

Implementation of Program 5s in a Refrigeration Industry

Marcelo Marinho dos Santos¹, Marden Eufrazio dos Santos², David Barbosa de Alencar³

^{1,2}Academic department, University Center FAMETRO, Manaus-AM, Brazil

³Research Department, Institute of Technology and Education Galileo of Amazon (ITEGAM), Brazil

Abstract— The implementation of the program of quality and improvement in the process of production based on the methodology in 5S was implemented in a refrigeration company located in the Industrial Pole of Manaus, based on bibliographic research in books. This philosophy is intended to inform and train the people who are involved in the process of organizational change. The 5S technique was used to apply the improvement in the assembly line, in relation to cleaning in the work environment, organization of the utensils of immediate use, creation and demarcation of layout to attend the process flow, as well as the verification of the lighting of the environment among other factors.

Keywords— 5S, Layout, process flow, refrigeration industry.

I. INTRODUCTION

The integration of the 5S quality program in a refrigeration company located in the Industrial Hub of Manaus (PIM) -AM, Brazil, aims to emphasize the characteristics and possible implementation specificities. The proposed benefits and how to promote the improvement in the behavioral areas, as well as a new structuring of the work routine, besides reducing the costs by wasted time, and better use of the layout of the company benefiting significantly the factory environment. "5S is a set of concepts and practices that have as main objectives the organization and rationalization of the work environment, the 5S program appeared in the 50s as a program of the Japanese Total Quality Control" [1].

The objective of this work is to present the 5S knowledge opportunities, it has as a goal a case study, referring to a refrigeration company, on the perspective of the research was used the PDCA cycle, observation and other tools, where annotations were constituted with regard to the positive and negative aspects, the survey carried out on the assembly line, information was collected, both from the employees' interviews and from observance in relation to the structure of the sector. As the research target was the people and their respective jobs and productive environment, it was possible to initiate the improvements in the aspects of organization and cleaning, and for the detailing of the problem was used the 5W2H, following after the resolution of the problems began, if trainings with employees knowing that they need to know the benefits and raise awareness about

the problems in the company, were shown photos on slides and videos related to positives and negatives, following after implementation of 5S, comes the Management for Total Quality (TQM) , Second [2], total quality management can be understood as a philosophy or a management approach that consists of a set of techniques.

According to [3], Any process of total quality is subject to failure if there is not a very strong support base.

II. THEORETICAL FOUNDATION

The benefits of the 5S methodology are explicit in virtually all large multinationals and local companies, however this program emphasizes their organizational improvements in a clear and detailed way, many are their improvements some academic works even deal with this philosophy called 5S as gateway. input to other tools that aggregate in the production process as 5W2H [5]. This tool is used to verify if all the resources are available in relation to the project, its main function is to assist in the decision making, according to [6], and a kind of check list that must be developed with maximum clarity and efficiency to the performance of the activities and those involved with the project, the estimated deadlines, and how much human and financial resources will be required to carry out the activities, what will actually be done, why will be done, how will it be done, and thus taking into tool guidelines.

In his work, [7] emphasizes that in 5W2H "each specific goal can be detailed through this tool. This

procedure requires that the implementation of the programs reflect the coherence, the harmony and the compliance with the organizational guidelines".

For [8], PDCA is a methodology that serves as a basis for analyzing a process after any improvement has been made, since this tool allows one to analyze the problem using the parts of its cycles in order to apply them, to know the results and perfect the possible problems encountered and thus acting with the solutions of their methods. For [9] this methodology has the purpose of guaranteeing the process in a way that creates a culture of continuous improvement to the point of producing products with high quality.

2.1 PROGRAM IN THE REFRIGERATION INDUSTRY

The 5S program can be deployed in any company, be it microenterprise, medium, large, private or public company, because it is a universal tool it has no use restriction [10]. It provides all of the great benefits, makes the manufacturing environment more enjoyable and using only what is needed according to the 5S philosophy, as well as promoting health and ordering. According to [11] the philosophy of use and its beliefs of improvement determine, it is known that it does not depend exclusively on the methodology, but rather on all those involved in the business environment, but for this to occur, the employees must be made aware of the benefits of the tool. Although the 5S is simple to implement, it should be borne in mind that top management should be focused on its feasibility because without proper monitoring by the managerial and operational levels it will not be possible to continue with the improvement changes. In order for the 5S methodology to be clearly established, it is necessary to have meetings with employees to demonstrate their benefits, since we know that investments are very low in relation to their gain, whether in the production process, or in the offices, or in industry, but all its mechanisms for improvement must be weighed. It is important to remember that it is necessary to respect the culture of each company, and if there is a change of culture the leaders must be willing to dialogue with the employees who are involved, so that the plan can continue without obstacles.

According to [7] in his work, he affirms that the characteristics and the procedures of implantation of the Program 5S depend on the characteristics of each company and each organization must create his own method of application.

2.2 PDCA CYCLE IN PROBLEM ANALYSIS.

The PDCA cycle is a tool to analyze problems, where each cycle has a meaning, shown in Figure 1, the first

cycle "PLAN" means to plan the actions in relation to the problem, in the second "DO" cycle after having done everything the planning comes execution, following with the third cycle comes "CHECK", where a verification of all activities is done, the fourth cycle "ACTION" in this phase is made a verification of all steps of the cycle, if it is verified that there are points that needs to be improved, then the cycle will be run again.

[14] adds that by using the PDCA cycle unfolding of problem analysis, the improvement team follows a structured methodology that avoids hasty decisions about the problem.



Fig. 1: PDCA Cycle, Source: adapted From [13]

The essence of this cycle is continually co-ordinated efforts towards continuous improvement, it emphasizes and demonstrates which improvement program should begin with a careful planning phase [15].

The systematic use of the methods in problem analysis, management and improvement of results is a concrete way to demonstrate and obtain the commitment of the people in the long-sought growth of the organization [14].

2.2.1 The following steps represent a suggestion to unfold the PDCA cycle.

Step 1- Identify the problem - Select the problem to solve, prioritizing the existing themes.

Step 2 – Observation - Understand the problem by raising your history and frequency of occurrence; Observe local characteristics such as environment, instruments, reliability of standards, training, among others.

Step 3 – Analysis - Identify and select the most likely causes of the problem.

Step 4 - Action Plan - Elaborate the strategy of action; Draw up the action plan.

Step 5 – Action - Disclose the plan of action; Train and empower people, seeking the commitment of all; Perform and monitor the action, recording the results; Collect data.

Step 6 – Verification - Compare the results with the expected goals; check whether or not the problem

persists. If the expected results are not achieved, return to step 2. List any side effects.

Step 7 – Standardization - Elaborate or change the standard; Communicate changes internally; Educate and train everyone involved in the new pattern.

Step 8 – Conclusion - Record the progress achieved by the group; Relate the remaining problems; Plan the solution of the remaining problems, returning to execute the PDCA cycle; Reflect on the work, aiming at future improvement.

2.3 5W2H UNDERSTOOD AS A PLAN OF ACTION

For the implementation of another tool, the 5W2H methodology was used to survey the variables of the problems, it was necessary to research and verify the points from which resources could be extracted, since knowing that without the resources it is not possible to continue making improvements in the productive process, or in a service, in this method of surveying possible peculiarities in a process and necessary, because it is through these surveys it is possible to verify how much we have so we can follow the project.

According to [16] The action plan comprises several factors: available technology, resources in general, being thus used, a table to compose the tool 5w2h can assure the elaboration and effectiveness.

This tool serves as a reference and assists in the monitoring and development of certain strategic management, in this case in the decisions of the actions taken in the implementation of the 5s.

The action plan describes how to put strategic planning into practice. It should indicate changes proposed in management or in the organization itself, as well as new challenges and procedures that the strategist should adopt [17].

What - what will be done? Determine the goals;

Who - who will do what? Defines who will be responsible for planning, evaluating and achieving objectives;

When - when will what be done? Establishes deadlines for planning, evaluating, and achieving goals;

Where - where will be done? Determine the location or physical space for the various proposed objectives;

Why - why will what will be done? Formulate the indicative of the necessity, importance and justification of executing each objective;

How - what will be done? Plan the means for the execution, evaluation and achievement of objectives;

How much - when will it cost? It determines the efforts and costs to achieve the objectives.

According to [16], the action plan comprises several factors: available technology, resources in general, thus using a table to compose the 5w2h tool, which can ensure elaboration and effectiveness.

III. TOOLS AND METHODS

This case study occurred in a process of manufacturing air conditioners in a "U" shaped assembly line located in an industrial complex in the industrial hub of Manaus. In this productive factory environment there are four processes of preparation until it reaches its stage main that is the line.

It was carried out the survey of the current situation and after the implementation of the 5s, 5W2H tools, along with the PDCA, the optimization of the process was carried out.

3.1 PROCESS OF MANUFACTURE OF AIR CONDITIONERS

At the beginning of the assembly line has a robot that raises piece by piece, throwing on the treadmill giving total agility in the assembly, then goes through the operators, where each one assembles his piece and finally arrives in the packaging process, these units apparatuses In this process, several models of different IBTUS, 30,000, 36,000, 60,000 and 80,000 are assembled in this process. The assembly process is composed of 32 employees who produce in a normal day up to 400 devices.

In this research one of the main problems encountered in the company sector was the organizational question regarding the cleanliness of the environment because it was continually dirty, it lacked order in the materials of routine use and of sporadic use, the office materials as expired document and others of use less common. There was also no layout for the benches, there was the absence of bins and cabinets in the assembly line for the organization of items that could not be in the benches as the documents of the process.

3.2 THE PROBLEMS AND INDICATORS OF THE PROCESS

The problems found were the lack of hygiene of the benches and tables, lack of aspiration of the floor, besides being in need of a painting, the ceiling was dirty needed a cleaning, lacked adequate lighting for the environment, because the lamps were few in relation to the This indicator was created to measure production efficiency, as shown in figure 01, there are several indicators in this graph, but the main focus of the research was to measure the quality index of the production process before the 5S quality.

LINE: 02		INDICATORS - 2019					February
Indicator:		Indicators before the implantation of the 5s					
Months	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	Accumulated
Scheduled Product	3.498	1.885	3.168	2.640	1.388	1.200	13.779
Product Produced	3.535	2.776	3.197	3.505	1.398	1.250	15.661
Product Target	90%	90%	90%	90%	90%	90%	90%
% Production	101%	147%	101%	133%	101%	104%	114%
Product defects	33	21	22	40	16	10	142
Defect target	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%
% Defects	0,93%	0,76%	0,69%	0,66%	1,14%	0,80%	0,9%
Quality Score	99,8%	100,0%	100,0%	78,0%	68,0%	100,0%	91%
Quality goal	98,0%	98,0%	98,0%	98,0%	98,0%	98,0%	98%

Fig. 2: Indicators before the implantation of the 5s

The purpose of this chart was to show the production in the light of the problems presented here, where the defect index is represented in March, circulated in red, the quality index of this process can reach up to 98% of the total production, in this case the index of defects is higher than the stipulated by the company, this percentage is inadequate for the process, it remains above expectations.

LINE: 02		INDICATORS - 2019					May
Indicator:		Indicators after the implantation of the 5s					
Months	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	Accumulated
Scheduled Product	3.498	1.885	3.168	2.640	1.388	1.200	13.779
Product Produced	3.535	2.776	3.197	3.505	1.398	1.250	15.661
Product Target	90%	90%	90%	90%	90%	90%	90%
% Production	101%	147%	101%	133%	101%	104%	114%
Product defects	33	21	22	23	16	10	125
Defect target	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%
% Defects	0,93%	0,76%	0,69%	0,66%	1,14%	0,80%	0,8%
Quality Score	99,8%	100,0%	100,0%	100,0%	100,0%	100,0%	100%
Quality goal	98,0%	98,0%	98,0%	98,0%	98,0%	98,0%	98%

Fig. 3: Indicators after the implantation of the 5s

In this second indicator, shows how it was after the 5S quality program, in the month of May the percentage of defects dropped significantly, as shown in Figure 03.

In this demonstration concerning the quantity of defect, shows that it hears a decrease of the defect quantities, there are several indicators in the table of Figure 2, the main focus and the quality index after implantation of the quality program 5S, in the table can be noted the indices circled in green, demonstrating the effectiveness of the program, where this percentage reached the mark of 100%, in relation to the quantity produced.

3.3 METHODOLOGY 5S IN THE FACTORY

The method of the 5S program was used to compose the organization of the work environment, in this stage the 5 senses were used, in the first phase the seiri method was used to make the organization of the work tools, separating the tools like keys, pliers, bolts, empty packaging without any utilities, obsolete capacitors, nuts, springs and others, these were taken to a disposal sector, then separated materials that were used from those that were not used routinely, sporadic materials can be kept in a separate cabinet.

The sector was in need of this ordering so the "seiton" method was used to put in this room the organization of the tools and all the work items, these had to be positioned correctly in the benches and in the cabinets, in this way the count was made of all the routine use items, beginning ordering of industry tools such as philips screwdrivers, manometers, goniometer, allen wrench, pressure pliers, precision scale to measure gas load, item that were out of use such as bolts, nuts, wires, defective electronic boards, and do a series of sorting in the industry documentation.

At this stage the third phase of the 5S was used the "SEISOU" method, following with the philosophy was made a cleaning in the environment, began by cleaning the cabinets, where it was removed from the corners to be able to do the proper hygiene of the furniture, then was designed layout for these utensils, followed by this action the drawers also received special treatment such as cleaning with cleaning products, tools like keys and others were cleaned and put in their place of origin, the floor was waxed by the local conservator, and the conditioners were cleaned by an external conservation company.

In the fourth sense "SEIKETSU", the people of the company sector were left with the philosophy of the first three senses already commented, that is, the hygiene and health in this area became part of the work routine of these people, where rules are established among employees of operational levels to the top level of the industry, knowing therefore that these program standards need to be maintained

In this fifth sense "SHITSUKE" was verified whether the deployment plan had really been successful. It was therefore concluded that the plan is actually being carried out in accordance with 5S standards and internal standards. And if people are meeting the standards, use only what is necessary for their immediate use, in addition to leaving the objects in their proper places, cleaning is in compliance with deployment, the sense of discipline has changed for the better, knowing that in the fourth sense deals with the health of the collaborator. In synthesis, the fifth sense (shitsuke) makes a self-evaluation of the first four senses.

3.4 PDCA CYCLE IN THE INDUSTRY PRODUCTION SECTOR

It was used to verify the process after the improvement of the 5S quality program, using its four cycles, in that phase some errors were corrected.

- Planning was defined as the goals to be achieved using (PLAN), in this way the assembly process was

verified where the organizational problem was occurring, at that point it was observed that in some points of the line had improved. It was defined where the intervention could be made in relation to cleanliness of the workplace, such as the organization of tools and other items of common use of the production process.

- Following with the second method (OD), the annotations of the problems already encountered were used in this phase, and necessary steps were taken to solve the problems. In the case, the tools in an inappropriate place, disorganized and without proper cleaning, a countermeasure to solve the gap, metal boxes were made to store these tools, also a routine of morning meetings with employees was created in relation to the problem.

- The third cycle (CHECK) was used, following the same line of reasoning in relation to the tool, some collaborators were assigned to do a check on the work already performed, noted that in order to continue it would have to do and have more commitment on the part of the idealizers of the project, was soon creating a committee to discuss and discuss all the variables of the problems detected in the process.

- After performing the three steps, it was time to gather the whole team to give positive feedback on all the checks in the production process.

3.5 THE 5W2H IN THE FACTORY PRODUCTION PROCESS

The focus of this tool, as shown in Figure 4 was to highlight the possible problems with the resources, such as the tools used in the research, the research materials such as: drawing boards, writing pens, marking labels, layout strips, a microcomputer was given by the company to make notes and send e-mail, and a financial resource was made available by the company to attend the project.

Deployment Schedule									
Tasks	2019								
	Feb	Apr	Mai	Jun	Jul	Aug	Sep	Oct	
Management commitment									
Activities planning									
5S Documentation									
Training									
Measure and monitor									
Corrections and changes									
5S program performance									
Evaluation of the program									
Measuring rich									

Fig. 4: Improvements with PDCA and 5W2H

Afterwards, the implementation of the study in the company will be demonstrated, detailing the elements used.

IV. IMPLEMENTATION OF THE STUDY IN THE COMPANY

At this stage of implementation of the 5S quality program, the senior management of the organization will be formally advised of the beginning of the improvement in the sector of the company, knowing that it is through this employee that it will be possible the capitulation of resources to go ahead with the improvement in the process, in addition to the commands that will be given, where a member will be chosen for the 5S program commission, that collaborator will be responsible for implementing the program in the company.

Based on the analysis of the assembly line problems, with the high index of materials rejected every day, by the process inspector, a hypothesis was raised that this could be happening because of the industry environment, because the bulbs did not were with their luminosities as they should, following from the lack of order with the tools like: the screwdrivers with lack of maintenance, besides the test apparatus, without gauging, adding with the dirty environment.

In order to arrive at this conclusion for the implementation of the 5S program, a survey was made with rejection indices by quality control, using a tool of the company itself, the FMEA analysis, where this methodology detected that the risk associated with these failure modes, because the environment is low light, and dirty environment and disorganized tools, could be the cause of the problems with regard to product quality.

4.1 PROGRAM IMPLEMENTATION PLANNING 5S.

In this first part of the improvement was carried out survey of all the variables of the sector, as the most critical points to be improved in the company, this way was used the tools of decision making, the 5W2H to verify the resources and which points to be attacked immediately, the PDCA cycle was also used to analyze the problems of the company sector.

Following the initial phase of implementation, a survey was made of all points in the sector to know the deficiencies in relation to the improvement, using materials of use of braço as: photographic camera and office materials to do all the annotation.

4.2 IMPLEMENTATION OF 5s IN THE COMPANY

In this first phase of implementation, leaflets were used with the 5 phases of the 5S to be pasted in place visible to the collaborators, as a way of disseminating; was chosen one day of the week to make the day of awareness, in this case on Fridays, on that day, all were

warned to fulfill the "D" day in which all come together to make a cleaning effort in the company.

The reorganization of the production sector was reorganized, where these were allocated at strategic points of production, layout was drawn around assembly lines, and a meeting was held to inform the importance of the program.

- Seiri: sense of use - identification of the materials, tools and objects required in the workplace, identifying the excesses and wastes, and the reason for the excess and defined standards were verified so that the problem will no longer happen.

- Seiton: sense of ordering - the organization of the tools, materials and objects was carried out and defined that each was returned to the appropriate place after use.

- Six: a sense of cleanliness - the workspace was organized, making it as clean as possible, so it was necessary to first eliminate the sources of dirt and investigate the root causes of the problems.

- Seiketsu: sense of health - after applying the first three senses and creating a climate conducive to continuity of improvements, dialogues are applied so that everyone will always check if the sine links are being maintained.

- Shitsuke: sense of discipline - the verification and revision of standards is performed. It is carried out the involvement of the workers so that the first four senses are maintained it is necessary to make verification of each one, made this observation to see if it is really being fulfilled.

4.3 CHECK VALIDATION CHECK LIST 5S

This document serves to validate the 5S quality program, aims at verifying the compliance of program goals in the sector, once a week the enclosure will be audited by internal auditors to measure program effectiveness, as shown in Figure 5, of the document the scan will be in ascending order.

CHECK LIST			
	5S TERMS	5S DEFINITION	SLOGAN
1	Seiri (Order)	Remove unnecessary items from the workstation	If in doubt remove
2	Seiton (Organize)	Create a specific place for all that's left	A place for everything and everything in its place
3	Seisou (Cleaning)	Clean and inspect the workstation	Clean and inspect
4	Shitsuke (Standardize)	Standardize best practices	Set the rules and follow them!
5	Shitsuke (Keep)	Make 5S a part of daily work culture	Do not fall back on old habits

Fig. 5: check validation list

4.4 TRAINING OF THE 5S PROGRAM

People attended lectures in relation to 5S, in this training all the employees of the sector got to know each

sense, example: it was said in the following way that the first sense server to organize the objects and to let that is used only what is of routine use, the sense, was explained as follows; that the senses serve to order the objects of use of the people, in the third sense was that said that serves to clean a certain place of work or service, already in the fourth sense, people were aware that to maintain their mental and physical integrity free of any pollution, should be concerned with the other previous senses, thus the sense of health reaffirmed its importance in this improvement.

V. ANALYSIS OF RESULTS

Before the implementation of the 5S program there was a major problem with the production process. Because the problems were due to the lack of order in the production area, it was known that production could not meet its goal of quality efficiency, because people did not have the base of support to keep the workplace in perfect condition.

The organizational mechanisms in the sector were outdated and had no effect on employees in the sector, ie employees were not motivated to perform these hygiene activities on the assembly line, employees perform their organizational tasks when the area leader requested that it be done.

There was no schedule of activities regarding the cleanliness and order of each operator's station and the process as a whole. In addition to the problems already mentioned, there were other factors that influenced the poor quality of the production process, one of the most serious being the low luminosity of the assembly line. With the help of the occupational safety professional, it was possible to measure and point out that the lack of luminosity had a direct impact on the activities carried out by the employees of the sector, thus causing the low quality index. Figure 2 shows how production was in the face of these problems.

After the implementation of the 5S program the quality index improved satisfactorily, the improvement occurred in the following problems, in the first point the cleaning of the area was precarious and consequently directly affected the productivities of the products. With the introduction of the 5s program using all its 5sense the operators started to mount with more freedom, because the layouts were unobstructed giving better agility the activities performed there. In the second point was made the packing of all materials of routine use, such as pneumatic, screwdrivers among other tools. In this way the production obtained its best quality index. In the third

point the environment was cleaned, and the next day the whole sector was painted.

Giving a pleasant sensation to the sector, and consequently impacting on the activities carried out and giving motivation to the employees of this sector. Following with the improvement, it was seen that, faced with the problems already solved, there was one that would also cause the problems: the low luminosity of the process, based on this information was requested the presence of the professional of the area, the (labor engineers) was activated to verify the problems raised by the developer of the 5S deployment. It was verified, however, that the sector needed to change all its lighting, and thus all the exchange of all luminaires in the industry was made, and the result of these changes are shown in Figure 03. In this indicator it shows that the gain with quality index was satisfactorily satisfied as the company's projection.

VI. FINAL CONSIDERATIONS

With the implementation process of the 5S program it was possible to notice that the change comes with the people's engagements and that it is no use trying to make any changes if there is not a team work besides it should be emphasized that the participation is an act of adding work in a team. People are the primary components in trying to make any improvement situation in any activities undertaken.

In these activities, many situations were verified in order to reach an improvement agreement, lectures were given in situations where listeners could ask and ask questions about subjects related to the 5S program, people did program-related gymnastic activities, and in the end it was applied to test their learning.

Posters were presented in the four corners of the process in order to help the productive sector, in these posters had the information pertinent to the 5S program, where he taught the good practices of this philosophy in order to fix the learning in the professional area or even in the personal life of each individual.

It is concluded that the improvement was fundamental in the aspects related to the conditioning of the people on the project schedule, knowing that the tool is of continuous use and can be considered as a tool of short term, medium and long term depending on how the company but in this case the tool was used with a view to achieving its short-term improvement according to previous information.

ACKNOWLEDGEMENTS

To the engineering coordination of the FAMETRO university center, and the teachers M.Sc. Marden Santos and Dr. David Alencar, for the support in the development of this work.

To the Institute of Technology and Education Galileo of Amazon (ITEGAM), Brazil.

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