SEVEN
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Implementation of the 5s Methodology in an electronics factory

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ABSTRACT
In the current global development reality, people are becoming increasingly critical and demanding in relation to various aspects, especially the quality of the products they consume. Camargo (2011, p. 19) states that constant evolution and easy access to information are increasingly demanding levels of quality in relation to products and services. In this way, the constant technological developments to which human beings are exposed require a continuous increase in the quality present in a company's various processes.

Keywords: 5s Methodology, Electronics factory, Quality.

INTRODUCTION

In the current developmental reality of the Globe, people are becoming increasingly critical and demanding in relation to various aspects, especially the quality of the products they consume. Camargo (2011, p. 19) explains that constant evolution and easy access to information increasingly increase the demand for quality levels in relation to products and services. Therefore, the constant technological developments to which human beings are exposed require a continuous increase in the quality present in the various processes of a company.

To achieve continuous improvement within any production context, there is an urgent need for the correct use of the 5S methodology. With the evolution of Quality methodologies and tools, it was realized that the more people involved in the qualitative process, the better. The ideal situation is exposed by Fernandes (2011, p. 42) who states that ensuring the quality of a product or service is everyone's job in the company, and it is necessary to define, in a clear and objective way, the participation of each employee in what they say. respect for Quality. Fernandes (2001, p. 42) also states that if the aforementioned situation does not exist, there is a risk of reduced responsibility, which would generate failures in quality processes.

In this way, the application of the 5S methodology is directly linked to the Quality of companies, as it aims to improve 5 vital aspects for the development of any manufacturing environment and consequently any production line and process, with these 5 aspects being covered in more depth when throughout the work, showing its importance and the like. As a pillar of the use of the 5S methodology

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and its implementation, this work uses the requirements of the Brazilian standard NBR ISO 9001 which deals with Quality Management.

GOAL

This work seeks to demonstrate the implementation of the 5S Methodology (Seiri, Seiton, Seiso, Seiketsu and Shitsuke) in an electronics factory located in the state of Ceará, manufacturer of electrical energy management equipment, using the Energy Management System as a reference. Quality, based on the ABNT NBR ISO 9001 standard.

METHODOLOGY

This work is based on research. About research: it can be defined as the rational and systematic procedure that aims to provide answers to the problems that are proposed (GIL, 2007, p.17). Still according to Gil (2007, p.32-34), research can be classified in four ways: according to the area of knowledge, according to its purpose, according to its more general purposes and according to the methods used. This work has research based on the Engineering knowledge area according to the National Council for Scientific and Technological Development (CNPq).

The purpose of the research presented here classifies it as applied research, as it is aimed at acquiring knowledge with a view to applying it in a specific situation. In the present case, the application is in the continuous improvement of an electronics industry. Regarding more general purposes, there is descriptive research, designed to identify possible relationships between variables. The scoring results of the 5S audits shown in figures 15 and 16 are the main variables of the context under study and are directly related to the objectives of the work. Finally, it can be mentioned that the present research has data of a quantitative and qualitative nature, investigating descriptive and personal information on the subject of the 5S methodology, including opinions and feedback, in addition to containing numbers and scores on the topic. It should also be mentioned that this research lasted 6 months and the collection space was an electronics company located in the municipality of Eusébio in Ceará.

DEVELOPMENT

This topic presents a review of the literature used in the work with an emphasis on the NBR ISO 9001 standard and the 5S methodology.

ISO 9001

With the increasing globalization of the economy, it has become necessary to standardize Quality systems across the globe. In this way, ISO (*International Organization for Standardization*), international

organization created in 1947 to take care of the standardization of various sectors of the economy and composed of several TC's (*Technical Committee*), approved five ISO 9000 standards in 1987 relating to Quality Management to facilitate international trade, and with the holding of new meetings, increments and updates were made. In Brazil, ABNT, a Brazilian association equivalent to ISO, created the Brazilian Quality Committee (CB) to prepare NBR ISO 9001, national standards similar to defined international standards (FERNANDES, 2011, p. 45). It is also highlighted by Fernandes (2011, p. 46) that the treatment of these norms is not a simple translation of the once first norms but rather a version adapted to the national reality. Furthermore, the creation of ISO 9001 enabled the certification of company systems by independent bodies, eliminating the need for companies to be evaluated by only a select group of government bodies or by specific clients.

Adopting a Quality Management System is a strategic decision for an organization that can help improve its overall performance and provide a solid foundation for sustainable development initiatives (ISO 9001, p. 7). The standard in question, last updated in 2015, still brings a series of benefits generated by the correct implementation of a Quality Management System, based on these international standards and adapted nationally. Here are some:

- Ability to consistently provide products and services that meet customer requirements and applicable statutory and regulatory requirements;
- Facilitate opportunities to increase customer satisfaction;
- Address risks and opportunities associated with contexts;
- Ability to demonstrate compliance with specified Quality Management Systems requirements.

It can also be highlighted that the ISO 9001 standard is based on some Quality Management principles, as cited by Albertin and Guertzenstein (2019, p. 19-20) in table 1 of this work.

Table 1: Quality Management Principles based on ISO 9001

ISO 9001:2008 principles	Description
Systemic approach to management	Understand the organization as a set of interrelated processes that contribute to the effectiveness and efficiency of the organization.
Leadership	They should create and maintain an internal environment in which people can be fully involved in achieving the organization's objectives.
Process Approach	A desired result is achieved more efficiently when related activities and resources are managed as a process.
Factual approach to decision making	Effective decisions are based on the analysis of data and information

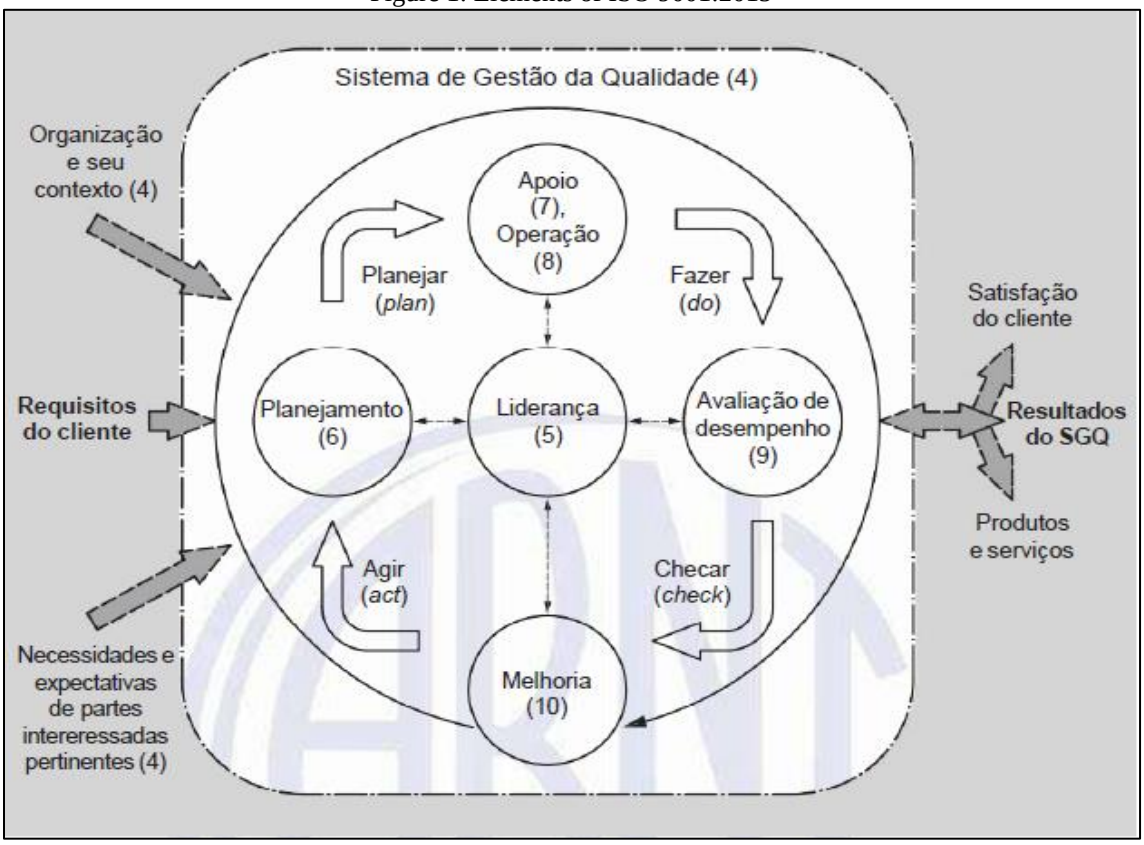
Continuous improvement	The continuous improvement of the organization's global performance should be its permanent objective.
People Involvement	People at all levels are the essence of an organization, and their involvement allows their skills to be used for the benefit of the organization.
Focus on the customer (and stakeholders)	Organizations depend on their customers and must meet their current and future needs, their requirements, exceeding their expectations.
Mutual benefits in relationships with suppliers	A mutually beneficial (win-win) relationship increases the ability of both parties to add value.

Source: Based on ISO 9001:2008

Aligned with the Quality Management principles mentioned in table 1, ISO 9001 has 10 elements in its high-level structure that relate to each other and dictate the use of the standard and configures a structure compatible with other Brazilian standards, such as NBR ISO 14001 (Environmental Management System), NBR ISO 50001 (Energy and Utilities Management System), NBR ISO 22000 (Food Safety) and NBR ISO 27001 (Information Security Management System). This alignment between standards has great relevance in government audits and in regulations requested by the Public Power, encompassing companies of all types and sizes and configuring another benefit of the Brazilian Association of Technical Standards (ABNT).

The 10 elements demonstrated in figure 1 are in a faithful orientation to promote continuous improvement in the management of a company's processes.

Figure 1: Elements of ISO 9001:2015

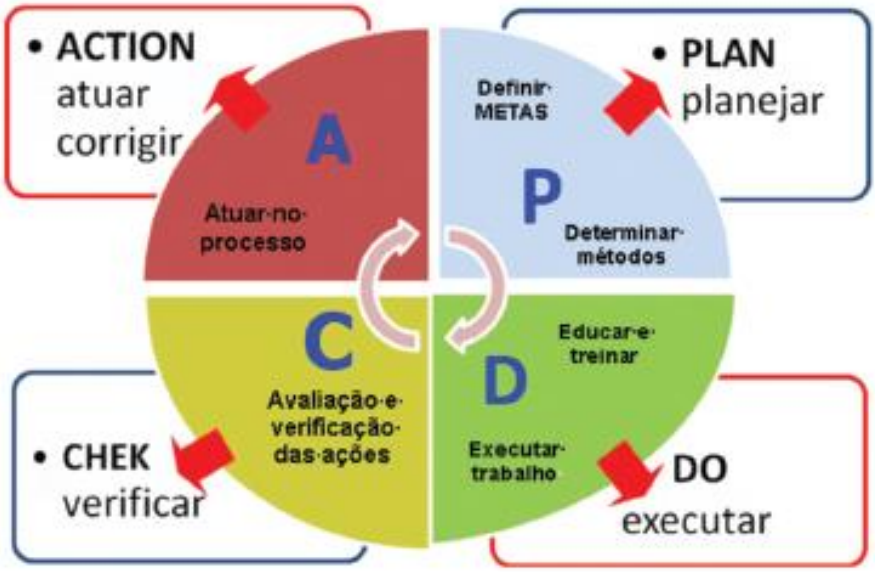


Source: ISO 9001:2015

The basic elements of ISO 9001 follow the logic of the PDCA cycle of continuous improvement, as shown in figure 2. The PDCA cycle consists of a powerful tool for quality programs and processes, as mentioned by Camargo (2011, p. 104). Each letter in the name PDCA has a practical meaning of activities to be carried out within the context of the processes and can be defined as follows (ISO 9001, p. 10):

- Plan: establish the objectives of the system and its processes and the resources necessary to deliver results in accordance with customer requirements and the organization's policies;
- Do: implement what was planned;
- Check: monitor and (where applicable) measure processes and resulting products and services against policies, objectives and requirements, and report results;
- Action: Take actions to improve performance as needed.

Figure 2: PDCA



Source: Camargo (2011)

The ISO 9001 standard also presents the determinations that organizations must follow to evaluate the performance of the QMS in these, and follow the logic of continuous improvement. Therefore, ISO 9001 (2015, p. 19) indicates that the organization must determine:

- What needs to be monitored and measured;
- The methods for monitoring, measurement, analysis and evaluation necessary to ensure valid results;
- When monitoring and measurement should be carried out;
- When monitoring results should be analyzed and evaluated.

The standard is also judicious in pointing out that organizations must determine, provide and maintain an environment necessary for the operation of their processes and to achieve conformity of products and services (ISO 9001, p. 7). The standard also mentions on the same page the combination of factors that would generate this environment:

- Social (e.g., non-discriminatory, calm, non-confrontational);
- Psychological (e.g., stress reducing, burnout preventive, emotionally protective;
- Physical (e.g. temperature, heat, humidity, light, airflow, hygiene, noise).

It is at this point in the ISO 9001 standard that there is a correlation with the 5S methodology, because as will be presented in the next topics, this methodology has great value in offering a beneficial direction of change to adapt process environments, since the main benefit of the methodology is provide a

change in the organizational culture of a company. Therefore, the use of 5S in the implementation of ISO 9001:2015 enables continuous improvement.

5S METHODOLOGY

As mentioned by Martinelli (2009, p. 52), the 5S movement emerged in Japan at a time in history where Japanese companies found themselves in a pitiful state, dirty, disorganized, with several operational problems, unqualified labor, among other aspects.

As a result, at the end of the 1960s, the 5S movement began to take part in Japanese organizations, with the aim of contributing to the country's reconstruction process. The Japanese realized that they needed to rescue the image of the defeated country and transform it into a meaning of strength and reconquest, seeking to enhance self-esteem, including that of the population. The impact of implementing the process was the strengthening of the powerful *made in Japan brand* .

The 5S method is a practice focused on the spirit of mobilization and proactivity of employees, due to the chaotic situation of Japanese companies at that time, and aimed at implementing cultural changes in the work environment, including everything from motivational aspects to the elimination of waste. office supplies, room tidying, cleaning, organization and especially discipline.

The name 5S comes from Japanese:

- *Seiri* – Organization, Use, Disposal;
- *Seiton* – Tidying, Ordering;
- *Seisou* – Cleaning, Hygiene;
- *Seiketsu* – Standardization;
- *Shitsuke* – Discipline.

Still according to Martinelli (2009, p. 53), the main objective of the 5S model is to change the organizational culture, discipline and way of thinking of employees, in favor of a higher quality of life, both professionally and personally. and family, being intrinsically linked to the determination, preparation and maintenance of an environment necessary for the operation of its processes.

The model was responsible for breaking paradigms present in most organizations, such as “let's keep this, because one day we might need it” and other automatic and unaware behaviors of employees.

To this end, Japanese companies began to encourage employees to create and have ideas, as well as motivating the use of each person's potential and personal capacity, in addition to educating employees.

employees to keep rooms and transit areas for internal and external customers clean, unobstructed and organized, among other actions.

The methodology for implementing the 5S model is simple and objective and the activities are divided into two groups: awareness, which includes education and training of employees, and perpetuation, which is directly related to discipline and standardization of procedures.

The implementation of the 5S model can be described in five steps, guided by the five words: *Seiri, Seiton, Seisou, Seiketsu and Shitsuke* – and which enable the organization to achieve the program's objectives.

Using the definitions presented in Camargo (2011, p. 87 – 92), the meanings of the 5S methodology can be presented as follows:

- *Seiri*: In this sense, organizing means separating necessary things from those that are not necessary. After this separation, a destination must be given to all those things that are no longer useful for that activity or environment. Sense of Use recommends that in addition to identifying excess and waste, we must also identify "the reason for the excess", so that it does not happen again;
- *Seiton*: "Ordering" means arranging, therefore, it is the act of storing according to ease and frequency of use, always with the aim of facilitating access. An orderly and tidy environment naturally presents more pleasant aspects for work and is therefore more productive, comfortable and less tiring. The habit and practice of ordering and organization greatly favors improving the quality of processes;
- *Seiso:* Cleaning is eliminating dirt, inspecting to discover and attack the causes. The act of cleaning should be seen as a way of inspecting the environment. It is recommended that this be done by the user of the environment;
- *Seiketsu*: Environmental conditions must consider the preservation of everyone's health. Maintain a sanitized environment and cleanliness habits, and always ensure that the previous "senses" (orderliness and cleanliness) are maintained. It is important to standardize habits, this helps to constantly maintain the program's senses. Always sanitized work environment or activity will make the place much healthier and more pleasant. This practice favors the physical and mental state;
- *Shitsuke*: "Self-discipline" promotes goodwill and creativity. It is important to adopt a "critical attitude" in the environment and processes and also to create and adopt habits of discipline in the activities that will be carried out. Obedience to the rules does not mean that you must submit to

rigid and submissive obedience. The word “self-discipline” can be seen as meaning “self-control”, however in the social environment one must act and communicate in a cooperative manner.

PRESENTATION AND DISCUSSION OF RESULTS

The company under study is an electronic products industry located in the municipality of Eusébio – Ceará (CE). The organization's field of activity is the manufacture of electrical energy management products of various sizes. Among the company's products, three of them can be highlighted with a large number of sales to customers of different types: UPS, stabilizers and line filters. For greater understanding and contextualization, the definition and function of each of these products follows:

- UPS: according to ABNT NBR 15014 (2003, p. 1), a UPS is an uninterrupted power supply system. Among the three products to be mentioned, it provides the most complete protection, as in addition to stabilizing the voltage and having an internal line filter, they have internal batteries, which ensures continuity of power supply to connected electronics in the event of a blackout. . Figure 4 illustrates this tool;
- Stabilizer: according to ABNT NBR 15014 (2003, p. 1), a stabilizer is a power system that does not have its own energy source and has the function of keeping the alternating output voltage regulated and stabilized for a given input variation. Figure 3 illustrates this tool;
- Line filter: this is the name given generically to the surge protector on the power line, generally intended to protect computers and electronics. These devices only prevent the burning of the products associated with it.

Figure 3: Stabilizer Produced in the Company Under Study

Source: Course Completion Work by João Victor Silva Pinheiro (2019)

Figure 4: UPS Produced in the Company Under Study

Source: Course Completion Work by João Victor Silva Pinheiro (2019)

COMPANY SECTORS

The company in this work is divided into a series of sectors that develop various processes, such as logistics, after-sales, human resources, etc. However, it is important to highlight the four production sectors of the company, as the quality analyzes in this study focus on these parts of the factory, and some processes in these sectors are paused to carry out certain audits and quality inspections. The processes will not be detailed with emphasis in this work, however the complete flowchart and other information can be found in the company's Quality Management System:

- Integrated Circuit Board (PCI): this is the sector of the company that takes care of the entire process involving integrated circuit boards and their components. As these are materials with a high degree of detail and electronic security, this sector is located in a closed space and with a series of security measures imposed by the occupational safety sector. Quickly describing its flowchart, we have: receipt of material from the warehouse, component separation and preparation process, micro controller recording process, component insertion process, welding process, finishing process, giga test process and process of releasing parts into the warehouse;
- Wiring: at this stage of the process, the product will receive most of the wiring necessary for its correct operation, despite this, some wiring is placed in other sectors, depending on the type of process to be carried out. This sector is one of those with the fewest processes in the entire company. The flow of this sector consists of: receiving raw materials from the warehouse, cutting process, crimping process, tinning process, finishing process and process of releasing parts into the warehouse;
- Transformers: sector of the factory that deals with this electrical component contained in basically all of the company's products. The transformer has its own wiring and connections, in addition to specific and detailed chemical, mechanical and electrical processes. The sector flow consists of: receiving raw material from the warehouse, winding process , finishing process, tin process,

crimping process, welding process, pressing process, lamination process, insertion process, testing process (for sampling), varnishing process and process of releasing parts into the warehouse;

- Assemblies: this is the sector of the factory where various parts of the product are attached to it and some connections are made. Furthermore, the last stages of the production process are present in this sector, including the Out of Box (OOB) test, which consists of carrying out several tests on a certain sample of the product, removing it from the box after it has been finished and packaged. . For this sector, there is: receipt of raw material from the warehouse, separation process, transformer fixing process, battery fixing process, board preparation process, electrical test process, Final Test (FT) process, closing process, labeling process, packaging process, Out of Box (OOB) process and production note process.

PROJECT PROCEDURE

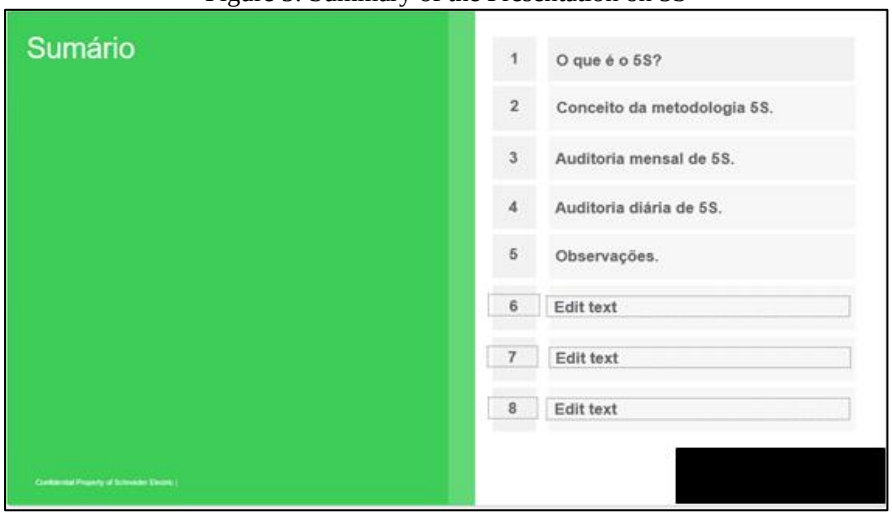
After internal meetings between the managers of the Logistics and Quality teams of the company under study, a series of implementations to improve the factory were discussed, always guided by the ISO 9001 standard in its Brazilian version. Therefore, in order to promote a suitable environment for process development, as already mentioned in this work, it was decided to implement the 5S methodology.

The implementation was only possible, from its conception, thanks to the previous and vast experience of 4 company employees on 5S, thus forming the organization's leadership for this topic. Furthermore, to follow this methodology, it was decided to monitor monthly and daily through audits.

In this way, the 4 leaders were responsible for the following actions:

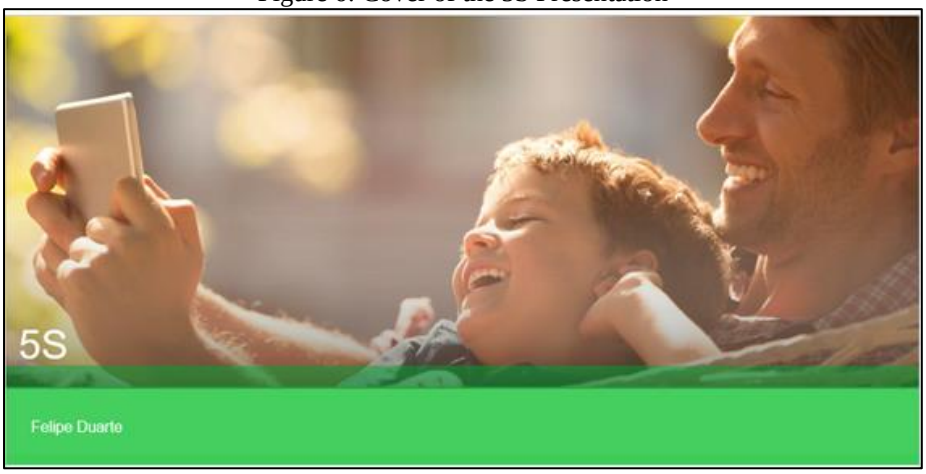
- Conducting training for all company employees, explaining what the 5S methodology is and its use in this, covering the tools used to audit areas and the techniques that are necessary in the application of the audit: mastery of the 5 senses, auditor's posture , application of notes, treatment of audit actions, discipline in the audit schedule;
- Creation of a monthly and daily 5S audit scoring form, to be presented to all factory employees. Therefore, the above actions can be highlighted in figures 5, 6, 7 and 8.

Figure 5: Summary of the Presentation on 5S



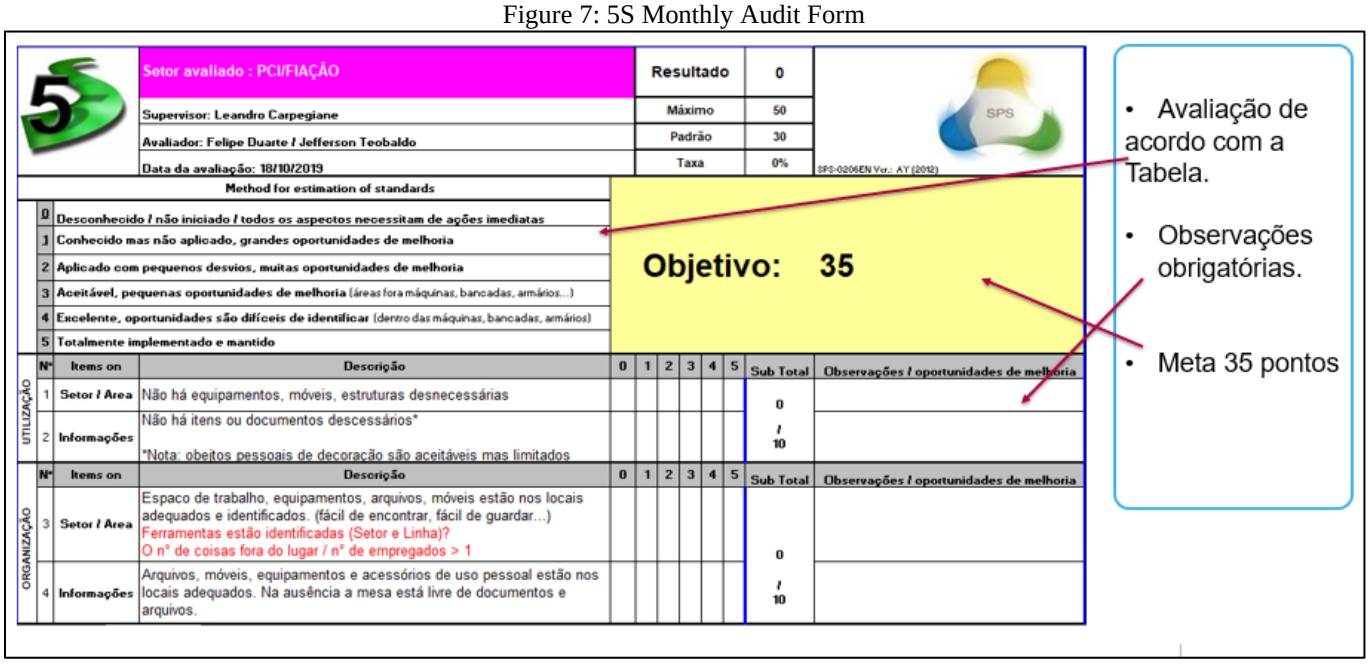
Source: Prepared by the Author (2020)

Figure 6: Cover of the 5S Presentation



Source: Prepared by the Author (2020)

Figure 7: 5S Monthly Audit Form

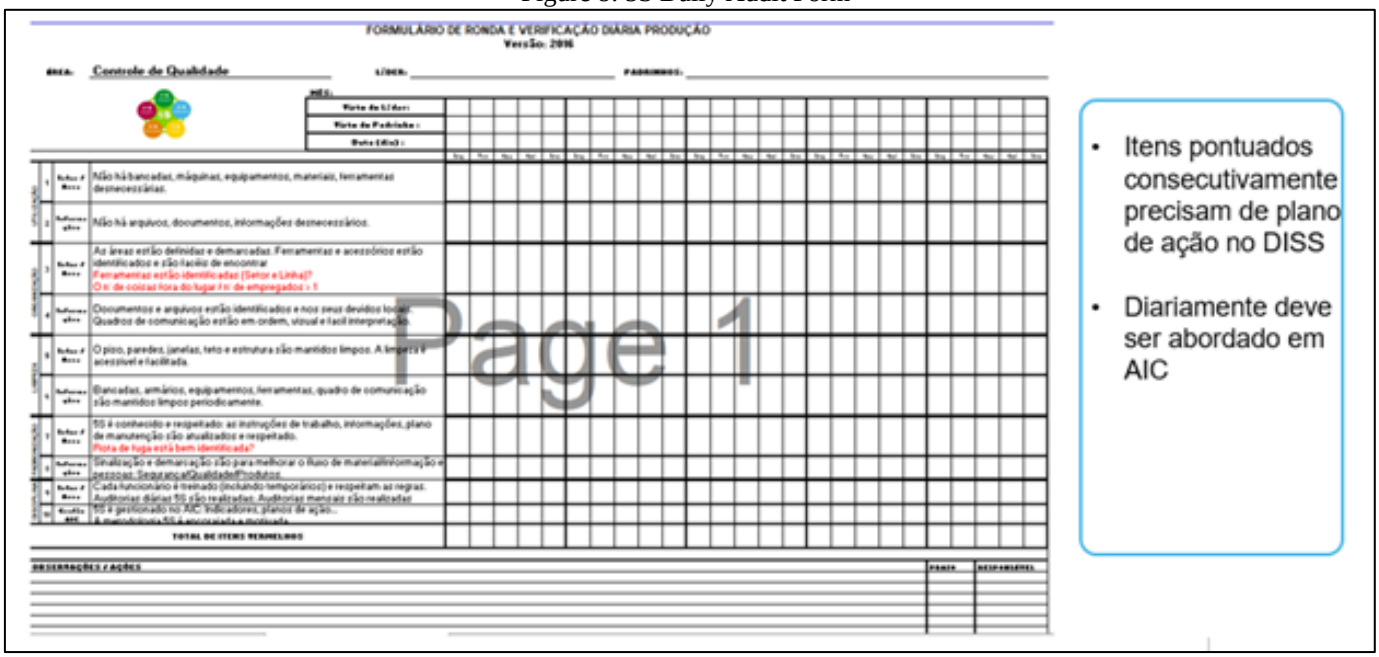


Setor avaliado : PCI/FIAÇÃO								Resultado	0		
Supervisor: Leandro Carpegiane								Máximo	50		
Avaliador: Felipe Duarte / Jefferson Teobaldo								Padrão	30		
Data da avaliação: 18/10/2019								Taxa	0%		
Method for estimation of standards											
0	Desconhecido / não iniciado / todos os aspectos necessitam de ações imediatas										
1	Conhecido mas não aplicado, grandes oportunidades de melhoria										
2	Aplicado com pequenos desvios, muitas oportunidades de melhoria										
3	Aceitável, pequenas oportunidades de melhoria (áreas fora máquinas, bancadas, armários...)										
4	Excelente, oportunidades são difíceis de identificar (dentro das máquinas, bancadas, armários)										
5	Totalmente implementado e mantido										
	Objetivo: 35										
	N°	Items on	Descrição	0	1	2	3	4	5	Sub Total	Observações / oportunidades de melhoria
UTILIZAÇÃO	1	Setor / Area	Não há equipamentos, móveis, estruturas desnecessárias							0	
	2	Informações	Não há itens ou documentos descessários* *Nota: obejtos pessoais de decoração são aceitáveis mas limitados							/ 10	
	N°	Items on	Descrição	0	1	2	3	4	5	Sub Total	Observações / oportunidades de melhoria
ORGANIZAÇÃO	3	Setor / Area	Espaco de trabalho, equipamentos, arquivos, móveis estão nos locais adequados e identificados. (fácil de encontrar, fácil de guardar...) Ferramentas estão identificadas (Setor e Linha)? O n° de coisas fora do lugar / n° de empregados > 1							0	
	4	Informações	Arquivos, móveis, equipamentos e acessórios de uso pessoal estão nos locais adequados. Na ausência a mesa está livre de documentos e arquivos.							/ 10	

- Avaliação de acordo com a Tabela.
- Observações obrigatórias.
- Meta 35 pontos

Source: Prepared by the Author (2020)

Figure 8: 5S Daily Audit Form



Source: Prepared by the Author (2020)

After the presentation on the 5S methodology, the company's 5S auditors committee was formed. This training had a multipurpose bias within the company, as employees from different sectors applied for this position, promoting the selection of auditors with diversity and generating integration between different functions at all factory levels. This selection took place through interviews and brainstorming sessions with candidates, led by 5S specialists at the factory. In this selection method, the knowledge acquired on the subject through the training offered and the interest in the topic were taken into account, always seeking a sense of ownership among the candidates.

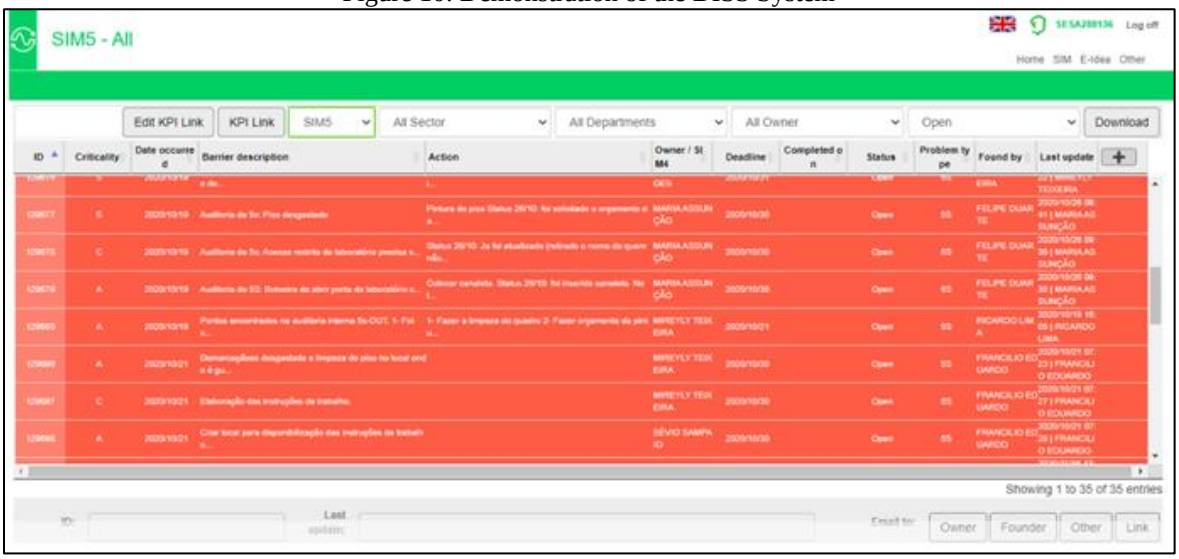
With the formation of the audit committee, it was then possible to prepare the flow of monthly audits in the manufacturing sectors. For this methodology, it is important to mention that two digital tools were used for process management:

- BOX: specific digital cloud where the company's documents under study are stored and updated with cybersecurity. For 5S, this cloud stored the reports and forms related to this topic. The initial screen of this cloud is shown in figure 9;
- DISS: computer program that manages actions and plans for the company. For our object of study, DISS controls the actions generated by carrying out 5S audits, indicating who is responsible, the deadline, etc. A DISS page is present in figure 10.

Figure 9: BOX System Demonstration

Source: Prepared by the Author (2020)

Figure 10: Demonstration of the DISS System



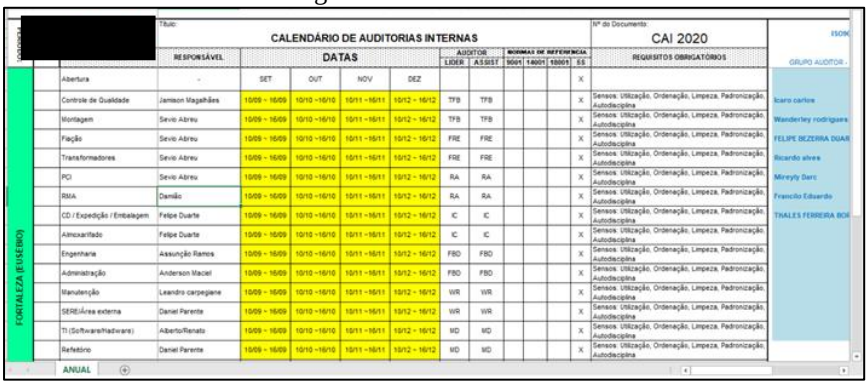
Source: Prepared by the Author (2020)

So, the flow of monthly 5S audits had the following sequence:

- Sending a 5S schedule: in this first stage, the factory's 5S specialists prepare and send in advance to the auditors and those responsible for each sector, a schedule, shown in figure 11, indicating the date that each area will be audited;
- Check open actions in DISS: the second step consists of checking, from the second month onwards, the actions that were not carried out in the previous month. This fact serves as activity control and is vitally important for the company's continuous improvement;

- Carry out audit at designated locations: for this stage of the flow, the selected auditors must promptly attend the audit locations and carry out the audit. Those responsible for each sector inform their employees in advance so that they are available to help the auditor;
- Update report form in BOX: after carrying out the audit and filling out the form already presented in this work, the auditor must transfer the information to the company's digital cloud, sharing the file with all employees;
- Meeting with the 5S committee: after carrying out all audits, the auditors meet to discuss various issues identified as important by each one: difficulties, opportunities for improvement, etc.;
- Assign actions in the DISS to the business owner: much more important than giving a score for each sector in the audit, is generating actions to improve it. At this stage, the auditor places in the DISS system the actions that must be carried out in the audited sector, also informing the person responsible for this and the deadline;
- Consolidate report with Job Rotation: after all the previous steps, a member of the audit committee is selected to compile the audit data into an Excel file. This activity is carried out by a different auditor each month, valuing the Job Rotation.

Figure 11: Audit Schedule

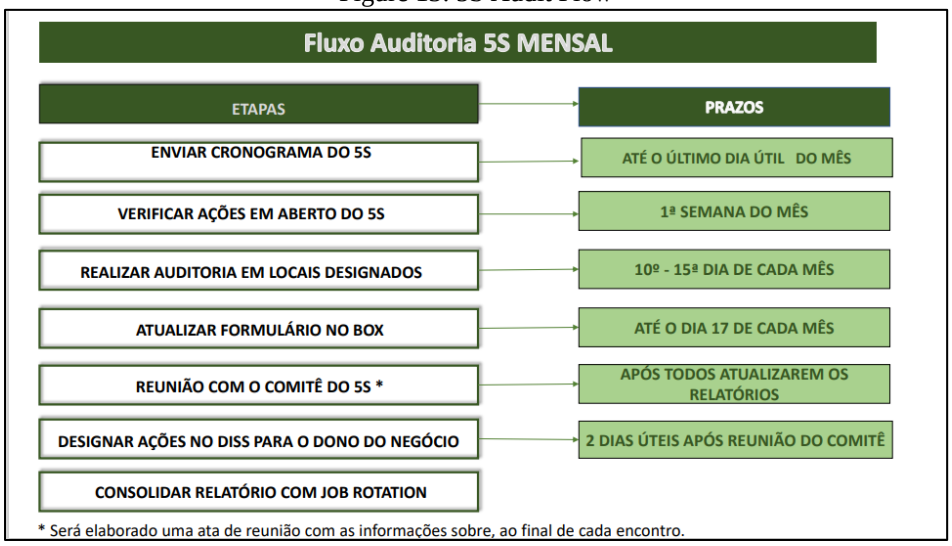


Source: Prepared by the Author (2020)

Figure 12: Human Resources Information on 5S in the Company Under Study

Source: Prepared by the Author (2020)

Figure 13: 5S Audit Flow

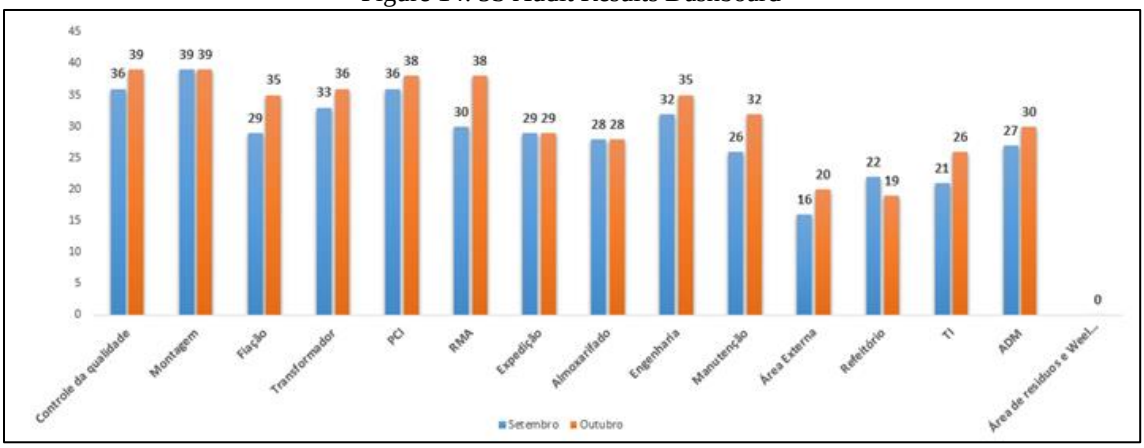


Source: Prepared by the Author (2020)

As mentioned in the last stage of the flow in figure 13, at the end of the audit process, these data were always compiled into an Excel file. The Dashboard of this file had an extremely educational, informative and simple format for all audiences, and was even highly praised by the Company's employees. In order to show the evolution and results of each sector, the Dashboard presented the following aspect and was created by the audit committee. Furthermore, figure 12 explained the information about the 5S methodology in the Company.

In figure 14, the Dashboard sought to compare the score results of each sector of the Company on a monthly basis in an accessible way, which allowed employees from all areas to easily observe the score of their sector and employees from sectors with scores below the target, to instigate to be on the same level as every factory.

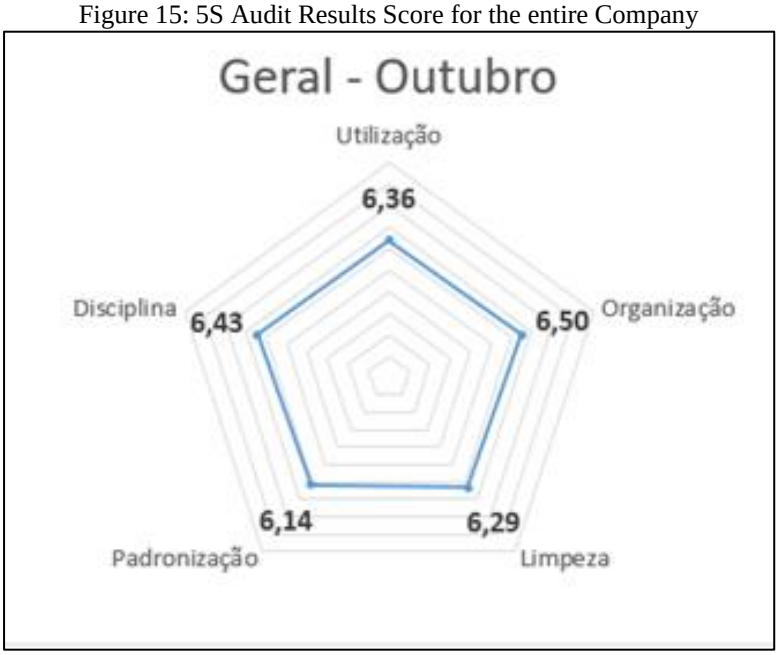
Figure 14: 5S Audit Results Dashboard



Source: Prepared by the Author (2020)

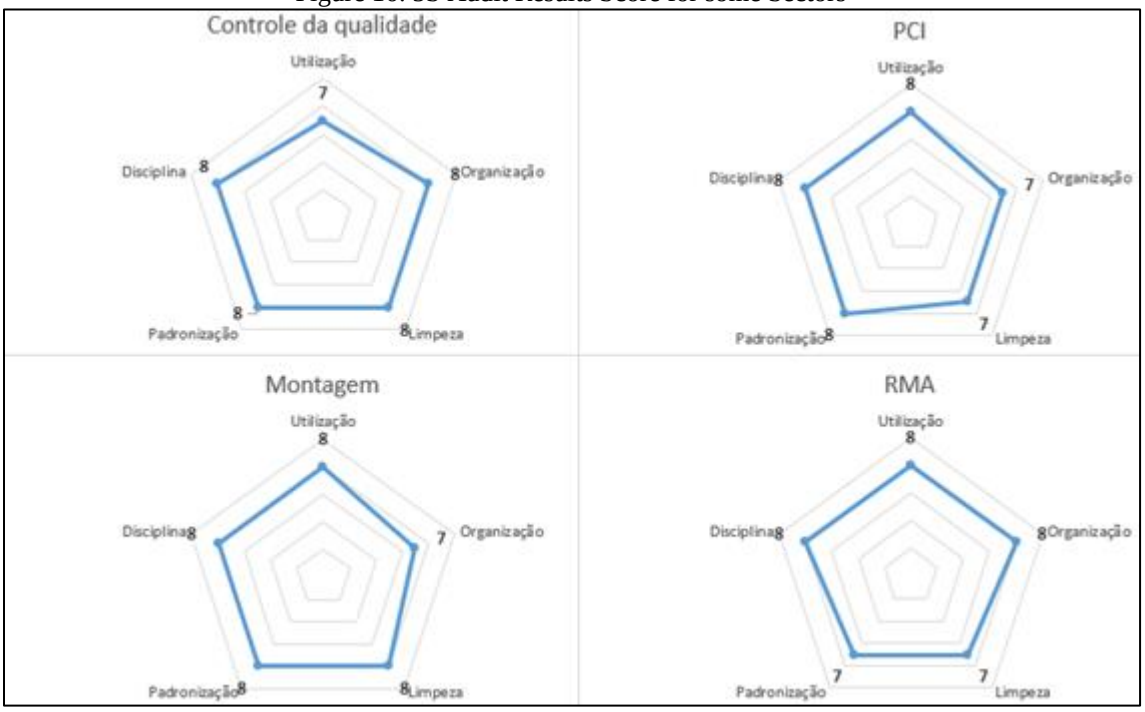
In figures 15 and 16, there was a presentation of results from each sector through the analysis of each of the 5 senses already studied. This demonstration provided a visualization of where each area could improve.

Figure 15: 5S Audit Results Score for the entire Company



Source: Prepared by the Author (2020)

Figure 16: 5S Audit Results Score for some Sectors



Source: Prepared by the Author (2020)

After carrying out all stages of the 5S methodology implementation process within the established deadlines and in 6 consecutive months, a series of excellent results were obtained through this, increasingly promoting a suitable environment for operating processes as required. by the ISO 9001 standard in its Brazilian version. Among the improvements achieved:

- Recognition of the Company's Human Resources as an activity of excellence;
- Recognition by the Company's Board of Directors as an activity of excellence;
- Reduction in the number of incidents;
- Improvement of the Company's cleaning;
- Improvement of the Company's organization;
- Reduction of costs with company products and warehouse;
- Increased process efficiency;
- Greater well-being among employees;
- Positive feedback from employees as shown in table 2.

Table 2: Feedback from Employees based on the Question “In your opinion, what were the improvements made by the new 5S committee”

Collaborator	Feedback
Engineering Collaborator	“Carrying out audits within the established deadline” “Open shares in DISS”
Quality Collaborator	“It was the organization and engagement of the team” “Not to mention the efforts of the areas to comply with the actions”
Production Collaborator	“The management of actions by DISS”
PCI Collaborator	“The discipline of keeping the sector organized” “Action monitoring”

Source: Prepared by the Author (2020)

FINAL CONSIDERATIONS

The implementation of the 5S methodology was a multidisciplinary project, which involved employees from different sectors of the Company under study, ensuring a better organizational and process level. With this, the topic of the ISO 9001 standard, related to the promotion of an appropriate environment for processes, was covered.

It should be noted that the implementation was carried out successfully, as employees highlighted this fact in opinion surveys, in addition to recognition from the Human Resources sector and the Company's Board of Directors.

In this way, the present work was successful in the objectives proposed between the lines of it, being of grateful use to future readers of this work.

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