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Application of MASP tool to avoid ruptures in the stock of a steel plant

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ABSTRACT
In today's highly competitive economic environment, with challenging goals to be achieved, companies are always seeking to remain competitive, aiming for a high level of efficiency in their processes and seeking total customer satisfaction. To achieve a high level of performance, organizations need a high level of management in their operations so that their product reaches its destination as planned.

Keywords: MASP tool, Steel mill.

INTRODUCTION

In the current economic scenario of great competitiveness and with challenging goals to be achieved, companies always seek to remain competitive, aiming for a high level of efficiency in their processes and seeking total customer satisfaction. To achieve a high level of performance, organizations need a high level of management in their operations so that their product reaches its destination as planned.

Maintaining good raw material inventory management is a fundamental part of a company's strategy, and inventory control in manufacturing industries, in general, is one of the factors necessary for the economic health of every company. According to Slack, Chambers and Johnston (2008), inventory management consists of planning and controlling the resources acquired during the period. These resources can be materials, information, money and even customers.

For Pozo (2007), all processing companies must be concerned with inventory control, considering that they perform and affect the company's results in a well-defined way. Inventories need to be controlled so that there is no disruption in the production chain and affecting customer service. Poor management can result in the lack of an item necessary to manufacture the product that the customer demanded and this will cause the production sector to stop, consequently causing financial losses for the company.

Much more than having a well-designed physical space in the work area, good inventory management can bring numerous benefits throughout the company's structure and thus raise the level of

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earnings for the organization. Managing inventory means managing an important part of your assets. Steel products represent strong indicators of a country's economic development, and with the high competition at an international level, companies are forced to adapt to the scenario by offering better quality products.

In this sense, the objective of this work is to identify possible causes that cause disruptions in the production process, leading to production stops and delays in delivering the product to the customer, to be treated at the root cause in order to be eliminated and prevent them from recurring, thus ensuring that the process is continuous.

To achieve its results, the work is structured as follows, a literature review where topics on the subject are addressed, followed by the methodological procedures used in preparing the work, presentation and discussion of the results and finally its conclusions.

GOAL

This work aimed to analyze failures that generated stoppages in the production sector due to ruptures caused by the lack of scrap, using the MASP tool.

METHODOLOGY

This research will investigate the application of the MASP tool - Method of Analysis and Problem Solving, in order to analyze and propose an efficient method for managing scrap stocks. This research is considered basic in nature since the objective is to expand knowledge of the topic exposed here, contributing to the creation of a more aligned and efficient inventory management method, which guarantees its applicability in all spheres of the company under study.

Through the application of the MASP tool, since the research will be of a basic nature, the work will carry out analysis through the use of documents, management reports, and the collection of data collected from the operating system, which favor the identification of opportunities for improvement for the company under study.

This research was carried out in a steel plant located in the municipality of Maracanaú, Ceará, with data collection, investigations and analysis provided by the company. In this way, the information presented in this research will be based on the references collected during this work. The company has been in existence for 110 years and has been operating in the State of Ceará for 37 years, employs around 300 employees and has an annual production capacity of around 189,000 tons of steel per year.

The work was organized in such a way as to make it easy to understand the information about the company under study. The data collected was analyzed and consolidated in order to answer the problem

of this research. Through these records, stock control analyzes were carried out, observations of storage, analysis of production and sales behavior, and statements issued on the data collected.

DEVELOPMENT

In this chapter, concepts will be presented that will provide the necessary basis for the work, with the aim of delving a little deeper into the topic.

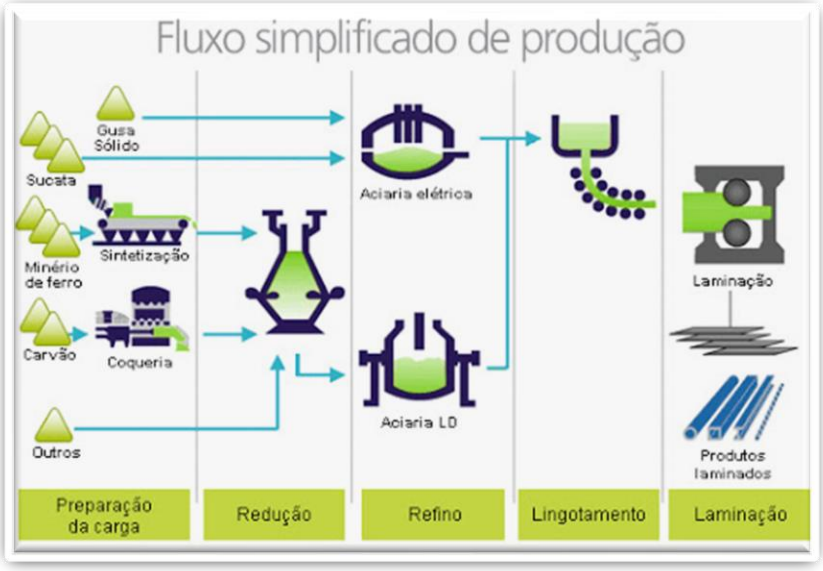
STEEL INDUSTRY

Steel production in the world today continues to be a key element that drives the development of a country, defining the degree of development, maturity and several other socioeconomic indicators of a nation. Within the global context, the steel industry is constantly growing and with this challenges go hand in hand.

For Carvalho, Mesquita and Araújo (2015), steel is an iron-carbon metallic alloy in which iron occupies around 98% and carbon up to 2%. Among many other properties, steel presents mechanical resistance, malleability and ductility, as its main characteristics necessary for its various applications in structural engineering.

Figure 1 illustrates the simplified steelmaking process flow:

Figure 1 – Overview of the steel production process



Source: Brazil Steel Institute (2020)

INVENTORY MANAGEMENT

In search of competitive advantages, companies are increasingly seeking to reduce costs in their operations. One of the alternatives for reducing the capital burden employed is to work with minimum

stocks and in quantities that meet demand, and do not cause disruption in the production system. their stocks.

Therefore, it is important that there is harmonious coordination between demands and supplies, having a complete analysis of what to buy, in what quantity, and when to request the purchase. All of this involves a thorough study so that there are no surpluses, stock shortages, or errors in the transformation process and that the organization does not suffer losses, but rather profits, with this planning (PESSOA and LOOS, 2017).

For Dias (2005), inventory is necessary for a company's production and sales process to operate with a minimum number of concerns and without unpleasant surprises. For this to happen, accurate stock control is necessary that represents reality in real time and this is a challenge for many companies.

According to Martins and Alt (2006), inventory management consists of several actions with the aim of verifying whether the resource is being used correctly, whether it has been handled appropriately and whether it has been well controlled. This is extremely important considering that inventory control represents a large part of a company's assets.

It is a very difficult task to work with thousands of stocked items, supplied by different suppliers, selling the product to many different customers, this makes the operations task quite dynamic and complex. Controlling such complexity requires highly improved practices and methods. This requires a system where stock information is kept up to date safely and quickly and is always updated and detailed according to its specific characteristics.

ABC ANALYSIS

The ABC system is a technique used to measure and have a better visualization of costs in all activities of a company, as well as attributing this cost to the product or service provided by the organization. Pozo (2007) states that the principle of the ABC curve was initially developed by Vilfredo Pareto, in Italy, at the end of the 19th century, when in 1897, he prepared a study of the distribution of income and wealth of the local population. This general principle was later spread to other activities and became a very useful tool for administrators.

According to Slack, Chambers and Johnston (2008), a common way to differentiate inventory items is to classify them by their consumption value. Items with a high consumption value must have more careful control and, on the other hand, those with lower values do not need to be controlled as rigorously as those with high value. In this way, items are classified into categories A, B or C, which will vary depending on their consumption value.

The ABC analysis has the following division and classification of items according to their degree of relevance:

Class A items: These are the most important items and should receive full attention at the first stage of the study, as the data classified here corresponds, on average, to 80% of the total monetary value (guideline value, not a rule); Class B items: These are intermediate items that must be dealt with immediately after the measures taken on class A items, and correspond on average to 15% of the monetary value; Class C items: These are items of lesser importance, although large in quantity, but with a very low monetary value, allowing more time for analysis and taking action and representing on average only 5% of the monetary value.

MASP

The Problem Analysis and Solving Method (MASP) is a systematic way of carrying out corrective and preventive actions to eliminate problems. According to Aguiar and Loos (2017), the MASP method is of Japanese origin and has 8 steps, where each step helps to identify the problem and develop corrective and preventive actions to eliminate or minimize it.

It is a method based on a sequence of eight steps that serves to identify, analyze and solve problems, in order to avoid recurrences, through tools that complement the method, as shown in table 1. The 8 steps of the MASP tool are:

Table 1: MASP Stages

1	Problem identification	Selection and history of the problem and its losses.
two	Observation	Data collection and problem characteristics.
3	Analysis of probable causes	Discovery of influential causes, choice of the most likely.
4	Action planning	Preparation of the strategy and action plan.
5	Action	Practice of the action plan, beginning of implementations to block the problem.
6	Verification	Comparison of results, listing of effects, checking whether or not the problem continues.
7	Standardization	Development or change of standard, communication, training and communication of the use of the standard.
8	Conclusion	List of remaining problems, planning the attack on problems and reflection.

Source: Author (2020)

According to Lobo and Loos (2019), when applying MASP to solve problems, the user inevitably needs to use some quality tool. This means that just using the method is not enough to solve problems effectively. The tools need to help the process, doing something that the method is not capable of.

Among the main advantages of using MASP are: the possibility that people involved in the process understand the importance of quality through problem solving; the generation of benefits in terms of quality, costs, safety, delivery, morale, sales, the identification of leadership skills, and the management of people.

CASE STUDY

Relevant information regarding the problem of inventory management was observed, that is, information linked to inventory control and management, as well as the efficiency of scrap processing that generated losses, high inventory costs and disruptions in the steel production sector.

Data relating to the company's stock control necessary to identify the problem and understand how it starts was collected through rounds of Brainstorming. In this survey, the following observations were found:

Increase in total stock; High inventory costs; Production losses on some processing fronts; Lack of standard procedures for inventory management and control.

The analyzes were carried out based on data obtained from the company in question. As can be seen in graph 1, there was a gradual increase in the scrap stock:

Graphic 1. Variation in total scrap stock over the months

Source: Author (2020)

As can be seen, according to graph 1, it was possible to see an increase in scrap stock between the months of April and June 2019 and it remained on a growth trend. Also according to graph 1, consequently, it was possible to observe an increase in inventory costs, since the demand necessary for a safe operation would be around 20,000 tons of scrap.

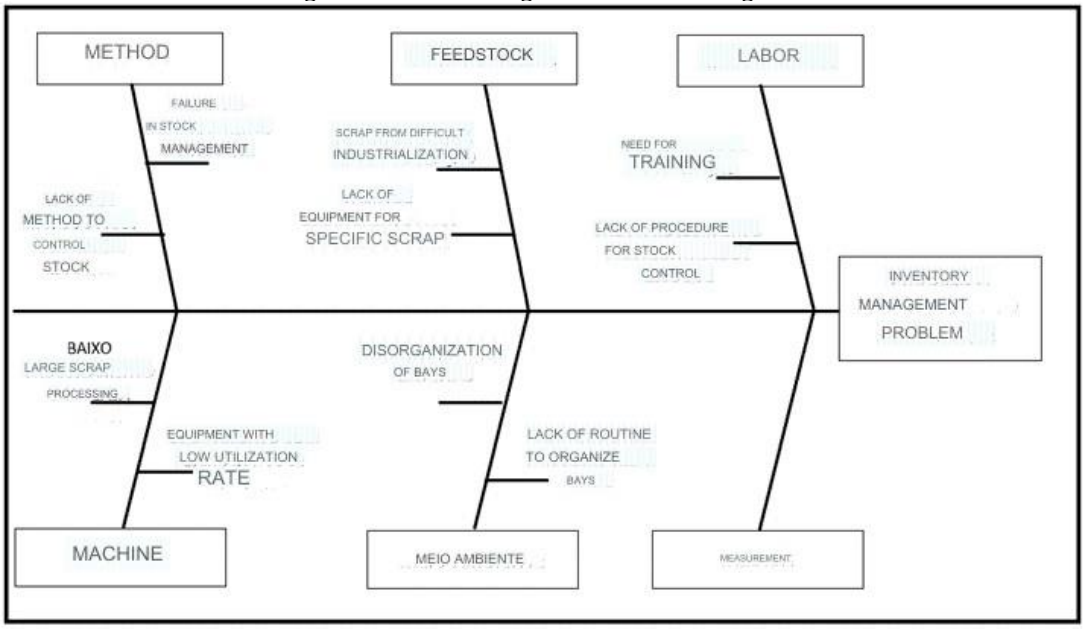
CAUSE AND EFFECT ANALYSIS

In this stage of problem analysis, a cause and effect analysis was carried out to identify the problem of the gradual increase in scrap stock. For this, the Ishikawa diagram (fishbone diagram) was used, aiming to identify the probable causes of the inventory management problem.

According to Morais and Loos (2016), the cause and effect diagram, or even Ishikawa diagram – its “creator”, or even better known as the fishbone is used to facilitate visualization between the factors that cause the problem, and the its effect.

According to Moreira and Loos (2018), an Ishikawa diagram is a graphical tool whose main objective is to identify the causes of an effect or problem. It hierarchically structures potential causes, as well as opportunities for improvement, as shown in figure 2.

Figure 2. Ishikawa diagram or fishbone diagram.



Source: Author (2020)

In figure 2, some basic causes and root causes were identified that corroborated the generation of the problem. Causes that after on-site analysis, it was realized that they were caused by a chain reaction, since stocks increase at an accelerated pace, outside of normal, making it difficult to organize the physical space, easily losing control and no longer being able to resume it if there is not a medium term planning. In the next topic, the action plan that was used to treat and eliminate these causes will be shown.

ACTION PLAN

At this stage, the 5W2H tool was applied for planning, putting together the plan and monitoring the unfolding of actions over time, with the aim of making it clear who was responsible for each action with the respective dates.

According to Pinheiro and Loos (2016), 5W2H is a tool for preparing action plans which, due to its simplicity, objectivity and action orientation, has been widely used in Project Management, Business Analysis, Preparation of Business Plans, Strategic Planning and other management disciplines. Below, in figure 3, the plan according to the 5W2H methodology is demonstrated.

Figure 3. 5W2H.

5W2H							
AÇÃO	O QUÊ	PORQUE	COMO	ONDE	QUEM	QUANTO	QUANDO
1	Aplicar método de gerenciamento eficaz para controle de estoque	Para gatrantir uma rotina no gerenciamento de estoque	Consultoria	Externo	Coordenador da produção	R$ 20.000,00	30/03/2020
2	Capacitação da equipe do pátio de sucata em gestão de estoque	Para gatrantir o cumprimento do procediemento de gerenciamento do estoque	Treinamento com equipe do SENAI	Externo	Coordenador da produção	R$ 5.000,00	30/04/2020
3	Contratar equipe terecirizada para realizar processamento	Para garantir os níveis de produção e atendimento a ordens de produção	Contratação de equipe terceirizada	Externo	Gerente de produção	R$ 1.000.000,00	01/10/2019
4	Estudo de viabilidade de fontes de processamento alternativo para industrialização de sucata GRA	Para aumentar o processamento da sucata graúda para corte	Fazer uma análise de viabilidade técnica	Externo	Coordenador da projeto	R$ 15.000,00	01/11/2020
5	Criar rotina de manutenção preventiva de equipamentos de industrialização	Para aumentar a disponibilidade dos equipamentos de industrialização de sucata graúda para corte	Criar cronograma de manutenção de equipemantos	Interno	Coordenador da produção	R$ -	03/01/2020
6	Criar rotina de organização das baias de sucata periodicamente	Para garantir uma completa organização da área garantindo a produtividade de todas as fentes	Criar cronograma semanal	Interno	Coordenador da produção	R$ -	03/10/2019

Source: Author (2020)

MONITORING OF ACTIONS

All actions were monitored by their respective managers so that the status of each one could be viewed. This monitoring was led by the person responsible for the project, with an engineer specializing in projects being the central leader. Monitoring took place on-site, checking progress with each person responsible and, if there were any problems, corrections were made to the deviation.

One of the most important actions at this stage was the application of the inventory control method following the ABC curve. Through it, it was possible to check and take actions to reduce stock and a specific action to reduce the stock of large scrap for cutting. According to table 2, the ABC curve method is applied to control scrap inventory. The table concerns scrap stock items, which were listed and classified according to their degree of importance and quantity, respectively. The ABC classification helped in making classification decisions.

Table 2. Scrap stock items according to ABC classification

CURVA ABC				
MATERIAL (sucata)	QUANTIDADE (kg)	PERCENTUAL (%)	PERCENTUAL ACUM. (%)	CLASSIFICAÇÃO
GRA-SUCATA GRAUDA PARA CORTE	12.027.643,40	32%	32%	A
MIS-SUCATA MISTA/CHAPARIA	8.291.777,00	22%	53%	A
PME-SUCATA PCTE MISTO DE ENCHARUTADO	6.936.461,40	18%	71%	A
SPCTE-SUCATA PACOTE (CONSUMO)	1.452.367,20	4%	75%	B
STES-SUC TESOURADA (CONSUMO)	1.362.758,67	4%	79%	B
FFG-SUCATA DE FERRO FUNDIDO GRAUDO	1.065.756,00	3%	82%	B
SPES-SUC PESADA(CONSUMO)	983.073,41	3%	84%	B
EMR-SUCATA DE EMARANHADO	911.480,00	2%	87%	B
MIU-SUCATA MIUDA	834.076,98	2%	89%	B
REC-SUCATA RECUPERADA	578.910,98	2%	90%	B
SGU-SUCATA FERRO GUSA	511.776,00	1%	92%	C
PEP-SUCATA PCTE DE ESTAMPARIA PRETA	506.870,00	1%	93%	C
SSHRV-SUC SHREDDED (VENDA)	468.160,00	1%	94%	C
SMIU-CONSUMO	425.953,27	1%	95%	C
SFOFO-SUC DE FERRO FUNDIDO (CONSUMO)	308.410,30	1%	96%	C
SUCG-SUC DE GUSA (CONSUMO)	244.022,70	1%	97%	C
ARP-SUCATA ARAME DE PNEU	235.416,60	1%	97%	C
SESP-SUC ESTAMPARIA PRETA (CONSUMO)	194.329,49	1%	98%	C
TES-SUCATA TESOURADA	180.379,00	0%	98%	C
SPCT-SUC DE PACOTE (CONSUMO)	134.854,20	0%	99%	C
SREC-SUC RECUPERADA (CONSUMO)	125.447,70	0%	99%	C
ESG-SUCATA ESPECIAL GRAUDA	121.631,40	0%	99%	C
CFF-SUCATA DE CAVACO DE FERRO FUNDID	67.060,00	0%	100%	C
SUCATA CANIVETE.	63.680,00	0%	100%	C
CANIVETE REFRIGERANTE	54.400,00	0%	100%	C
SCAVA-SUC CAVACO DE ACO (CONSUMO)	38.393,46	0%	100%	C
FERRO GUSA TIPO 1	25.000,00	0%	100%	C
FFM-SUCATA DE FERRO FUNDIDO MIUDO	5.334,00	0%	100%	C
BFF-SUCATA DE BRIQUETE DE FERRO FUND	1.298,00	0%	100%	C
ESR-SUCATA DE ESTAMPARIA REVESTIDA S	733,98	0%	100%	C
PMI-SUCATA PCTE DE MISTA/CHAPARIA	406,00	0%	100%	C
OXI-SUCATA DE OXICORTE	283,00	0%	100%	C
CAV-SUCATA DE CAVACO DE ACO	124,70	0%	100%	C
OSE-SUCATA OBSOLESCENCIA SEPARADA	73,00	0%	100%	C
AMT-SUCATA AMORTECEDOR	62,00	0%	100%	C
SHR-SUCATA FRAGMENTADA	58,98	0%	100%	C
FERRO GUSA FORMATO IRREGULAR	0,00	0%	100%	C
RECUPERADA BAIXO TEOR "C"	0,00	0%	100%	C
ESP-SUCATA DE ESTAMPARIA PRETA SOLTA	0,00	0%	100%	C
PER-SUCATA PCTE DE ESTAMPARIA REVEST	0,00	0%	100%	C
MDI-SUCATA MIUDA DE INDUSTRIA	0,00	0%	100%	C
FBA-SUCATA DE FUNDO DE BAIA	0,00	0%	100%	C
RETORNO INTERNO PARA PROCESSAR	0,00	0%	100%	C
RETORNO INDUSTRIAL PRONTO CONSUMO	0,00	0%	100%	C
SSHR-SUC SHREDDER	0,00	0%	100%	C
SEMR-SUC DE EMARANHADO PARA CONSUMO	0,00	0%	100%	C
SGUS - FERRO GUSA (CONSUMO)	0,00	0%	100%	C
SMIS - SUC MISTA (CONSUMO)	0,00	0%	100%	C
SUCATA B (CONSUMO)	0,00	0%	100%	C

Source: Author (2020)

For Chagas and Loos (2019), one of the ways to analyze and control inventory is through the ABC curve (Activity Based Costing – Costing System), as it allows identifying products that justify attention and appropriate treatments in relation to their administration.

In this case, action needed to be taken to reduce the stock of large scrap for cutting and reduce the total stock. The other actions were of great value, as with them the importance of taking actions to obtain reliable and effective inventory management could be realized.

5W2H was also very important at this stage, as all the action planning was carried out so that they were clear to the performers. At this stage, the aim was, specifically, to check whether something was out of control, taking into account the deadline, cost and whether the action was being implemented effectively.

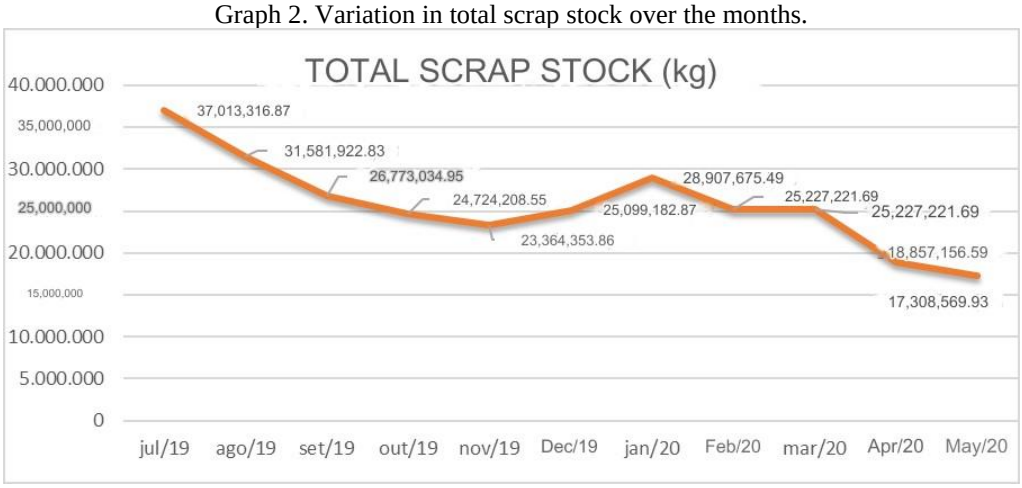
CHECKING THE EFFECTIVENESS OF ACTIONS

After the actions were completed, their effectiveness was examined, checking whether the objective was successful or not.

One of the main actions where the MASP tool was effective was in the implementation of inventory management using the ABC Curve method for scrap inventory management. This tool was extremely important for decision-making with regard to classifying items by degree of relevance, providing guidance for decision-making.

In the case of total stock, the action was successful, as there was a significant reduction in the amount of total stock available shortly after applying the ABC curve method for stock management, as shown in graph 2.

Graph 2. Variation in total scrap stock over the months.



Source: Author (2020)

STANDARDIZATION OF THE PROCEDURE

At this stage, a task force was created to standardize all actions carried out. The aim was to make stock control and management routine, using all the actions raised in the action plan. From then on, scrap inventory management using the ABC curve became routine.

All operational procedures were recorded and many lessons were learned, which were later passed on to operational levels.

FINAL CONSIDERATIONS

This work aimed to analyze failures that generated stoppages in the production sector due to ruptures caused by a lack of scrap. These scrap shortages were caused by the lack of good management of raw material stocks.

It can be concluded throughout the work that, due to a failure in stock management, the production process became unreliable and was susceptible to errors that caused losses to the business. It was also possible to notice that the failure in stock management masked many other problems related to productivity, which became possible to visualize throughout the work.

To eliminate this problem, the MASP tool was applied, which was fundamental for the treatment. MASP, together with other tools and techniques such as 5W2H, Brainstorming, graphs, Ishikawa diagram, among others, worked from identifying the problem, going through the action plan until reaching its conclusion.

Finally, it can be concluded that a control tool, the ABC curve for inventory control, brings numerous benefits to the business, by reducing the chances of interruptions/ruptures in the production sector that lead to unplanned stops in the production chain, maintaining organization of metal scrap storage bays, leaving visible problems that hindered the productivity of other production fronts, layout of scrap storage in the area, and guarantees the delivery of the product to the customer at the right time, which, in the end, is the biggest purpose of large, medium and small organizations, as the customer always comes first.

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