From Six Sigma to Lean Thinking: an evolution of corporate culture

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ABSTRACT

Competitiveness among companies has forced them to abandon traditional methods of management to adopt new sustainable development strategies. Without sustained growth based on increased efficiency and effectiveness of operations, reduced time, increased quality of products and services, high quality levels and consequent high customer satisfaction, companies are doomed to leave the market for lack of competitiveness. The Six Sigma philosophy, combined with Lean Management, Lean Six Sigma, presents itself as a new management approach, allowing to achieve the long sought-after differentiation in the market.

This article aims to review the literature on the issue of business competitiveness, the driving force behind the search for new forms of management, such as Six Sigma, Lean Management, and the combination of both Lean Six Sigma.

To meet our objective, it was defined that a documentary research on the subject would be carried out. Thus, it began with information gathering on the competitiveness of companies, namely the way it has evolved and the main challenges ahead. Then the essential concepts for the understanding of Six Sigma were approached and later the bridge to Lean though, namely Lean Management.

From this bibliographical research it is quickly realized that this search for new ways of managing dates to World War II, with the production system developed by Toyota, Toyota Production System, from 1950 to 1960. Six Sigma presented itself as a natural evolution, having appeared in early 1987 at the Motorola company, when she was trying to resolve the variability of its production processes due to the increase in claims regarding failures in the electronics under warranty. Given that Six Sigma focuses more on quality issues, an evolutionary philosophy of waste management, Lean Management, has evolved. Currently these two philosophies are combined obtaining Lean Six Sigma.

Key words: Competitiveness, Six Sigma, Lean Thinking, Lean Management, Lean Six Sigma.
INTRODUCTION

The purpose of this article is to review the literature on the issue of business competitiveness, and its impact on (changing) business culture.

Being competitive is essential and decisive for companies to remain in the market. Therefore, the forms of management that have always been part of our corporate culture have had to evolve into forms of management that focus on quality, differentiation, optimization, deadlines, among others, all with the aim of achieving maximum customer satisfaction. New forms of management, based on philosophies such as Six Sigma, Lean Management, or the combination of both, Lean Six Sigma, present themselves as a way to achieve the longed-for differentiation in the market.

When we think about this problem, the question that immediately arises is the question of production, whether it be a product or a service. The premise of producing to sell is no longer in line with current times; today, it is necessary to produce what is already sold. In the face of a market in which supply is higher than demand, it is no longer the companies that dictate sales prices. These are established by the market itself, so companies have to differentiate themselves by their ability to satisfy the customer, taking into account the quality they offer, without sacrificing margins so as not to impair their profitability. This requires companies to look at their cost structure, bet on impeccable quality, short delivery times, customized production, product renewal, and quick adaptation to the market.

For companies to respond to these great challenges, which are competitiveness, there has been a change in corporate culture over time. Toyota Production System is undoubtedly the basis for this cultural change. Other philosophies have appeared over the years, such as Six Sigma, Lean Management and, more recently, Lean Six Sigma.

This article is structured in three chapters. The first is dedicated to the issue of business competitiveness. The second chapter is dedicated to the basic concepts of Six Sigma. And finally, the third chapter, is dedicated to Lean Thinking. This article ends with the main conclusions and bibliography.
1. COMPETITIVENESS OF COMPANIES AND BUSINESS CULTURE

A concern that marks companies has always been the management of their production. And this importance has been gaining more and more space in companies, since there is a cause-effect relationship with business competitiveness.

As Courtois, Pillet and Martin-Bonnefous (2007) indicate, the environment of companies has evolved in three phases:

1ª. **Produce to sell**: The market had interesting margins and the supply of goods was less than demand. It was enough for the company to define economical production quantities, mass production, and set deadlines for the production cycle.

2ª. **Produce what could be sold**: Given that the customer could freely choose his supplier, companies started to make commercial forecasts, organize supplies and deadlines.

3ª. **Produce what is already sold**: The market offers more than demand, leading the customer to look at other standards, namely satisfaction via product or service quality. This forced companies to optimize costs, bet on impeccable quality, short delivery times, customized production, product renewal, and quick adaptation to the market.

However, when we reflect on these phases, we easily realize that the challenge currently facing companies is to go even further. That is, increasingly higher levels of quality, shorter and shorter delivery times, lower and more competitive prices, adaptation to the market almost instantly, anticipation of the market, among others. These challenges that have been posed to companies have implied a change in mentality over time. Thus, policies such as Just-In-Time (JIT), Total Quality Management (TQM), Six Sigma and Lean Thinking, and Lean Six Sigma (Pinto, Carvalho & Hoo, 2009) were imposed.

Courtois, Pillet and Martin-Bonnefous (2007) and Pinto, Carvalho and Hoo (2009) defend that companies will have to orient themselves towards a global improvement that incorporates from the various suppliers of the entire supply chain to the different levels of customers, that is, from the first supplier to the final consumer. This integrated process is called Supply Chain, which allows adding value to a product or service, from its production, distribution and customer support. This logic of adding value to the customer will compel the company to look at its activities, suppressing all those that do not contribute to this differentiating process.
In this logic of adding value to the client, which culminates in their total satisfaction, the company also must implement continuous improvement processes that can be called Continuous Improvement Process (CIP) or Kaizen (Pinto, Carvalho & Hoo, 2009).

In short, we can say that this whole process forces us to conceive and produce differently, implying a change in the company's culture and an evolution in the behavior of everyone involved in the hierarchy (Fantti, 2010).

Now, when we talk about added value for the customer, with the aim of achieving total satisfaction, we necessarily speak of the economic and financial aspect. In this way, and as Courtois, Pillet and Martin-Bonnefous (2007) indicates, the classic cost of production + profit margin = selling price has evolved to a sales price - production cost = margin profit or sales price - target margin = target costing.

When analyzing this evolution and observing the behavior of the market and business competitiveness, we find that companies have very little autonomy in defining the price of their products or services, since this is practically defined by the market. Thus, for companies to remain in the market, they must ensure that their real production costs are very close to the target costing.

According to Pinto (2010), the processes of world excellence (World Class Manufacturing - WCM), describe the best practices. These best practices are supported by the practices of the best industrial companies in the world, due to the quality of the products they offer to the market culminating in highly competitive companies worldwide. These good practices go back to the father of designated scientific management, Frederick Winslow Taylor. His method was based on the observation, measurement, analysis and improvement of working methods, and monetary incentives, maximizing the company's results.

Pinto (2010), also indicates that, in addition to Taylor, other people contributed decisively to the evolution of the management concept:

- **Frank Gilbreth**, in 1868, developed the principles of movement economics with application to any number of situations, namely, in understanding the work habits of employees in industries and finding ways to increase their productivity;
- **Henry Gantt**, in 1912, analyzed the importance of non-monetary remuneration in the performance of employees and, in 1912, developed systems to support planning and organization, the Gantt charts;

- **Henry Ford** developed the concept of mass production, having created the first automobile assembly line in 1913.

According to Pinto, Carvalho and Hoo (2009), Pinto (2010) and Abreu (2011), reaching a level of excellence implies that the company can achieve very high levels of performance in key areas, comparing the results obtained with the best in its sector, having to be able to maintain this standard of trust and reliability. This level of excellence can be represented by the Olympic rings that translate the production zeros:

- **Zero defects**, guaranteed by total quality (TQM);
- **Zero damage**, guaranteed by total maintenance (Total Productive Maintenance TPM);
- **Zero time**, guaranteed by the quick change of tools (Single Minute Exchange of Die - SMED);
- **Zero roles**, guaranteed by integrated management systems;
- **Zero stocks**, guaranteed by flexibility, quality and reliability.

1. **THE SIX SIGMA**

   According to Andrietta and Miguel (2007), Pinto, Carvalho and Hoo (2009), Fantti (2010), Montez (2011) and Abreu (2011), the concept of Six Sigma emerged in early 1987, at Motorola, when it was trying to resolve the variability of its production processes due to the increase in complaints regarding failures in electronic products, within the guarantee. Overcoming this difficulty meant products without defects, increasing customer confidence and reducing losses. In 1988, Motorola received the Malcolm Baldrige Quality Award. After the results obtained, other companies adopted Six Sigma, namely Texas Instruments (in 1988), IBM (in 1990), ABB - Asea Brown Boveri (in 1993), Allied Signal and Kodak (in 1994) and General Electric (in 1996), the latter being the biggest success story of Six Sigma implementation.
As evidenced by Andrietta and Miguel (2007) and Fantti (2010), Six Sigma is a structured management practice, which aims to increase quality through the continuous improvement of the productive processes of products or services, being applicable to any type of organization, public or private, any sector of activity, product or service, and of any dimension. Naturally, by reducing the costs of quality (or poor quality) and improving the efficiency and effectiveness of operations that add value to the customer, the profitability of the organization will increase.

Fantti (2010), Montez (2011) and Abreu (2011), indicate that Sigma levels 1 to 6 designate the number of defects per million in a process (also called Defects-per-million), that is, the probability of a process to be free of defects, for each level of sigma. For that purpose, see the table below,

<table>
<thead>
<tr>
<th>Sigma level</th>
<th>Probability (%)</th>
<th>Defective units (per million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1</td>
<td>30.23</td>
<td>697,700</td>
</tr>
<tr>
<td>±2</td>
<td>69.13</td>
<td>308,700</td>
</tr>
<tr>
<td>±3</td>
<td>93.32</td>
<td>66,810</td>
</tr>
<tr>
<td>±4</td>
<td>99.3790</td>
<td>6,210</td>
</tr>
<tr>
<td>±5</td>
<td>99.97670</td>
<td>233</td>
</tr>
<tr>
<td>±6</td>
<td>99.999660</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Source: Fantti (2010).

For the implementation of Six Sigma to be successful, the participation and commitment of all, particularly top management, is necessary, given the need to allocate resources to the project (physical, material and financial). In addition, it is necessary to choose who will be involved in this implementation since it is necessary to train the teams, implement, monitor and interpret results.

In order to distinguish the people involved in the project, according to the training and training hours, hierarchy in the projects and dedication of time to the program, Six Sigma uses a belt system:

- **Sponsor**, who promotes and defines the guidelines for the implementation of Six Sigma;
- **Facilitating sponsor**, who performs the main functions in the development of the program's projects;
- **Champions**, who are the project managers.
Regarding the rest of the team, and according to the levels of knowledge, we have (Fantti, 2010; Montez, 2011):

- *Master Black belts*;
- *Black belts*;
- *Green belts*;
- *Yellows belts* e *White belts*.

The latter are also called “shop floor”, which receive training on the use of the basic tools that apply to the various phases of the projects.

According to Andrietta and Miguel (2007), Pinto, Carvalho and Hoo (2009), Fantti (2010) and Leite (2014), it is crucial for the success of a Six Sigma project that the Criticals to quality (CTQs) are known, or characteristics critical to quality. Then, it is necessary to choose methods to solve problems such as,

- **M/PCpS** *(machine/process characterization study)*: Characterization and optimization of processes, aiming to eliminate wasted time;
- **DMAIC**: Definition of the steps: define, measure, analyze, improve, and control;
- **DFSS** *(design for Six Sigma)*;
- **DMADV**: It contemplates the phases: define, measure, analyze, draw and verify;
- **DMEDI**: It incorporates the steps: define, measure, explore, develop and implement.

Having analyzed the different methods exposed, the most used is DMAIC, due to the fact that it contemplates five stages that manage, in most Six Sigma projects, to structure the implementation, development and conclusion of the selected projects (Andrietta & Miguel, 2007; Pinto, Carvalho & Hoo, 2009; Leite, 2014).

According to Fantti (2010), Montez (2011), Abreu (2011), and Leite (2014), the objective of DMAIC is to create a solid and organized method to improve processes. Therefore, the main performance indicators (Key Performance Indicators - KPIs) will be used throughout the
DMAIC. It is necessary to define what are the problems of the process to be studied, understand its objective and what is expected of it, as well as the extent to which KPIs are expected to improve. Looking at the method itself,

- The "D" of Define, defines the problems encountered in the processes, and must be quantitatively highlighted;
- The "M" for Measure, measures the goals and variables that imply results;
- The "A" of Analyze, analyzes if there are cause-effect relationships through statistics;
- The "I" to Improve, applies improvements to the causes of problems. For this, it is important to work closely with people involved in the development of products, services and processes;
- The "C" of Control, evaluates improvements in the process, if they occur as planned, and if the results are continuous.

In summary, we can state that the main benefits of applying the Six Sigma program are, according to Andrietta and Miguel (2007):

- “the pursuit of continuous process improvement;"
- the achievement of customer satisfaction through a better understanding of the required requirements;
- a full understanding of the critical process inputs required to respond to changes in defined requirements and specifications;
- quality improvement;
- gains in the process flow;
- increased productivity;
- reduction of cycle times;
- increased production capacity and product reliability;
- reduction of defects, costs, and waste;
- the elimination of activities that do not add value to the process;
- and maximizing profits.”
It is also important to clarify some myths about Six Sigma. So,

- **Applies only to large organizations**: Six Sigma can be applied to any organization, regardless of size; many organizations have made Six Sigma their management system;
- **It only applies to industry**: while it is true that Six Sigma started in the industry, it has in fact been successfully applied to all segments of organizations - accounting, banking, healthcare, army, airlines, hotels and so on. If there is a repetitive process with a problem, we can apply Six Sigma;
- **Organizations must hire an external consultant**: If the methodology is not applied correctly, the results can be frustrating and have a negative impact on the organization, especially when organizations are starting to implement it, with high expectations. In organizations that are implementing Six Sigma for the first time, or in which previous attempts have failed, it is necessary to invest some extra effort in the first projects to ensure that they are successful, because once the first line of projects is implemented successfully, others will follow;
- **Six Sigma is a statistical methodology**: although statistics are a strong component of a Six Sigma professional, especially professionals with greater responsibility, for example, Black Belts, it is possible to apply many of the concepts that Six Sigma brings without mandatory use statistics;
- **Six Sigma projects do not include customer requirements**: The entire Six Sigma project begins with customers, determining the critical factors for it.
- **Six Sigma is TQM, but with a different name**: Six Sigma projects are selected to reduce or eliminate waste, which translates into lower costs and happier customers. Although Six Sigma has evolved from TQM, there are significant differences in the two methodologies;
- **Rising costs**: Organizations may fear that implementing Six Sigma, or any other improvement program, will cost money and may not be sure of the return. It is a normal concern, but if the methodology is applied properly, costs will be greatly reduced and not increased;
- **Fear of change**: The implementation of Six Sigma will require changes in the way of working, changes for the better;
- **Loss of time without results**: even if it is possible to happen, given that Six Sigma is a very structured approach, focused on solving problems, with the goal of permanently eliminating them, it will hardly become a waste of time without results.

2. **THE LEAN THINKING**

According to Courtois, Pillet and Martin-Bonnefous (2007) and Domingues (2013), in the current situation, companies are unable to obtain higher margins by selling more expensive. Thus, higher margins are only possible if you spend less, which necessarily leads to costs. The big question of spending less is related to the quality associated with the products: it has to remain at an acceptable level, and accepted, in order to maintain customer satisfaction. Now, the concept of Lean Management, developed by Japanese companies since the 1950s, in particular by Toyota, is part of the idea presented earlier.

According to Lousas (2018), the Lean philosophy had its origin in the automotive industry in Japan, by the hand of Taiichi Ohno in 1940, in the Toyota company. Ohno, author of the Toyota Production System (TPS), implemented the principle of producing according to a continuous flow, more efficient, given the need to produce a variety of products that was increasingly larger. The big issue lies in the mass production capacity, but without impairing quality, without errors and at reduced costs.

We can then say that this philosophy is based on two great ideas, according to Courtois, Pillet and Martin-Bonnefous (2007) and Domingues (2013):

- Elimination of all waste during all processes in the company;
- Place the man at the center of the process.

In order to achieve this level of management within the company, there are some considerations to consider, namely,

- Elimination of all waste;
- Quality management aimed at continuous and innovative improvement;
- Reduction of product development cycles;
- Favorable attitude towards customers.
TPS is, then, a system of continuous improvement, focused on reducing waste, involving all employees, in order to develop a team work to achieve the proposed objectives in order to improve quality, safety, reduce costs and times (Lousas, 2018).

Ohno defined the TPS system as a "home". This “house” is based on three parts (Lousas, 2018):

- **Foundations**, which forms the basis of the system. This basis is based on the following processes:
  
  - Stable and Standardized Process (the sequence of tasks is done exactly with the exact time),
  
  - Kaizen (continuous improvement, better safety, better quality, elimination of waste) and
  
  - Heijunka (adequate production, greater satisfaction reduction of production and stock costs).

  The basis of the system is based on people, because without them it is not possible to evolve towards continuous improvement;

- **Pillars**, which support the objectives of TPS, namely, JIT (just-in-time) and Automation (Jidoka). JIT is the exact production of what customers want and according to their specifications, at the right time, in the right quantities, avoiding costs and waste. Jidoka or automation, allows the employee the autonomy to stop whenever an anomaly is identified. Analyzing both methods, it is easy to see that there is a great concern in reducing the cost of production;

- **Roof**, which translates the objectives of TPS, that is, better quality, lower cost and shorter times.
Figure 1: TPS


Figure 2: Principles of Lean Thinking

<table>
<thead>
<tr>
<th>Lean Principles</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know the interested parties</td>
<td>Groups that are interested in the organization, i.e. know the people that we serve.</td>
</tr>
<tr>
<td>Value</td>
<td>Matches the customer’s requirements, the manufacturer only creates value after the final customer defines it.</td>
</tr>
<tr>
<td>Value Chain</td>
<td>Identifies all the processes and actions that create value, eliminating all other steps</td>
</tr>
<tr>
<td>Value Flow</td>
<td>Reduce the service times and product manufacturing</td>
</tr>
<tr>
<td>Value Pull</td>
<td>Manufactures only the necessary, always supplying the customer when needed</td>
</tr>
<tr>
<td>Perfection</td>
<td>Once the four other principles are established, the process should be restarted, always looking for perfection with zero waste.</td>
</tr>
</tbody>
</table>
We can then conclude that: (Lousas, 2018, p. 14):

“Thinking like Lean is quantifying, looking for ways, solving and learning from problems, finding opportunities, generating gains for everyone.

Lean production brings together all areas, from top management, to employees and suppliers, thus managing to double production and quality, while keeping costs low.”

We will now focus on the issue of eliminating waste. We have seven sources of waste that are known as seven Muda, namely (Courtois, Pillet & Martin-Bonnefous, 2007; Domingues, 2013):

1. **Overproduction**: Produce for stock;
2. **Expectations**: Long waiting times between machine cycles. The cycles are not balanced, and the processes are not aligned;
3. **Useless displacements**: Transport surplus products to stock, and then take them out again, generating unnecessary displacements;
4. Useless operations: Unsolicited levels of specification, beyond what is specified, which lead to an increase in production time, corrections, and then costs;
5. **Excessive stocks**: In addition to the cash tie, it generates higher costs in the management of stored stocks;
6. **Useless expenses**: Poor design of jobs, generating inefficiency;
7. **Defects**: In addition to generating costs for their repair, they may not be detected, affecting the quality perceived by the customer.

When we reflect on what Lean Management translates, the word that occurs to us is **time**:

- the time it takes to produce (the longer it takes, the greater the gap between investment and return on that investment);
- time that the products remain in stock, not generating return for the company; the time necessary to change tools;
- excessive delivery times (either from suppliers or customers);
- time to develop new processes, new products;
- time to work with the unexpected but in an assertive way; and
- time to react quickly to market changes and customer needs.

There are several Lean Management tools, especially Kanban (a different tool from JIT). Kanban, according to Courtois, Pillet and Martin-Bonnefous (2007) and Domingues (2013), controls the flow of resources in a production process, replacing only what has been consumed, making the production programs based on the real demand for the product and consumption, not the sales budget. However, there are other tools that should be mentioned:

- Suppliers, Input, Process, Output, Customers (SIPOC);
- Single Minute Exchange of Die (SMED);
- Total Productive Maintenance (TPM);
- 5 S;
- Value Stream Mapping (VSM);
- Spaghetti Diagram;
- Overall Equipment Effectiveness (OEE);
- Layouts configuration;
- The 5 Why’s, and The 2 How’s - 5W2H;
- Total Quality Management (TQM);
- One Piece flow;
- Continuous Improvement Process (Kaizen);
- Poka-yoke;
- Heijunka;
- Standard Work;
- Andon – Visual management;
- Jidoka;
- PDCA cycle;
- A3;
- Brainstorming.

Let's take a closer look at some of these tools given their importance.

1) Suppliers, Input, Process, Output, Customers (SIPOC):

It allows to identify the important causes of loss of performance, in order to obtain the greatest possible efficiency (see example below).

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Input</th>
<th>Process</th>
<th>Output</th>
<th>Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier A</td>
<td>Wood</td>
<td>Start.</td>
<td>Varnished wooden frames.</td>
<td>Companies that need wooden frames to post information to their customers.</td>
</tr>
<tr>
<td>Supplier B</td>
<td>Cutting saw</td>
<td>1. Cut wood according to the required dimensions.</td>
<td>Varnished wooden frames. Information about the execution of the process.</td>
<td></td>
</tr>
<tr>
<td>Supplier C</td>
<td>Sand</td>
<td>2. Sand the cut parts.</td>
<td>Material remains, such as leftover wood, empty varnish cans or defective nails.</td>
<td></td>
</tr>
<tr>
<td>Supplier D</td>
<td>Nails</td>
<td>3. Assemble the parts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier E</td>
<td>Varnish for wood</td>
<td>4. Inspect the part to verify that it is in conformity and does</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
not need any rectification.

5. Varnish the piece.

6. Wait for drying period (3 hours).

7. Final inspection of the produced part, ensuring the quality of the product.

End.

Source: Own elaboration (2019).

<table>
<thead>
<tr>
<th>2) Single Minute Exchange of Die (SMED):</th>
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<tbody>
<tr>
<td>Also known as “tool change in less than 10 minutes”, it aims to reduce series change times. This method has evolved over time, namely from One Touch Exchange of Die (OTED) to No Touch Exchange of Die (NTED). The first, OTED, limits human intervention to change series as much as possible, while the second, NTED, equates times of change without human intervention.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3) Total Productive Maintenance (TPM):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process that aims to maximize the productivity of the equipment, through the improvement of reliability, quality, and cost savings, involving all personnel in this process. Thus, people are the center of this tool.</td>
</tr>
</tbody>
</table>

According to Lousas (2018), six types of losses can be identified: - equipment failures; - production and adjustment time; - speed reduction in the process; - defects and poorly performed work; - downtime; - and reduced production.

For these losses to occur, essentially, we have the poor working conditions of the equipment, human errors and the lack of motivation, training, understanding and knowledge.

In order to maximize the efficiency and productivity of the equipment, it is necessary that improvements are directed, maintenance is planned, maintenance is autonomous involving
employees, there is safety, hygiene and environment, there is training, knowledge and training of employees.

4) The 5 S:

According to Lousas (2018), “This method is the most simple and effective, it is pure common sense. ... Seeks to implement a set of practices that reduce waste, as well as improving the performance of people and processes. These practices occur, both in terms of production, service provision and administrative organization, facilitating teamwork”.

The 5S are the initial activities of cleaning, organizing, and cleaning workplaces, namely:

- **SEIRI (storage)**: Separate useful objects in the workplace from those that are not; save only because it may be necessary does not increase efficiency;
- **SEITON (put in order)**: Organize the workplace in order to be functional, quickly finding the documents and tools necessary to carry out the task;
- **SEISO (cleaning)**: Since the cleaning of the machines is a kind of inspection, it allows the detection of anomalies;
- **SEIKETSU (cleanliness)**: Compliance with the three previous rules, making it a routine, and not something punctual;
- **SHITSUKE (control)**: Being a self-assessment process, it promotes team spirit, as well as the process of continuous improvement (Kaizen).

It follows that the implementation of this tool brings significant benefits to the company, such as the implementation / development of continuous improvement, improvement of quality and productivity, incentive to creativity, greater collaboration between people, better levels of cleanliness, more rigor, discipline and commitment.

Lousas (2018) indicates that it is possible to add one more “S”, which will be the sixth “S”. This sixth “S” is related to safety, that is, by implementing routines, keeping everything in proper order, safety is being stimulated, improving the development of tasks in the workplace, and facilitating waste reduction.
Note that the application of this tool must be done "S" to "S", and never move to the next one without the previous one being fully understood and implemented (Lousas, 2018).

5) Value Stream Mapping (VSM):

This tool is a visual tool, which helps to know the process and the whole connection of the value chain, leading to the identification of something more than waste, and its causes. It is, therefore, a simple and effective method (Lousas, 2018).

For it to be correctly implemented, it is necessary to go through the following steps (Lousas, 2018):

1. Take a roll of paper and stick it on a wall. With post-its and markers start to design steps based on the times and phases of the processes;
2. Choose which product or service to map, and this product or service must be representative for the organization;
3. Proceed to the identification from the customer (s) to the supplier (s), recording values and times on the map;
4. To arrive at the design of the process, it is necessary that the key people in the value chain participate, as this is the only way to achieve a global vision, contributing to a global improvement;
5. After completing the process design, the organization should quantify times and activities that add value.

6) 5W2H:

5W2H is a continuous improvement tool that helps in discovering the source of the problem, proposing corrective measures through the questions: what, why, where, when and who; how and how much.

Imagine that a problem was identified in the organization. The 5W2H tool can help solve the causes of this problem, efficiently, by asking the following questions:
• **What? (what will be done?):** Allows you to identify and describe the problem properly.

• **Why? (why will it be done?):** Find an explanation that contributes to the solution of the problem.

• **Where? (where will it be done?):** Look at the process and find where the problem is. This identification can be done through a location verification sheet.

• **When? (when will it be done?):** To achieve the goal set, it is necessary to determine when each of the proposed tasks will be carried out, and how long each one will take.

• **Who? (by whom will it be done?):** First, it is necessary to identify who are affected by the problem, customers, employees, among others. Subsequently, define who will be responsible for each action planned to achieve the goal that has been established.

• **How? (how will it be done?):** It is necessary to establish a specific plan for each necessary action so that the goal initially defined is achieved.

• **How much? (how much will it cost?):** According to the organization's financial situation, it is necessary to quantify the cost of this process.

7) **PDCA cycle:**

This tool appeared in the 1930s, by Walter A. Shewhart, and was taken to Japan in 1950 by Deming. The purpose of this PDCA tool, plan-do-check-act, is to assist in solving problems, giving indications. It is a simple and systematic tool, guiding those involved in the implementation of improvement actions (Lousas, 2018).

With Deming, this tool has evolved to a more complete form, becoming a cycle with designing, producing, placing, testing and redesigning, obtaining the current PDCA cycle or Deming cycle (Lousas, 2018).

Analyzing the acronyms of the PDCA cycle, it is concluded that each acronym corresponds to a step, namely,
- Plan: Definition of the problem, and raise possible alternatives for resolution;

- Do: Implementation of the solution found;

- Check: Analysis and evaluation of results;

- Act: Two situations can arise from here. Or the results are not satisfactory, in which case it is necessary to re-plan. Or the results are the desired, and the solution needs to be made a routine.

In summary, this tool, being simple to implement and perform, allows to have an overview of everything. However, its implementation requires the involvement of the team, thus getting people motivated and with a sense of commitment (Lousas, 2018).

8) Continuous Improvement Process (Kaizen):

Kaizen, or continuous improvement, is about change, but a change well done, efficiently and effectively. This tool can be applied to any business area, to any department, productive or not, and to any type of organization. Its great value consists in the fact that it allows “to evaluate and reassess the problem, designing and planning solutions, to then implement them” (Lousas, 2018, p. 16). In short, Kaizen aims to reduce waste and increase productivity.

According to Lousas (2018), “the process of continuous improvement is based on seven factors: - control of documents and records, - control of non-compliant products, - improvement actions, - quality audit, - system review, - satisfaction assessment of customers, and - monitoring the performance of the SGQ” (Lousas, 2018, p. 16). It should be noted that this process of continuous improvement only happens if the problems encountered be opportunities for improvement.

Having analyzed all these tools, we can, in conclusion, refer to the words of Courtois, Pillet and Martin-Bonnefous (2007, p. 356):

“The pursuit of excellence for the customer is the purpose of Lean Management; it is this quest for excellence that allows the company to continue to thrive in a world where everything is evolving.”
CONCLUSIONS

This article aims to review the literature on the issue of business competitiveness, and the new management methodologies, such as Six Sigma, Lean Management, and the combination of both Lean Six Sigma.

This article is motivated by the fact that business competitiveness has become more and more aggressive, leading companies to abandon traditional methods of management, in order to adopt new strategies for sustainable development. Without sustained growth, based on increased efficiency and effectiveness of operations, reduced times, increased quality of products and services, high levels of quality and consequent high customer satisfaction, companies are condemned to leave the market due to lack of competitiveness. The Six Sigma philosophy, combined with Lean Management, Lean Six Sigma, presents itself as a new management approach, allowing to achieve the longed-for differentiation in the market.

Now, when we talk about business competitiveness, we are talking, necessarily, about quality, creating value for the customer with the consequent satisfaction of the same. Thus, and according to Courtois, Pillet and Martin-Bonnefous (2007), the classic cost of production + profit margin = selling price ratio has evolved to a sale price - production cost = profit margin ratio or selling price - target margin = target costing.

In order to reach this level of excellence, as indicated by Pinto, Carvalho and Hoo (2009), Pinto (2010) and Abreu (2011), the company has to be able to achieve very high levels of performance in key areas, comparing the results obtained with the best in industry. To do this, it is necessary to pay attention to the Olympic rings: - Zero defects, - Zero damage, - Zero time, - Zero papers, and - Zero stocks.

If we focus on more innovative ways of managing companies, we must speak of Six Sigma and Lean Thinking. Thus, Andrietta and Miguel (2007) and Fantti (2010) indicate that Six Sigma is a structured management practice, which aims to increase quality through the continuous improvement of the productive processes of products or services, being applicable to any type of organization, public or private, any sector of activity, product or service, and of any dimension.

For its implementation, Six Sigma makes use of a belt system, in which:

- Sponsor (promotes and defines the guidelines for the implementation of Six Sigma);
- Facilitating sponsor (performs the main functions in the development of the program's projects); - Champions (are the project managers);
- Master Black belts;
- Black belts;
- Green belts; and
- Yellows belts and White belts.

It is also important when implementing a Six Sigma project to know the so-called Critical to quality (CTQs), or critical characteristics for quality. Andrietta and Miguel (2007), Pinto, Carvalho and Hoo (2009), Fantti (2010) and Leite (2014), present the main methods for their identification, that is,

- M / PCpS (machine / process characterization study);
- DMAIC (includes the define, measure, analyze, improve and control phases);
- DFSS (design for Six Sigma);
- DMADV (includes the phases to define, measure, analyze, design and verify);
- DMEDI (incorporates the steps to define, measure, explore, develop and implement).

Of all the methods mentioned, the most used is DMAIC, as it includes five stages that manage, in most Six Sigma projects, to structure the implementation, development and conclusion of the selected projects (Andrietta & Miguel, 2007; Pinto, Carvalho & Hoo, 2009; Leite, 2014).

Looking now at the Lean Management philosophy, developed by Japanese companies since the 1950s, in particular by Toyota, we can then say that this philosophy is based on two great ideas, according to Courtois, Pillet and Martin-Bonnefous (2007), Domingues (2013), and Lousas (2018):

- Elimination of all waste throughout all processes in the company;
- Put the man at the center of the process.
In order to achieve this level of management within the company, there are some considerations to consider, namely, elimination of all waste; quality management aimed at continuous and innovative improvement; reduction of product development cycles; and proactive attitude towards customers.

There are several tools used by Lean Management: Kanban; SIPOC; SMED; TPM; 5 S; VSM; Spaghetti Diagram; Overall Equipment Effectiveness (OEE); Layouts configuration; 5W2H; TQM; One Piece flow; Kaizen; Poka-yoke; Heijunka; Standard Work; Visual management; Jidoka; PDCA cycle; A3; and Brainstorming.

As future investigation, it would be interesting to cross these methodologies with the process mapping and flow mapping tools, knowing how they complement each other and how they are structured.
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