REDUCED PREPARATION TIME AND THREADING THE COILS IN THE INTRY SECTION PLTCM*

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Abstract

This article deals with a project to reduce the preparation time and threading the coils in the input section of a pickling line coupled to the cold strip mill (PLTCM) at ArcelorMittal Vega. The project developed serves for the detection and elimination of bottlenecks in the input section. The project was conceived by the philosophy of the Theory of Constraints (TOC) and Lean Six Sigma (6 sigma), here seen as sequencing serial / parallel in the preparation and threading the coils. In this context, a proposal to modify the automatic sequencing and reduction of interruptions due to failure of the automation / equipment confirmed its effectiveness reducing the total time preparation time and threading the coils in the entry section by 15%. This project was developed without investment costs, bringing gains on the order of US$613,769.00.

Keywords: Bottleneck; Preparation and threading coil, setup in continuous processes; Lean Six Sigma.

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1 INTRODUCTION

Increasing the complexity of chains and production networks, coupled with the evolution of consumption patterns in world society, a profound change has been observed in the last decades in the manufacturing of manufactured products, giving space for the emergence of new ideas and improvements in industrial processes. In the industry sector, due to meeting the challenges required for a lower cost of production and aiming high efficiency rates in the increasing market competitiveness, it is necessary to continuously improve the pickling line coupled to the cold strip mill (PLTCM).
According to Muther (1986) **(1).** and Slack, Chambers e Johnson (2002)**(2).**, he physical arrangement or layout can be defined as the study of the relative positioning of productive resources, men, machines and materials, that is, it is the combination of the various equipment / machines, areas or functional activities arranged adequately.
In this sense, the present article seeks to present a case study where it was proposed to apply improvements to reduce the preparation time and the coiling of the coils in the entry section of the PLTCM. The main objectives of the project are:

- ✓ Reduced preparation time and threading the coils in the PLTCM entry section, defined in this article as KPI - T0;
- ✓ Identify the idle time of the input section and propose optimizations;

Identify the potential / critical causes of the KPI - T0;

- ✓ Create specific controls to generate actions on detected deviations.

2 MATERIAL AND METHODS

With the objective of safe conditions for the implementation and operation of a system, as well as the identification of design errors, it was assumed that the designed solutions were previously evaluated using statistical methods before the system was effectively implemented.
The Theory of Constraints or TOC - Theory of Constraints**(3,4)**. designed by Eliyahu Goldratt, reveals itself as a decision model that seeks to identify constraints to optimize production while improving lead time for customers. For studies in the process, Six Sigma**(5).** is a methodology that focuses on improving processes, that is, identifying and eliminating the causes that cause the process to change over time. .

2.1 Pickling Line coupled to the cold strip mill (PLTCM)

ArcelorMittal Vega, located in São Francisco do Sul / SC, is one of the most modern flat steel processing units in the world, operating with advanced pickling, cold rolling and galvanizing processes. The company processes hot coils supplied by ArcelorMittal Tubarão, in Vitória / ES, which are transported by means of an innovative system of oceanic barges, known as cabotage.
The first process that the coils are subjected to the pickling line (Figure 1), where the steel coils are unrolled and welded together (type top) by a laser solder process, after being directed to the pickling tanks, chemical process that uses hydrochloric acid in the process of continuous cleaning of the plate, for elimination of the grindstone (remnants of iron from hot rolling). After this chemical bath, the sheet passes through the edge scissors section where the sides of the strip are trimmed to the width desired by the customer.

Subsequently, the strip is directed to the cold strip mill, a process that has four chairs that, through tension and pressure on the strip, stretch and reduce the thickness of the strip, being able to transform materials with a thickness of 1.8mm into 0, 37mm which is the minimum thickness reached today by the equipment, however the maximum input is 4.8mm.

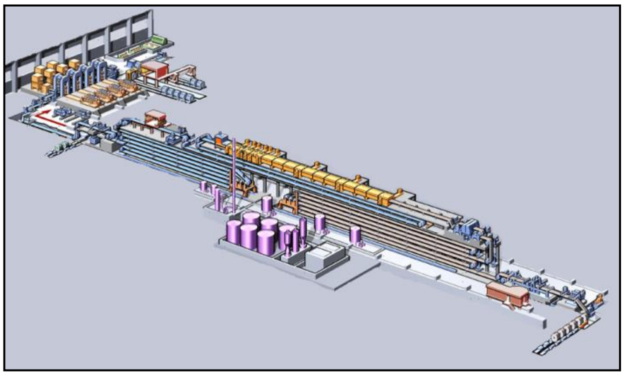

Figure 1. Layout pickling line coupled to the cold strip mill (PLTCM). (6)

2.2 Software and Equipment

In the configuration of the software and equipment used in this project to design a new coil preparation sequence mode in the input section, the following automation equipment (PLC) was used with the software, as shown in (Figure 2):

Figure 2. Layout HPCi and P80i (Alstom). (6)

2.3 Software Intouch (IHM)

In the configuration of the man machine interface used in this project to represent the tree of the sequences (CLP) was the Wonderware Intouch 7.1 / 7.11, according to (Figure 3):

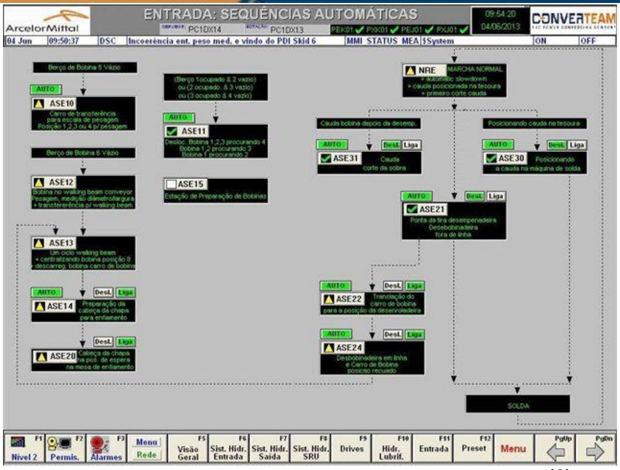

Figure 3. Layout Operation Screen. (6)

Figure 4 shows the configuration of the serial / parallel sequences of coiling and preparation of the coils at the PLTCM input, where KPI - T0 = 127,28 seconds.

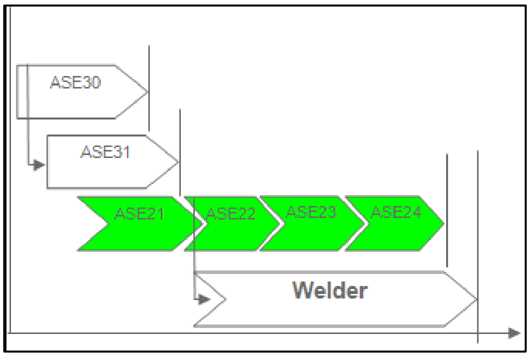

Figure 4.
serial / parallel sequence configuration of the PL.(6)

2.4 Basic statistics (before)

The studied KPI - T0 is composed of sequences (series and parallel) that, after execution, the result is in seconds.
Process capability report is the measure of the probability of a process generating defects, which is measured in standard deviation (σ). The greater the probability of a process generating defects, the smaller the capacity and, therefore, the lower the value of (σ). The short-term capacity (Zst = 2.21sigma), generating 23.89% of events outside the target KPI studied (goal 127sec.) as shown in (Figure 5):

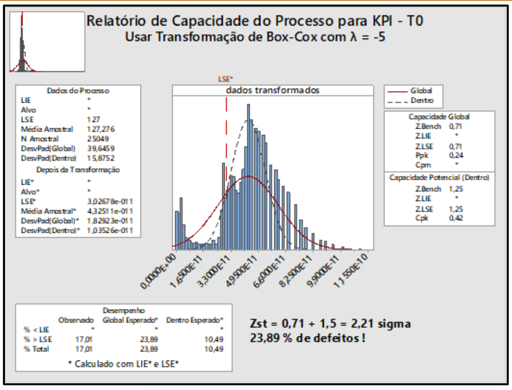

Figure 5. Process capability report (before).(6)

It was used to evaluate the KPI-T0 standards over time the Time series chart graph (Figure 6). In this graph it is possible to identify many events above the target (127sec) reaching values of 600sec here in this study called the standard deviation.

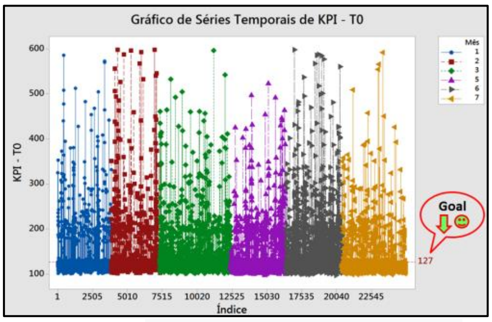

Figure 6. Time series chart graph.(6)

3 RESULTS AND DISCUSSION

3.1 Measure and Analyze Phase

In the measurement phase 4 steps were created to analyze the studied KPI-T0 behavior as shown in Figure 7.

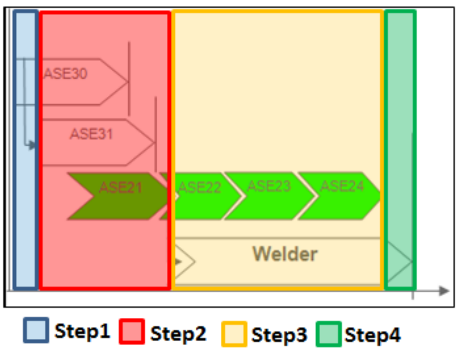

Figure 7. Steps configuration of the KPI-T0.(6)

Using the multiple regression method to study the influence of the 4 steps on the KPI-T0 result, in order to understand the correlation of the variables that have the greatest influence. The R2 (Aj) indicates that the correlation of the 4 steps is 99.47%, the P-value indicates that there is no multicollinearity and the VIF indicates that there is no correlation between the steps. It shows an equation that allows to find the ideal value for each step for the desired goal, according to (Figure 8):

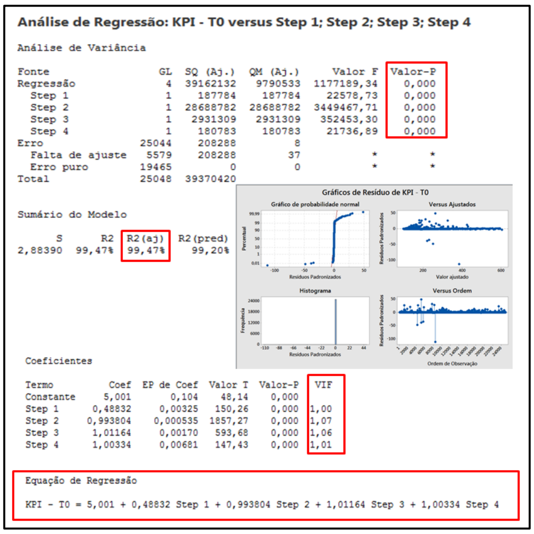

Figure 8. Multiple Regression.(6)

We analyze the Pareto graph of the effects (Figure 9), which allows us to define that Steps2 and 3 are the largest generators of the KPI-T0 result.

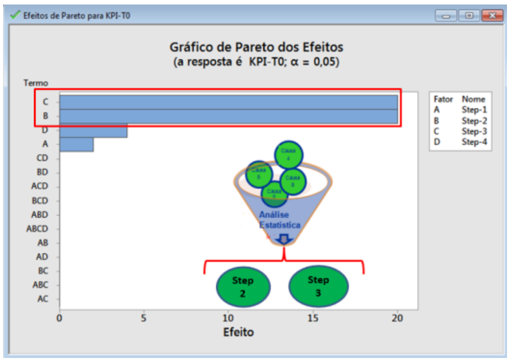

Figure 9. Pareto chart of effects.(6)

From the selection of Steps 2 and 3 the Pareto graph was generated for the fault modes, where 10 fault modes were selected to mitigate the effects in the studied KPI_T0, as shown in (Figure 10):

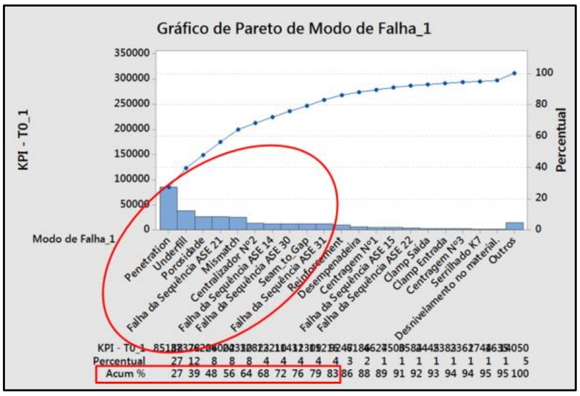

Figure 10. Pareto's chart.[6]

After executing the action plans for the selected fault modes, the new process capability was made increasing the Zst to 2.61sigma (σ) and reducing the percentage of defects to 13.40% according to Figure 11.

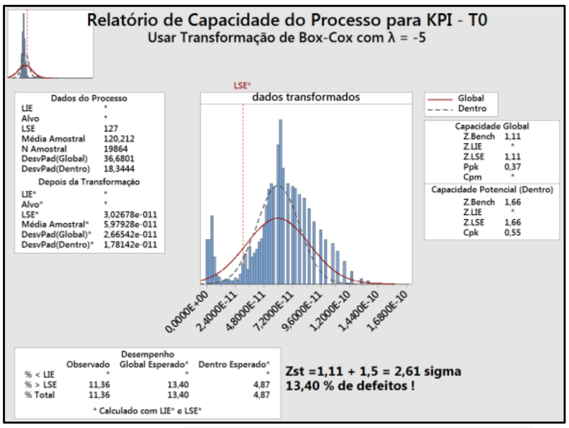

Figure 11. Process capability report (current).[6]

With this, it was seen that the mean and standard deviation of the KPI-T0 changed (Figure 12), with an improvement in 15% of this indicator, bringing gains on the order of US$613,769.00.

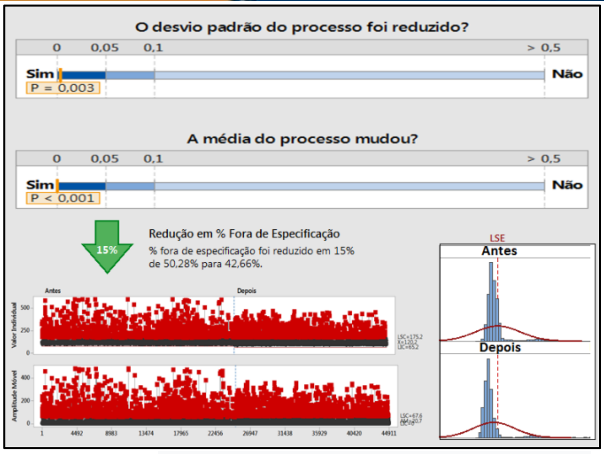

Figure 12. Comparative table (before and current).[6]

Nevertheless, goal indicators were created for each Steps, thus allowing the creation of statistical process charts (CEP) for daily monitoring of the KPI-T0, according to Figure 13.

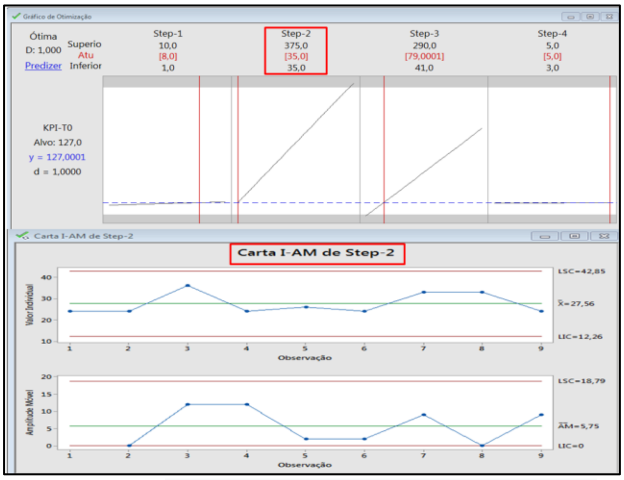

Figure 13. Comparative table (before and current).[6]

3.1 Phase implementation

The changes in the automatic and fault sequences to mitigate the standard deviation, and to act directly in the reduction of the bottlenecks of the pickling line coupled to the cold strip mill (PLTCM), was necessary, in the implementation phase using the 6 sigma methodology.
In contrast, the concept of productivity that the new mode of insertion establishes aims at eliminating bottlenecks of the entry

section contemplating the optimal scenario for each step of the studied KPI-T0.
The implementation of the project initially brought discomfort and conceptual doubts to maintenance and operation employees. To minimize the impact, a training routine was established with the objective of gradually enabling them to each modified sequence and mitigated failures.
This routine was supported by top management, where monthly reports were issued informing the evolution of the project. At the end of the implementation phase, the KPI-T0 indices were significantly reduced and paradigms in terms of continuous improvement in production processes, where today the project was integrated into the day-to-day operations and maintenance teams, currently an indispensable tool.

4 CONCLUSION

In this work we propose the use of serial / parallel sequencing and fault sequences to mitigate the standard deviation for the coiling and preparation of the coil at the PLTCM input. This sequencing is quite simple, and has demonstrated efficient performance, having a 15% reduction in KPI-T0.
The automation developed used a control block implemented in a HPC high performance controller, where it provided faster and more efficient control in the new preparation and threading mode.
It is important to emphasize that the results obtained in an industrial process do not guarantee positive results for other industrial processes, and it is advisable to simulate several scenarios for each application, thus allowing an evaluation of the feasibility of implementation in the industrial process studied.

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