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Lean Six Sigma in the Logistics of the Loading Process of a Paper Mill

Lean Six Sigma na logística do processo de carregamento de uma fábrica de papel

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Abstract

Customers are each day more demanding with costs reduction, sustainability, quality improvement and shorter lead times. Since logistics operation is involved in every step of the chain, it becomes an important asset for companies to win market share. Seeking to attend the organizations and customers' needs, Lean Six Sigma methodology could bring benefits to logistics services. Aiming to study those benefits, this article presents a case study about the interaction between the LSS and the loading process in a paper mill located in Brazil. The site had already adopted the DMAIC method in the manufacturing areas, but not in the service ones, which made it easier the implementation, guaranteeing the support and involvement of management. In the end of the study, it was possible to notice several benefits in implementing the LSS, as reduction of 32% of cycle time and 43% of performance improvement.

Keywords: Six Sigma; Lean Manufacturing; Logistics; Production Control.

Resumo

A cada dia, os clientes são mais exigentes com redução de custos, sustentabilidade, melhoria da qualidade e prazos mais curtos. Como a operação logística está envolvida em todas as etapas da cadeia, torna-se um ativo importante para as empresas ganharem participação de mercado. Procurando atender às necessidades das organizações e dos clientes, a metodologia Lean Six Sigma pode trazer benefícios aos serviços de logística. Com o objetivo de estudar esses benefícios, este artigo apresenta um estudo de caso sobre a interação entre o LSS e o processo de carregamento em uma fábrica de papel localizada no Brasil. O local já havia adotado o método DMAIC nas áreas de manufatura, mas não nas de serviço, o que facilitou a implementação, garantindo o apoio e o envolvimento da gerência. No final do estudo, foi possível notar vários benefícios na implementação do LSS, como redução de 32% do tempo de ciclo e 43% de melhoria de desempenho.

Palavras-chave: Six Sigma; Lean Manufacturing; Logística; Controle de Produção.

1 Introduction

Every day, customers require shorter lead times, lower prices and higher quality, in this context logistics operations represent an essential element to improve those demands and add value to products and services (Zhang et al., 2016). Logistics is the tacit part of the productive system; it is involved from procurement to delivery in the final customer, showing many opportunities to reduce costs, increase customer satisfaction level and improve the operations speed.

Hilmola, Hämäläinen, and Hujala (2014) reinforce the importance of an efficient transportation cost management in the paper industry, due to the small profit margins in the European market, affected by the increasing of Internet use.

For Koskinen (2009) the importance of Supply Chain in Finnish paper industry is increasing because of exportation, the necessity to deliver the products outside Finland with better prices than other Central European competitors.

Lean Six Sigma is a quantitative management strategy which has the purpose to increase the performance and profitability of companies by improving the quality of products and reducing costs (Silva et al., 2017; Chiminelli, 2018). Noticing the necessity to eliminate waste, reduce costs and improve quality in logistics operations of paper industry, this study aims to evaluate the Lean Six Sigma methodology applied in loading operations. The LSS is one of the most effective tools in performance improvement used for the companies nowadays (Shokri, 2017).

For this purpose, a case study has been performed in a medium-size paper mill in Brazil. The case study approach provides an explanation about the relations of several events that occurred in the real word and aims to understand how or why those events occur (Voss, Tsikriktsis, & Frohlich, 2002).

2 Background Literature

2.1 Lean Six Sigma

The Six Sigma methodology was created by Motorola and become popular through GE in the late 80s. Its approach can be resumed in improving the capability of processes, using statistical tools to reduce/eliminate variation. It was developed for being applied in manufacturing companies, but now its uses were expanded to service and other industries (Werkema, 2004).

It arrived in Brazil in the end of 1990s, being brought mostly by the multinational organizations that already used the methodology in their headquarters. For Augusto Cauchick Miguel and Marcos Andrietta (2009), many companies that uses it in Brazil had their initial investment, in adopting and training the professionals, back with projects' savings or gains. Per year, it is executed an average of 50 projects per company.

The Sigma (σ) is the Greek letter used to represent the standard deviation of a distribution, the lower the σ of a process more standard deviations are accepted in the specification (Mendes et al., 2017). The Sigma Scale is used to measure the quality level of a process, it is calculated by the ratio of the number of defects per million of performed operations. Six Sigma quality level is 3.4 defects per million (Chakrabarty & Chuan Tan, 2007). Breyfogle (2003) determined the Sigma Level by Equation (1).

$$\text{Z-value} \approx 3 * \text{Ppk} + 1.5 \quad (1)$$

In Ozkan et al. (2017) literature study, it was concluded that Six Sigma leads the implementing company to better knowledge management and to improve job quality. All as a result of the structured method and fixed goal setting that the methodology requires.

Lean philosophy was born from Toyota Production System, developed right after the Word War II due to the shortage of capital and resources available. Because of this, the instructions given to the employees were to eliminate all waste, identifying all value-added and non-added activities, and reducing the most of the second one (Pepper & Spedding, 2010).

Its goal is the reduction of cycle times, the improvement of accuracy in quality and inventories, the reduction of downtimes, scrap and rework, relying in work procedure standardization combined with the use of tools to identify and remove waste from the processes (Gutierrez-Gutierrez, de Leeuw, & Dubbers, 2016).

Lean Six Sigma (LSS) is the union of both methods. Six Sigma provides the structure for improvements project (e.g. DMAIC) and Lean, the performance improvement. The integration brings more benefits than implementing each separately, besides the construction of a constant improvement process more solid and the providing of higher potential for gains (Snee, 2010).

2.2 Logistics Operations

According to CSCMP (2013), logistics is the process of planning, implementing and flow controlling of raw materials, work in process inventory, finished goods inventory and information, from the point of origin to the consumption point, attending the customer's needs.

To Ballou (2006), logistics is important to the company strategy. When recognising that it interferes significantly in the costs and its results affects directly the customer service, logistics can be used to gain new markets, to expend the participation in the market and to raise the profit. Stępień et al. (2016) agrees and affirms that a slightly reduction of logistics costs can be decisive to competitiveness position in market. Depending on the method of management applied and kind of business, the share of company turnover tends to be at least 10 per cent (Engblom et al., 2012).

2.3 Lean Six Sigma and Logistics

Many companies of the service industry still have the misunderstood idea that the Lean Six Sigma is exclusive to manufacturing industry. But three statistics principles prove they are wrong: all work occurs in a system of connected processes, all processes content variability and all processes create data, which made possible to study and understand the source of this variability and define effective plans to reduce or eliminate it. Antony (2006) lists some benefits for service companies using LSS: a better decision management, reducing costs with misdirected problem solving; increases the understanding of customers' needs and expectations; more efficient and reliable internal operations; reduces the number of non-value added activities; and, reduces the variability in service performance.

In logistics, the impact the LSS could be expressive. The method seeks to eliminate wastes and reduce the variability from the processes, which made possible to reduce inventory levels, work in process, finished good, and specially, safety stock, reduce production lead time, improve processes flow, raise the sector speed, reduce costs, and as result, increase customer satisfaction (Goldsby & Martichenko 2005).

Gutierrez-Gutierrez, de Leeuw, and Dubbers (2016) promoted a study of logistics services of a large electronic company and concluded that to a LSS project be effective is necessary to know the customer requirements, to have the management and directory involvement, commitment and support and it is necessary to provide training not only to professionals who are going to execute the project, but to teach the basics principles of LSS to all employees involved in the process area, so they can understand and be more opened to changes. The lack of those can lead the project to failure.

In Samsung Group, the Six Sigma implementation at the Supply Chain Management (SCM) was done in two phases: Black Belt Program and SCM projects. First, they trained all professionals that were going to be involved with the Six Sigma projects, and then, it was done a benchmarking with other successful companies to develop the best design for the methodology. Those actions allowed them to create a tailored method called DMAEV, instead of using DMAIC or DMADV, more suitable for their processes and the results were projects prepared and conducted more disciplined, being the last phase – V is a continuously monitoring of results, to guarantee continuously monitoring of results, to guarantee that the improvements are not going be lost (Yang et al., 2007).

3 Methodology

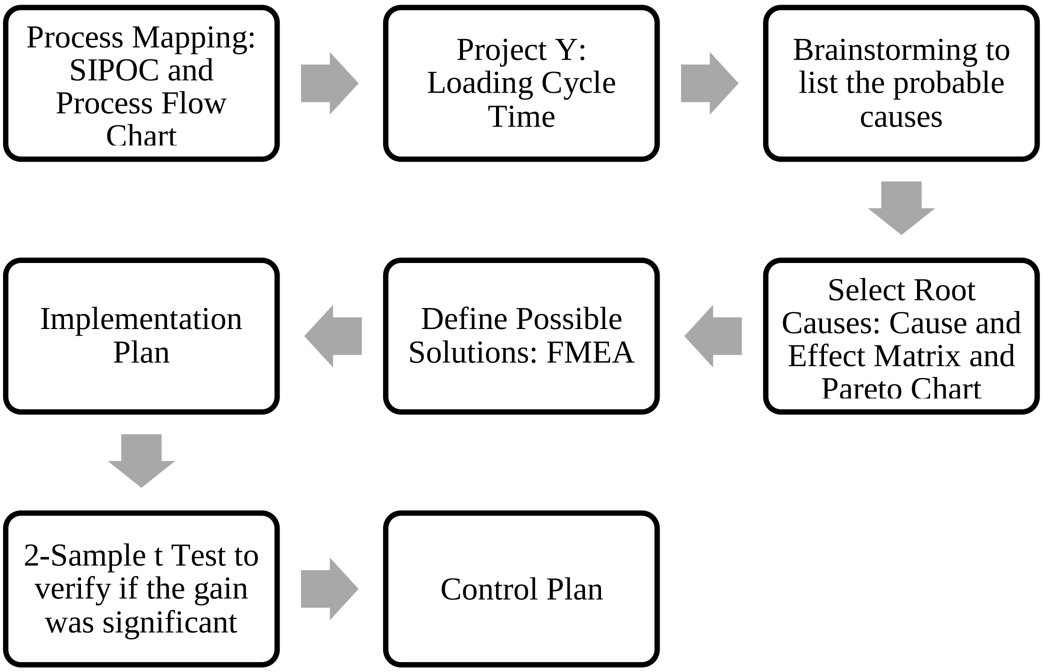
It was adopted a case study approach to understand the applicability of LSS in Logistics Service. The object of study is a multinational company specialized in paper production located in Brazil that already had embraced the methodology in the organization, but only in manufacturing processes.

The DMAIC has been chosen as the roadmap for the study, because it is the most popular method from LSS, besides the fact of being the standard method used in the company, which would facilitate the implementation.

When analysing the possible projects, it was noticed a high number of complaints caused by delays in the Shipping Area, as reduction of lead time is one of the main gains of LSS, the purpose of the case study was to verify the practical benefit of DMAIC on reducing loading cycle time.

To illustrate the steps of this case study project guided by the DMAIC method, Figure 1 presents the project flow.

Figure 1 - Reduction of Loading Cycle Time Project Flow



4 Result and Discussion

To evaluate the Lean Six Sigma benefits in loading operations, it has been done a case study in a paper mill, applying the DMAIC method to reduce the loading cycle time, the average was 03 hours and 07 minutes. The first stage, Define, was essential to understand the process and identify and clock all steps required to complete it. The company loads three types of vehicles with two packages types, which with a specific disassembly and assembly process.

Zhang et al. (2016) reports that primary implementation challenges faced were resistance to change and that, employees do not understand the implementation rationale. Seeking to solve this issue, all the workers involved directly in the process were invited to a presentation where it was explained the LSS methodology, the need of adoption and what was the project objective. By this way the communication and the change resistance improved, resulting in a more engaged team.

To list the probable causes and select the root ones, it was held a brainstorming with some of the employees, generating a Cause and Effect Matrix and a Pareto Chart, shown in Figure 2, to prioritize the causes. Table 1 shows the probable causes discovered and their points of influence. As seen, the first 5 causes sums more than 50% of the total points of influence, been chosen as main causes. The other probable causes were eliminated due to their lower scores.

Figure 2 - Pareto Chart of Probable Causes

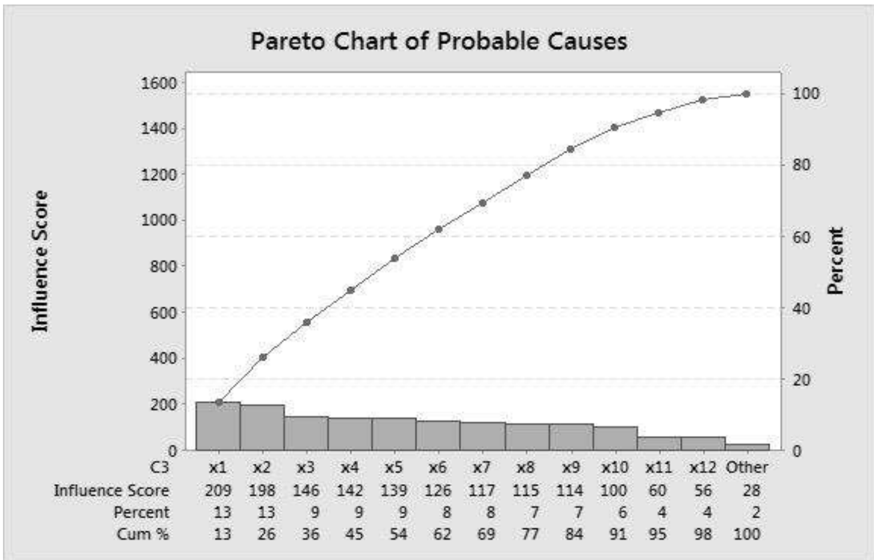
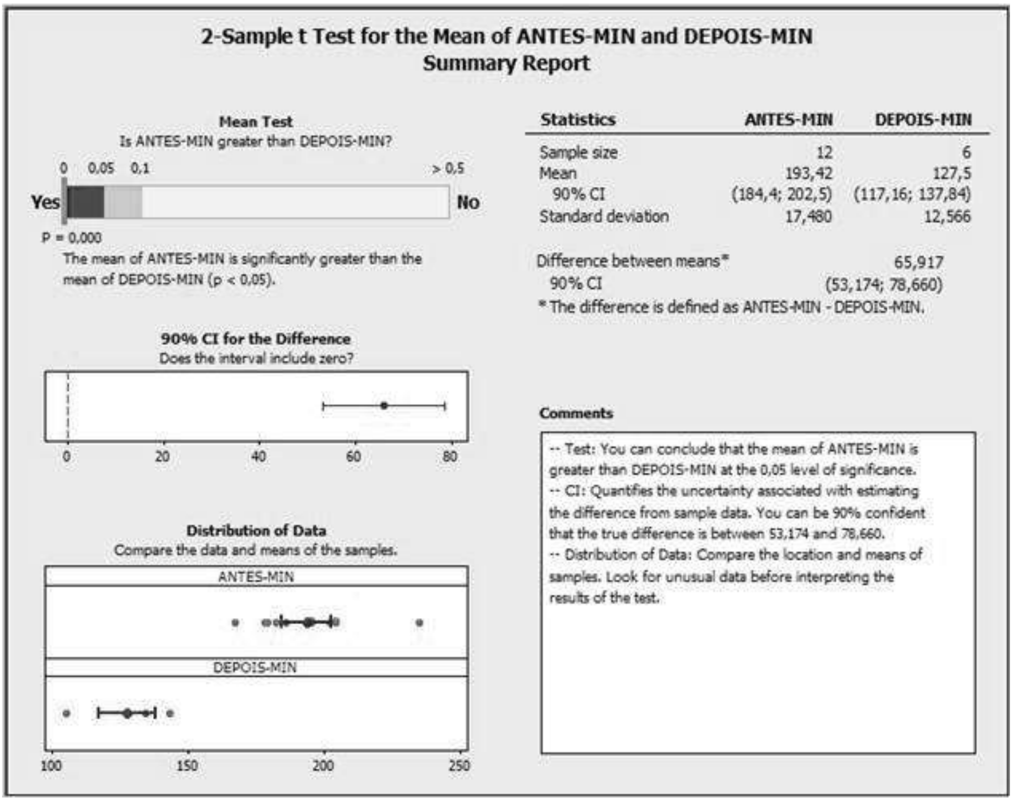


Table 1 - Probable Causes classified by their Influence Score

Probable Causes	Xn	Influence Score
Lack of planning	X1	209
Sales Order not registered in the system	X2	198
Volumes with wrong identification	X3	146
Product not delivered by production	X4	142
Disorganization of customers from domestic market and advanced payment	X5	139
Invoicing delay – Systemic Issues	X6	126
Unavailable number of forklifts	X7	117
Cargo location at the warehouse	X8	115
Clerk from vehicle yard arrival	X9	114
Lack of carrier	X10	100
Forklift Check-list	X11	60
Scale in maintenance	X12	56
Vehicle/Container non-conforming	X13	28

During the implementation of improvements, there were no resistance from the employees or from any other professional involved directly in the process. But the sales area has not supported the project in changing the procedure to domestic market or advanced payment, the customers included in those categories were not in favour of it. After three months of implementation, were possible to notice that the cycle time had reduced the average of these months to 02 hours and 08 minutes, representing 32% of reduction. It was done a 2-Sample t Test to verify if the mean before the improvements was significantly bigger than after the improvements, Figure 3 illustrates the tests results.

Figure 3 - 2-Sample t Test for the Mean Before and After the Improvements



Besides the cycle time, it was possible to notice other indirect gains in the Shipping Area, as: the raise of productivity, due to the cycle time reduction it was possible to load a higher number of vehicle per day, increasing in 43% the daily loading; the reduction of overtime, compared to previous periods of demand peaks in the month, it was necessary to work overtime to attend all customers, but with the new cycle time the overtime was reduced in 38%. The financial gain was not accounted in this study because the objective was to measure only the operational gain, but it will be as a suggestion of future study, the impact of LSS in overtime financial budget.

After 12 months from implementation, it was calculated the Sigma Level to confirm the improvement. Figure 4 shows the Capability before the LSS improvements.

Figure 4 - Process Capability before LSS implementation

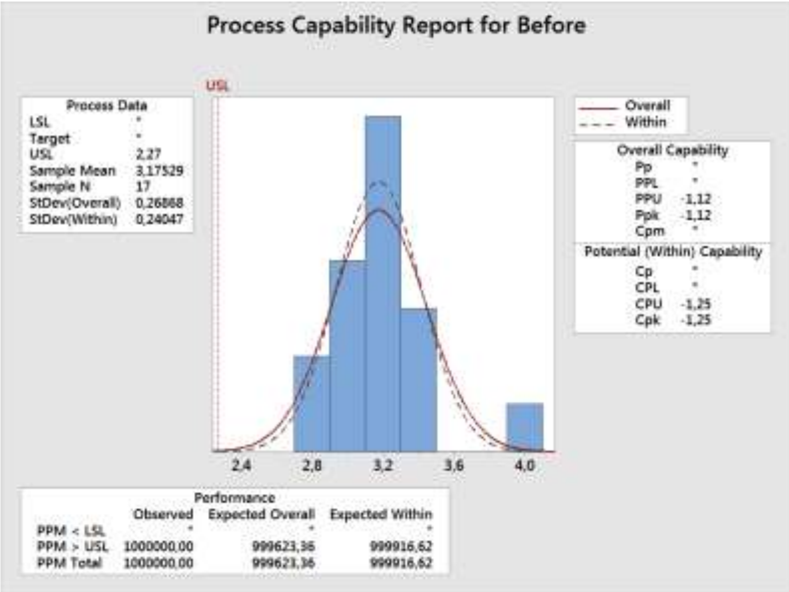
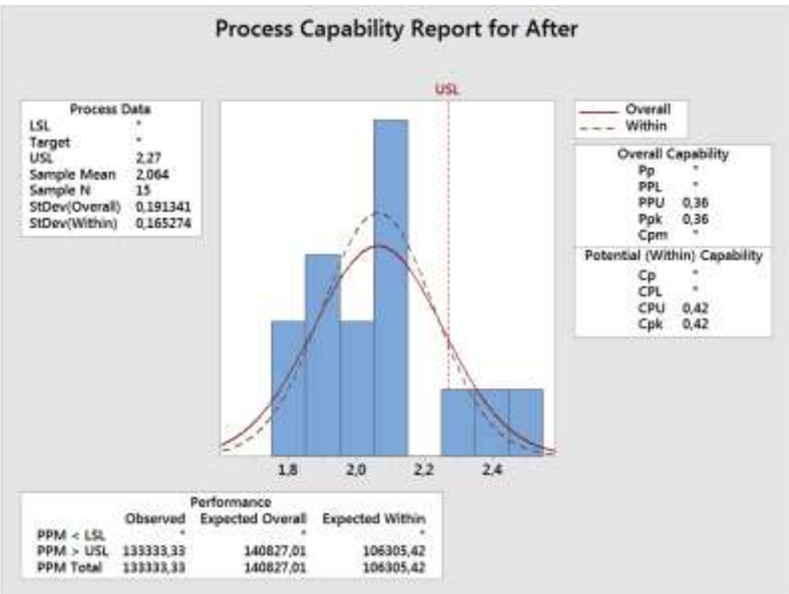


Figure 5 presents the capability after the implementation. After using the Equation (1) to calculate both Sigma Levels, it was possible to notice that the Sigma Level improved from -1.86 to 2.58 after the project closure.

Figure 5 - Process Capability after the improvement



It was possible to verify that the LSS project had a positive effect in the loading cycle time, confirming the potential of benefits and gains of the methodology used in logistics operations.

5 Conclusions

Lean Six Sigma is one of the most popular performance improvement methodologies. Being already consolidated in manufacturing industry, in the last few years it has acquired space among the service industry. The main reason is the increasing competition, forcing the organizations to reduce their costs and improve their services and products quality to raise the customer satisfaction and keep themselves in better market positions.

The logistics process is essential for the organizations' survival. It is involved from the receipt of purchasing order to delivering the service or product in the final customer, any failure through this results in rework, delay, waste, more costs and customer dissatisfaction.

This article aims to discover the benefits and challenges of implementing the DMAIC method in loading process. During the literature research was possible to notice that several authors report the resistance to change as one of the many challenges to apply the methodology in service industry. Objecting to circumvent this problem, it was held presentations and mini courses with the employees and inclusion of their opinions in the brainstorming, this way the implementation stage had no resistance from them.

Other explicit benefit was the reduction of the loading cycle time. This avoids several customer complaints, not only from the final customer but also from the carriers that had to wait all day to load their vehicles. Also, leads to two important gains, productivity improvement and reduction of overtime, both affect directly the company costs. As future study proposes, it is suggested to research the financial impacts of Lean Six Sigma to reduce overtime.

A challenge face during the probable solutions phase were the resistance from the customers to change the way of work, it was proposed to standardize the procedure to invoice and load the goods for domestic market and anticipated market to organize both categories. However, the sales area was not in favour to do any change against all customers' agreement.

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