to standardize these same indicators, since each organization should define the indicators that best suit their needs, but to help organizations in the identification process.

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*Implementing the BSC*

At this point, it is intended primarily to align the goals and indicators identified in the previous steps. Through the BSC, it is possible to translate the four perspectives, financial, customer, processes and learning and growth, into those indicators that reflect the goals to be achieved (Fig. 2). It is suggested that both the perspectives and respective indicators should be reviewed and updated periodically.

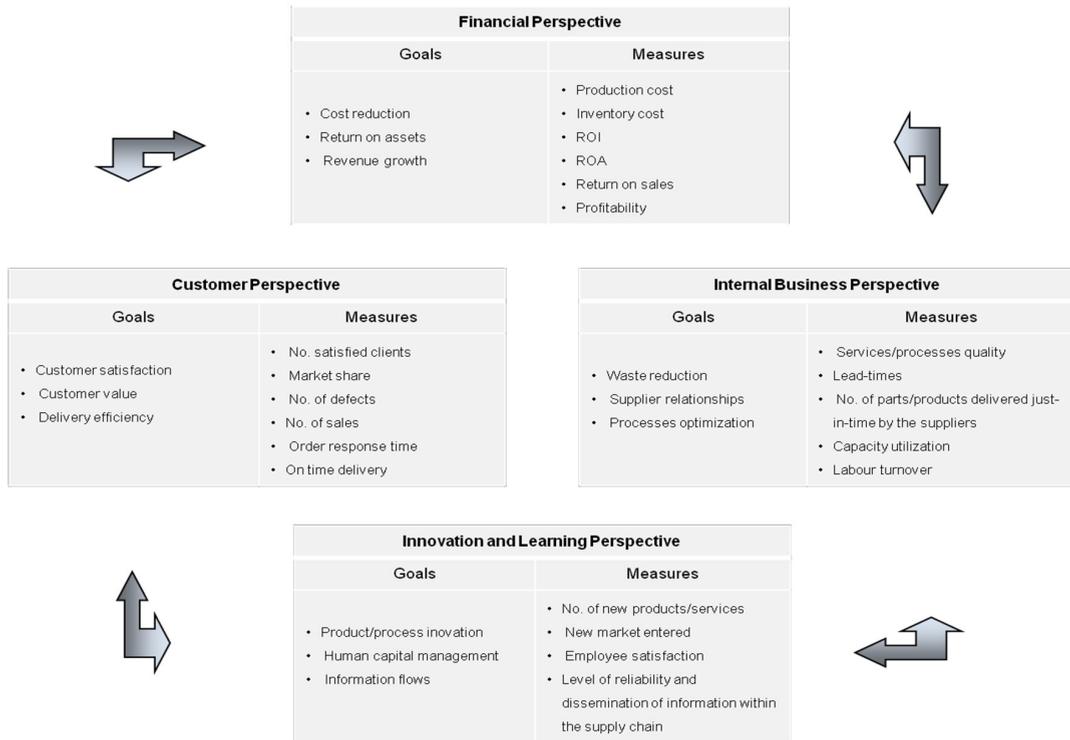


Fig. 2 - Application of the BSC for LSC measures

*Selection of lean performance measures*

At this stage, the most important indicators of performance measurement will be selected. The choice of indicators should follow the principle of minimizing the same for the measurement of performance to be effective, easy to use and analyze. This suggests that the process is conducted based on a system, Analytical Hierarchy Process (AHP). Determining the weight of each indicator will be instrumental in the assessment stage.

Initially, we define the most important indicators in each perspective of BSC. It should be noted that the method under discussion is not sealed differing depending on factors such as the type of organization, structure of the supply chain, objectives to be achieved, and so it is possible to identify indicators giving more relevance to one or several BSC perspectives in detriment of another (s). In the second phase, it is proposed that the importance of the indicators identified in the first phase is on four main dimensions, Cost, Time, Quality and Flexibility and finally with regard to the goal. Through the AHP the comparisons will be made between the importance of each dimension and the main objective, then with regard to the weighting of each indicator in each

dimension and finally to the weighting of each indicator for the goal. Having chosen indicators, or metrics, for each of the BSC perspectives and the weighting related to the LSC dimensions, the process can be layer out as follows (Fig. 3):

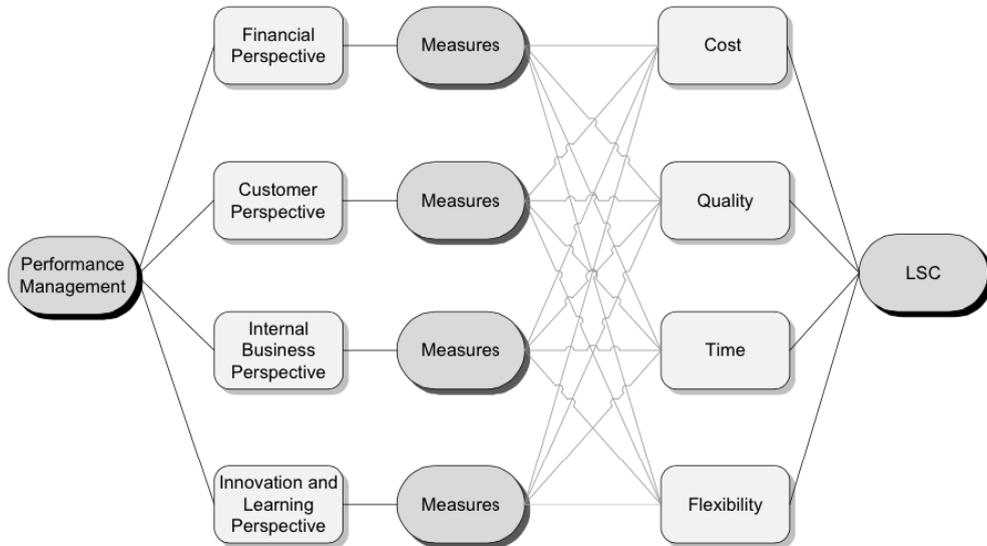


Fig. 3 - Relationship Matrix

*Measuring process*

At this stage, there are some points that need to be clearly defined by management, such as who will perform the measurement and it is important to define the person or persons responsible for the actual measurement. Another criterion that deserves special attention relates to that of data collection, how it proceeds, which sources we use, and the support to register the data. The frequency of measurement is an essential aspect, which will be scheduled by management based on factors such as availability of data and the importance of each performance measure.

*Assessment of results*

Once measures registered, it is necessary to analyze the results and thus assess the organization’s leanness degree. Bearing this in mind, it is proposed the use of a lean performance score developed by Searcy [44] where are recorded: Balanced values of each performance index in relation to an objective end; the historical values or initial measurement (baseline) which corresponds to a zero or starting point for the other measurements; the goal to achieve, namely the values defined for management on the basis of which one wishes to achieve objectives (future state); the improvement to be achieved, which represents the difference between the point of start and goal to achieve (targeted improvement), current results as a result of several measurements taken over a period of time and fourthly the actual change, representing the interval between the current results and the improvement to be achieved (Table 1).

Table 1 - Searcy’s model – first stage

Measures	Weight	Baseline	Future State	Targeted Improvement	Current Results	Actual
	A					
...	...					
	H					

The importance, of data recording, relates to the fact that it is required to make a comparison between historical measures and current results in order to reduce the gap between them and the goals to achieve.

To achieve the results to be analyzed, it is necessary to obtain the ratio between the actual difference and improvement to be achieved. The final score for each measure is calculated as the product between the value previously obtained and the respective weight. The sum of all scores will translate the final score, e.g., the leanness degree of the organization, or in other words, the percentage of long-term goals (future state) achieved (Table 2).

Table 2 - Searcy's model - second stage

Measures	Baseline		Current state		Future state		
	Weight	Results	Score	Results	Score	Results	Score
A		0%	0%			100%	
B		0%	0%			100%	
C		0%	0%			100%	
D		0%	0%			100%	
E		0%	0%			100%	
F		0%	0%			100%	
G		0%	0%			100%	
H		0%	0%			100%	
<b>Overall Score</b>	1,000		0%		X%		100,0%

After this stage, two possible roots can be identified (i) results achieved in the performance measurement are not in accordance with the objectives and it is inevitable to carry out new measurements, making this an iterative process until it reaches the goals pursued by management, or; (ii) the objectives were achieved and thus it becomes necessary to define new goals, following a philosophy of continuous improvement (Fig. 4).

*Identification of improvement opportunities*

After analyzing the results, it is important to identify opportunities for improvement. Based on the scores obtained, it is possible to see what results lagged most of the goals to be achieved. As such, it is necessary to take measures to improve these specific areas. It is proposed in this way, whenever possible, the implementation of measures leading to a lean continuous improvement of processes and services, contributing to the excellence of performance in organizations and therefore the LSC.

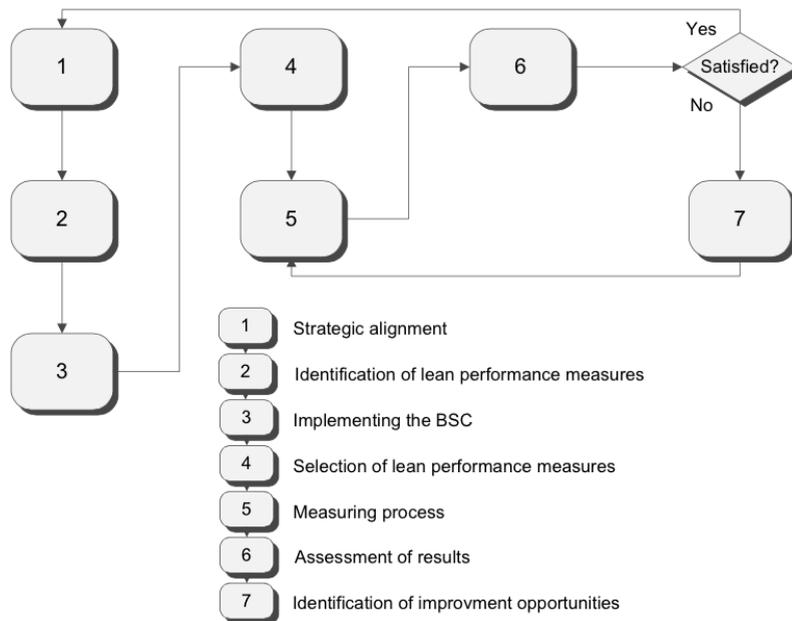


Fig. 4 - Framework for the assessment of the LSCP

## 7. Putting the proposal into practice – application in a SME

The literature on the performance measurement in SME's appears to accept the fact that the level of acceptance for practical performance measurement remains low due to the differences contexts of the SME's. However, other authors argue that the SME are playing a key role as an engine of economic growth in industrialized economies [45].

The framework is currently being implemented in a Portuguese SME operating in the food manufacturing sector. The purpose of our work is the introduction of a measurement performance system to assess the organization's leanness degree. It is also expected that the company gains awareness of the importance of such practices and of their contribution to the performance improvement.

Following the definition of strategic objectives, 16 lean metrics are identified, four for each perspective of the BSC. The organization has defined the metrics to be used taking into account the objectives to be achieved. After this process, the selection of the most important metrics was conducted with the aid of AHP. Through this model, the comparisons has been made between the importance of each dimension and the main objective, then with regard to the weighting of each indicator in each dimension and finally to the weighting of each indicator for the goal. Having chosen indicators, or metrics, for each of the BSC perspectives and the weighting related to the LSC dimensions (Cost, Time, Quality and Flexibility), the eight more important (with more weight) metrics were selected (Fig. 5) with the follows values:

- Return on sales – 15,8%
- Warranty costs – 17,6%
- No. of satisfied clients – 19,9%
- On time delivery – 10,4%
- Level of production schedule effectiveness – 9,2%
- No. of products delivered in time by the suppliers – 19,6%
- No. of new products/services – 3,0%
- Investment in training per year – 4,5%

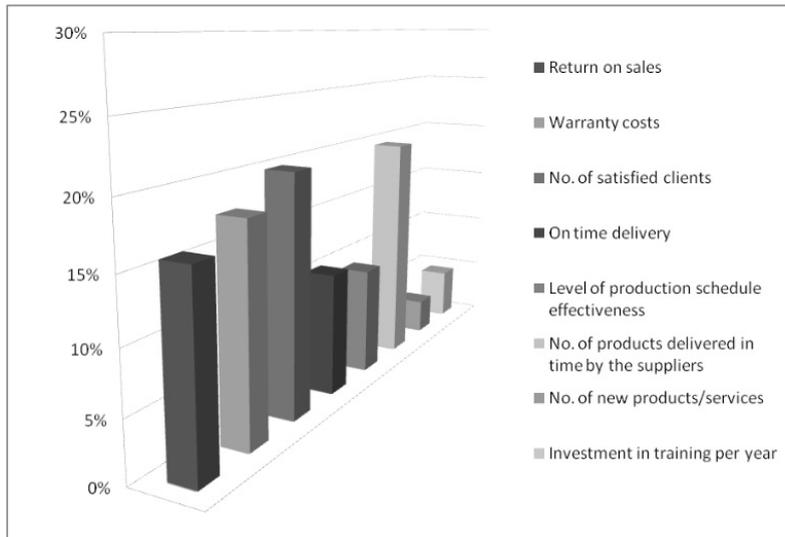


Fig. 5 - Selected metrics

At this stage, we are in condition to define who is responsible for the measurement process.

### 8. Discussion and results

After the measurement process it is used the Searcy’s model to conduct the evaluation of the results. The leanness degree, as depicted in table below (Table 3), after the first measurement is 27.4% which indicates that there are several aspects to improve. Since this is a work in progress it is not possible yet to extrapolate other meaningful conclusions about the results. The next step is identifying opportunities for improvement and the implementing lean measures that can result in better organization’s performance.

Table 3 - Results

Measures	Weight	Baseline		Organization'Current state		Future state	
		Results	Score	Results	Score	Results	Score
A – Return on sales	0,158	0%	0%	-9,3%	-1,5%	100%	15,8%
B – Warranty costs	0,176	0%	0%	37,0%	6,5%	100%	17,6%
C – No. of satisfied clients	0,199	0%	0%	42,9%	8,5%	100%	19,9%
D – On time delivery	0,104	0%	0%	50,0%	5,2%	100%	10,4%
E – Level of production schedule effectiveness	0,092	0%	0%	14,3%	1,3%	100%	9,2%
F – No. of products delivered in time by the suppliers	0,196	0%	0%	27,3%	5,3%	100%	19,6%
G – No. of new products/services	0,030	0%	0%	50,0%	1,5%	100%	3,0%
H – Investment in training per year	0,045	0%	0%	10,0%	0,5%	100%	4,5%
<b>Overall Score</b>	<b>1,000</b>	<b>0%</b>	<b>0%</b>	<b>27,4%</b>	<b>0%</b>	<b>100%</b>	<b>100,0%</b>

## 9. Conclusions

This empirical methodology provides indication of how LSCP could be assessed and improved in SMEs. Our study provides a wide set of metrics that can help the organization's managers selecting performance measures best suited to fulfil the goals. In assessing the degree of lean company also aims to raise awareness among managers for lean practices, even in environments not traditionally lean. The successful integration of tools such as the BSC or AHP in the evaluation of the LSCP was also one purpose of this study. The fact that this is a work in progress in some way limits the conclusions drawn from the implementation of the methodology, however the continuation of this in the future will infer the validity of this methodology.

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