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Implementation of 5S in Test Engineering in a Manaus Industrial Pole Mobile Telephony Factory

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Abstract *— The industrial pole of Manaus follows the worldwide trend of engagement on the issue of continuous quality improvement, especially regarding the organization of work environments and the need for managers to do more with less. This view has become paramount at this time when the market is extremely competitive. This article describes in essence the fundamentals, concepts and benefits of implementing the 5S program in the field of test engineering of the electro-electronic pole in the field of mobile telephony, as well as the possibility of correcting failures and waste, motivating employees and seeking that the own collaborator, has how to produce with quality and low cost in an environment where it is realized maintenance of Pcbs for cellular.*

Keywords *— **5S, Continuous Quality Improvement, Mobile Telephone Handset.***

I. INTRODUCTION

After the Second World War Japan was destroyed, the Japanese found through the 5S program from the 50's a way to recover and develop Japan [1]. With this program in place there was a fight against filth and disorganization in postwar Japanese entities. In Brazil, in order not to differentiate from the original words, the word senso was used to describe 5S, which are in Brazil the 5 senses, the words in Japanese to Portuguese are equivalent Seiri - Sense of use, Seiton - Sense of Ordination , Seisou - Sense of Cleanliness, Seiktsu - Sense of Health and Shitsuke - Sense of Self-Discipline.

According to [2], it also says that in essence, 5S generates a change of conduct that tends to mobilize the whole organization, thus the advantages of deploying 5S in one sector, and in the long run in the whole factory are numerous. It is possible to have immediate results, as is the issue mainly of the visibility of the work you are developing when using the sense of use, and in the long term as is the case of Senso self-discipline, for example the Japanese will teach the 5S culture to their children and discipline them in these principles, consolidating and extending into adulthood, in society and in the professional environment [3].

In order for the 5S program to be deployed at the KM (Fictitious Name) Plant, in the field of Test Engineering, there was a need due to the excess of time lost in searching for work tools, Excess materials in the area dedicated to Jigs test, Out-of-use and scrap items taking up space for new and usable materials in the industry. It is necessary to develop the sense of urgency to make and maintain organized, material and functional sites [4].

The overall objective of this case study was to improve performance in the test engineering sector at KM Factory through the 5S program, aiming to meet with excellence the need of the production sector, thus encouraging employees to be able to implement the 5 steps, and to combat eventual losses and waste in the sector.

II. THEORETICAL FOUNDATION

In order to effectively carry out the research work, we sought to base the use of the 5S Program in the context of a process of quality improvement within the segment of the mobile telephony electric-electronic pole.

2.1 WHAT IS THE 5S PROGRAM?

The 5S Program is the set of five common senses: Seiri, Seiton, Seiso, Seiketsu and Shitsuke [5]. The 5S is the basis for the implementation of a well-structured management system that, with its practice, promotes continuous growth of people, a pleasant work environment and an improvement in the quality of life [6].

The aforementioned author also mentions that when 5S is applied in any organization, the environment is

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prepared for profound changes and that generate visible and immediate results.

The 5S Program is the support for applying the quality program, and when well developed it is recognized as an excellent transformation tool in the organization [7].

All the people of the company, from the president to the operators, will have a great responsibility for change, everyone needs to be committed to achieving this through education and training.

The five senses according to [8], mean:

Seiri: The sense of use implies leaving only what is actually used in the work environment, the unnecessary tasks should also be eliminated, the frequency of the equipment being used must be analyzed.

Promote the "Clean or Discard" day when everyone should select the unnecessary items to perform their tasks and give a suitable destination to them [8].

Seiton: The sense of organization and the second phase of the 5s methodology. The Japanese word Seiton literally means "putting everything in order", so under this methodology means organizing materials, equipment and other necessary items so that anyone is able to find them easily and quickly [9].

Seiso: The sense of cleaning comes to eliminate dirt, more important than cleaning and not soil. This sense comes also in a preventive way seeking improvements and awareness, focusing on the clean environment is the one that is less dirty.

Seiketsu: The Sense of Normalization comes to systematize the new values and standards that the three senses Seiri, Seiton, Seiso. Seiketsu calls for the awareness and commitment of all leading to standardization.

Shitsuke: The sense of self-discipline seeks through awareness raising to encourage the collaborator to practice good deeds whether in relation to 5S, or in relation to continuous improvement.

It can be observed in figure 1, where shows examples of application of tool 5s.

Japanese Term	English Equivalent	Meaning in Japanese Context
Seiri	Tidiness	Throw away all rubbish and unrelated materials in the workplace
Seiton	Orderliness	Set everything in proper place for quick retrieval and storage
Seiso	Cleanliness	Clean the workplace; everyone should be a janitor
Seiketsu	Standardization	Standardize the way of maintaining cleanliness
Shitsuke	Discipline	Practice 'Five S' daily - make it a way of life; this also means 'commitment'

Fig. 1: Example of application of 5s. Source: [10].

For [11] there are several positive results with the implementation of "5S" as an improvement of the working environment, standardization of procedures, cleaner and more comfortable environment, saving time and effort, eliminating unnecessary paper and objects, improving layout for greater use of space, improvement of internal communications and greater participation of employees to achieve the success of the 5S program in the company.

With the implementation of the 5S in a company or in a sector and possible to verify that people will have changes in their lives, in the behavioral side, because the discipline of the acquired culture helps in that improvement.

It is expected that differences in productivity, efficiency and employee satisfaction will also be observed, as well as physical results, such as improvement in the internal space of the company, with the elimination of equipment that is obsolete.

2.1.2. Audit of 5S

According to [12], auditing is responsible for analyzing and assessing the performance of an organization, in whole or in parts, with a view to formulating recommendations and comments that will contribute to improving the economy, efficiency and effectiveness aspects.

The audit becomes necessary to measure the current 5S standard to then evaluate the changes, serve as feedback for evaluation of the implementation plan or the action plans.

According to [13], "We do not manage what is not measured, we do not measure what is not defined, we do not define what we do not understand, and there is no success in what we do not manage."

2.2 PROCESS OF CONTINUOUS IMPROVEMENT OF QUALITY

Continuous Improvement establishes in its vision that no product, process or service is so good that it can not be improved, that is, it aims at constant improvement.

In the nineteenth century, in the introduction of the assembly line concept at Ford Motor Company, continuous improvement gained importance. In 1948, in Japan, the continuous process improvement that would change the trajectory of large-scale productions began to emerge. Lean Thinking, derived from the Japanese Continuous Improvement, can now be seen in many companies.

Implementation Steps for continuous process improvement. Solutions for a Model that can be used:

- The PDCA Cycle;
- Kaizen Method;
- Lean Thinking;
- Six Sigma.

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Of these four tools, only the PDCA Cycle was used to implement the 5S in the field of Test Engineering, below is an explanation.

2.3 CONCEPT OF PDCA

The PDCA, figure 2, is an American origin management methodology, in the 1930's it was developed by Engineer Shewhart, but it was Deming who disclosed the method and made the PDCA known initially in Japan and then worldwide, through four words in a cycle using Plan, Do, Check, Act.

Fig. 2: PDCA Cycle, Source: adapted from [14].

• Plan: Identify the problem, analyze and elaborate the plan of action to achieve the goals.

• Do: Implement Action Plans, perform quality assurance, meet standards.

• Check: Control the effectiveness of the action plans, always watching the work, in order to follow the results obtained.

• Act: Act correctively if necessary, act with standardization, review of activities and planning.

2.4 MANAUS INDUSTRIAL POLO IS THE KM FACTORY

The Industrial Pole of Manaus (PIM), in Brazil. It was created by decree-law number 3173 of June 6, 1957 and improved ten years later. In 1957, with the predominance of the electro-electronic sector, multinational companies aimed to guarantee the mass production of final consumer goods.

According to [15] the PIM brought together more than 600 cutting-edge industries in the Eletroelectrical, Two Wheels, Naval, Mechanical, Metallurgical and Thermoplastic segments, among others, which generate more than half a million direct and indirect jobs. The indicators of billing and production of the incentive park of Manaus are increasing each year, having billed in 2012 values over US $ 37 billion.

The KM Factory, in which the 5S program was implemented in Test Engineering, was located in the industrial hub of Manaus, belongs to the electro-electronic pole, its Production is focused on Mobile Telephony, The factory has 500 employees, to supply the demand of 7 models of cellular devices that the factory produces.

III. TOOLS AND METODS

The tools used to compose the improvement actions were Excel spreadsheets, Presentations and Power point, periodic meetings during the implementation, at the end of the implementation of the 5S in the sector was selected an audit team to be trained to perform correctly verification of conformities and nonconformities using the Checklist.

In the Analysis of Results, in the verification items considered problematic, the 5W2H tool was used, which consisted in analyzing the root cause of the problem, through the seven questions: What, Why, Where, When, Who, How, How Much.

3.1 VERIFICATION SHEET FOR 5S EVALUATION

The Checklist is part of the 7 statistical tools for quality control, very simple to apply also known as Checklist, or list of defect recall. The first step at the beginning of most process controls or efforts to troubleshoot. The Checklist makes it possible to control the execution of tasks and their subsequent evaluation.

The following is a step-by-step guide on figure 3 on how to construct and define the purpose of data collection using the check sheet:

Telephone Interruptions

Reason	Day					
	Mon	Tues	Wed	Thurs	Fri	Total
Wrong number	𝍸	||	|	𝍸	𝍸 ||	20
Info request	||	||	||	||	||	10
Boss	𝍸	||	𝍸 ||	|	||||	19
Total	12	6	10	8	13	49

Fig. 3: Information on how to build the Check Sheet, Source: Adapted from [16].

IV. IMPLEMENTATION OF THE 5S

presentation to the Supervisor of the Engineering area of test Rogerio gato, responsible for the team, requested the necessary authorizations for the implementation, and authorizations granted by the same. The research project was implemented through a case study that began with a planning stage where an implementation schedule was defined, identifying the action, the person responsible and the time of execution.

The PDCA Cycle, which has four steps, 1- Plan, 2- Do, 3- Verify, 4- Act, will be addressed by explaining each task performed in the deployment.

4.1 PLAN

In this phase, Team 5S was defined, this team was responsible for planning the implementation, the team

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evaluated several problems in the sector, such as equipment disorder, obsolete material along with materials in use, lack of labeling and control in the shelves. Computer workspace extremely messy, being that we only had two computers for staff to use in the maintenance area. Work tools totally out of place, generating wasted time in solving some problem in the productive area. With several photos of the Sector was made a presentation to show employees the current state, also set the weekly Action plan in a meeting with the entire 5S team.

ITEMS	PDCA	TASK NAME	DAYS
1	Plan	Team Definition	1
2	Plan	Industry Assessment	2
3	Plan	Preparation of the Presentation	1
4	Plan	Action Plan	2

Fig. 3: Planning Step

4.2 Do

After the preparation of the Weekly Action Plan by the 5S Team, we sent the document to be approved by the Supervisor, the first action after the approval, was to mark the date of the presentation for the employees of the sector, in this presentation was approached the 5S Program, the situation current sector of the industry through photos and the Weekly Action Plan created by the 5S team, the employees visualized the need for change, as the factory had three different shifts, Team formation among employees became necessary, There was also a material request for the beginning of activities, after the material was released, we began the deployment with the Sense of Use.

ITEMS	PDCA	TASK NAME	DAYS
5	Do	Meeting for implementation	1
6	Do	Team building	1
7	Do	Request Materials	2
8	Do	Implementation - Start of activities	5
9	Do	Implementation - (Ordinance)	5
10	Do	Implementation - (Cleaning)	5
11	Do	Implementation - (Health)	5
12	Do	Implementation - (Self-discipline)	5
13	Do	Disclosure of Results	1

Fig. 4: Step Do

4.2.1 Week of Sense of Use

In the first week of project execution the command was to separate what is useful from what is not, to improve the use of what is useful, to keep only what is needed in the workplace, to fight waste. Before the Week of use, it was possible to find several empty boxes in the sector taking up space on the shelves, many unused equipment for productive area. In Figure 5, an analysis of the equipment was made, and many of them were sent to the sector responsible for obsolete equipment.

Fig. 5: Activity carried out in the first week (Organization of shelves).

4.2.2 Ordinary Sense Week

In the second week, it was the turn of the Sense of Ordinance, presented in figure 6. The organization, in this sense, referred to the arrangement of tools and equipment in an order that would allow the best flow of work. Tools and equipment were left in the places where they will be used later. The process was done in order to eliminate unnecessary movements.

Fig. 6: Application of the sense of orderliness

4.2.3 Cleaning Sense Week

In the third week, the Sense of Cleanliness shown in Figure 7, began to be used, throughout the sector was already visible along with the other senses the difference everywhere. At this stage it was important not only to perform the cleaning of the environment, but also to maintain it. The time has come to educate us not to get dirty, and to watch over everything that is our responsibility.

Fig. 7: Application of Cleaning Sense

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4.2.4 Week of Health Sense

In the fourth week, the Health Sense was implanted, with him the challenge was to keep what was already clean and organized, favoring the physical, mental and emotional health, from practices of hygiene. A meeting was also held for suggestions and praise, reinforcing a Harmonious work environment.

4.2.5 Self-Discipline Awareness Week

By the fifth week, the Sense of Self-discipline was already present, since in other senses this practice had already been stimulated, for the fact that every week,

Having a climbing team, for the organization and monitoring of the work environment, helped a lot to keep everything that had been done. Also every Monday was collected the major changes to be made in the current week, on Friday was collected the results (photos), and we sent to the whole team.

4.3 CHECK

For maintenance of the 5S Program, a group was set up to carry out audit training with the SGI (Person in charge of the Integrated Management System), so that there was control and monitoring of the development of the implementation.

The audit took place seven days after the meeting to disseminate the results of the implementation, through a Checklist, shown in figure 8, produced by the SGI, where all 5S items that had been implemented were analyzed.

The results achieved were very gratifying, although we did not have the highest grade, but the team was able to pass the Audit.

ITEMS	PDCA	TASK NAME	DAYS
14	Check	Training for Auditors	3
15	Check	Creation of checklist for SGI audit	3
16	Check	Application of Audit in the sector	2

Fig. 8: Step Check

4.4 ACTION

After the Audit, there was a meeting with Team 5S, Auditors and SGI where the results were discussed and also decided the time that a new audit would be performed, it was decided at that meeting that the Audits would be held once a month for the continuity of the program and adaptation of employees to the new reality.

Check items in which employees had larger grades would be added to the list of standardized items, check items that had smaller grades would be treated as problem points, 5W2H were applied to these items to get closer to solutions. Figure 9 shows the action step, with the solutions found a new Action Plan was defined so that employees had the opportunity to achieve better scores in the next audits.

ITEMS	PDCA	TASK NAME	DAYS
17	Action	Analysis of audit results, meeting to define new action plan	2

Fig. 9: Step Action

The results of the deployment will be presented.

V. ANALYSIS OF RESULTS

Through the verification of Figure 10, it is possible to analyze that the results of the first Audit were between 80% and 90%, Performance considered Good.

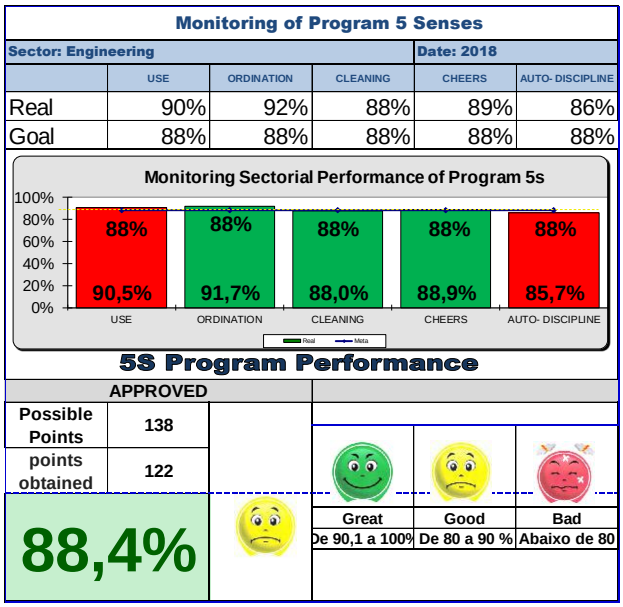

Fig. 10: Result of the first audit

It is possible to visualize all the verification items used to carry out the Audit, during the Audit we had four items of verification, which were considered problematic items, two items of the sense of use and two items of the ordering sense, these items, before the application of the Program 5S were already quite critical items. Below in Figure 11, the following check items found that at least one nonconformity was detected relative to the item in question:

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VERIFICATION ITEMS	Punctuation			
	0	1	2	3
SENSO OF USE				
4- Removal of leftovers from materials, reworked products etc. from the workstation.			2	
6- Items in good operating condition, but not used in the environment. Could have been discarded.			2	
SENSATION OF ORDINATION				
3- Properly Wired / Properly Wired			2	
5 - Cabinets and Archives well organized, coinciding with the external identification and without excess of			2	

Standard for 5S Program Evaluation	Punctuation
.No non-compliance was detected in the item being evaluated	3
.At least one nonconformity was detected in relation to the item in question.	2
.At least two nonconformities related to the evaluated item were detected.	1
.More than two nonconformities related to the item evaluated were detected.	0

Fig. 11: Problem Check Items

For the treatment of items with nonconformity, after the 5W2H and on-site investigation, it was analyzed that item four and six of the sense of use used to occur in the employee shift exchange, for these items standard operating procedures were created , in addition to the call via e-mail to stimulate the containment of the problem, even so the procedures regarding these items were not followed.

In item three, we did not have any problems after the call via e-mail, but in item six, there was a great resistance from the employees, especially on the days when action that the 5S Team took in relation to this item was that on the days of product exchange on the lines, a control report was signed by the executing employee. So it was possible to better track who was not complying with the procedure is to direct the point of attention.

Several campaigns within the sector were carried out, so that in the next audits the standardization items would continue with a high score, and that the problematic items would be remedied.

VI. FINAL CONSIDERATIONS

Specifically the implementation of the 5S program took place in the test Engineering sector, where the employees performed the maintenance work of the production test jigs. The application of the 5S Program contributed immensely with the development of the sector through the improvement of the work environment, giving employees more agility in the flow of their activities.

During the implantation several resistances were found, mainly with the company's older employees, the thought "I am like this and I will die like this" was addressed to us in many moments. But the cultural changes take time and effort, but were overcome with the help of all of the 5S team.

The main difficulties encountered were when the team was doing maintenance in the production area and carrying many work tools, the return of these tools almost always was not done in an organized way. It was possible to visualize this, because the employees of other shifts complained a lot of this fault, also when there were changes of product in the production lines, almost always the equipment did not return to the places of origin, due to the little space of the sector, we had to always request a readjustment of the labels for identification of such equipment.

The environment after 5S was really very pleasant, the sector began to breathe an air with more cleaning. Some difficulties were overcome, others really only with the analysis time, for possible adjustments. The Program demanded of every employee constant self-discipline, respect for standards and procedures was a great victory for Team 5S, and certainly a gain in productivity and elimination of various wastes that were occurring in the industry.

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