

# The 5s Program in School Spaces a Proposal For Quality Improvement

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**Abstract**— In an increasingly competitive market, companies have shown a constant interest in improving their processes. In this sense, the 5S program is a tool that addresses these issues of process quality, promoting organization of spaces, elimination of waste and optimization of time. In this perspective, this study proposes the implementation of the 5S program in a private elementary school in the city of Manaus-AM, in order to optimize the spaces to improve its use, to develop a sense of organization in school employees and to promote the efficiency of quality of services provided. This research was based on the qualitative approach and used the case study as a methodology. The tools used were the 5s Program, the Ishikawa tool, the Brainstorming and a questionnaire. The result showed that the 5s program can promote quality in the processes, optimization of the physical space of the school secretariat that was the scenario of application of the program and the personal development of the collaborators.

**Keywords**— Quality program, 5S, Quality in school.

## I. INTRODUCTION

Companies are looking for effective and easy-to-apply solutions to improve processes and physical spaces and the 5S program offers an easy and practical solution. Composed of five senses: use, discipline, organization, standardization and cleanliness.

This study demonstrates the stages of implementation of the 5S program in a private school for children, located in the city of Manaus-AM. The quality of school services was evaluated through indicators of space optimization, organization of the environment, accessibility and use of resources, based on the 5S program to guide their daily actions.

For [1] there are several quality systems that can be applied to reduce costs, optimize time and increase competitiveness. Among these, the 5S program.

The implementation of the 5S program requires the commitment of the team, that is, participate in the training, understand the proposal of the program and participate in the implementation stages. The school secretariat was the chosen place for the application of the program, since in the previous evaluation it was the chosen sector, due to the disorganized conditions of the

cabinets, unidentified materials, toys mixed with expedient material, computer screen supported under a ream of paper, plastic chair inappropriate for that function the ideal would be an executive chair. The quality tools of 5S programs as a quick and effective solution to prepare and organize the secretariat that used to implement the quality program to provide a better quality in the services offered by the school.

In this sense, this work aims to describe the stages of implementation of the 5S program in the school secretariat.

## II. THEORETICAL FOUNDATION

The school quality program offers a proposal to improve all processes involved in the school to provide a quality service [2]. It is important to make a prior analysis of problems and formulate solutions that will improve all sectors of the school.

The school has several sectors such as secretary, board, pedagogy, kitchen, bathrooms, sports court. These sectors need to provide a clean, organized and secure environment for teachers and students [3].

### 2.1 SCHOOL QUALITY PROGRAMS

The school quality program has the purpose of evaluating the quality of school education through indicators [4]. Quality indicators are tools that accompany the system proposed by school education, are used to evaluate organizational performance and thus measure and point out possible operational failures.

Its goal is to improve the quality of teaching. Through indicators the National Institute of Educational Studies and Research (INEP), conducts research to prove the quality of teaching in schools.

The concept of quality is widely diversified for William Edwards Deming, quality means continuous improvement, that is, we can always improve a process in order to make it better [5].

In order to obtain a quality education this quality has to be evaluated at various levels and by all sectors of a school. The school is composed of a pedagogical structure, administrative, within the administrative are provided services such as cleaning, organizing, cooking, craftsman [6].

In order to evaluate the quality of the school we can use many tools, one of them are the indicators, this tool helps us to know how the quality of the processes is. The school space must offer adequate conditions, because it is where the pedagogical practice develops, the classrooms, bathrooms, canopy, library, secretariat and sports court require conditions conducive to the well-being of teachers and students.

The 5S program can be applied in schools with the aim of promoting quality and excellence in services. This program can be applied at both the administrative and pedagogical levels which will have promising effects [7].

According to the Ministry of Education, quality in elementary schools is paramount for the formation of a conscious and productive society.

The need for a program that provides the tools needed to optimize each sector of the school. The 5S program responds to this need its structuring encompasses several sectors.

## 2.2 5S PROGRAM

The 5S program is a tool that contributes to promoting quality in the work environment. This tool generates possibilities for improvement in the processes of production and administration. Finally, a culture of organization is created where everything is arranged in its proper place, promoting the reduction of waste and the optimization of time and space [8]. The prologue to the

5S program went to Japan in the 1950s. William Edwards Deming is developing a paper to help the census and to apply new techniques that made the job easier.

Kaoro Ishikawa professor at the University of Tokyo in May 1950 develops a proposal to contain the waste to help the reconstruction of the country devastated by war in this context he created the 5S program [9].

The five senses proposed by the program are based on eliminating waste and gaining competitive advantages in the service or product offered. In Brazil, the program was officially known through the foundation Christiano Ottoni, the pioneer to adopt the tool was the business branch, in order to avoid wastes, increasing its productivity and maximizing its profits.

The organization, besides creating a good impression, the program contributes to the productive work environment, which allows efficiency in the internal and external routine for its employees, suppliers and consumers. The 5S program is based on the following principles:

**Seiri (Sense of Use):** its concept is to combat the accumulation of unnecessary objects, identify and adopt measures to eliminate the excess of items to no avail. By adopting our sense, we have as responsibilities to maintain the environment only with the necessary and to avoid wastes.

**Seiton (Concept of Organization):** its concept is to specify a place for each object, allocating it and keeping it in its proper place. The organization is an important step to achieve the optimization of a process, the objects must be organized according to their demand of use, it is also very important to save in the right place after the use giving flow as soon as there is need to use the material again, and it will be found easily.

**Seiso (Sense of Cleanliness):** the concept is to have a clean environment, that brings comfort, comfort and be pleasant to its users. Each employee must keep their workplace clean and organized, be responsible for picking up the garbage, preferably separate the materials that can be recycled and reused, and promote workshops to minimize the environmental impact. Working in a harmonic environment is critical to people's physical and mental health.

**Seiketu (Hygiene Sense):** its concept is the preservation of health, establishing normal and adequate conditions for the well-being, adopting cleaning methods that aim to avoid infectious diseases. Dust and dirt creates an environment conducive to the proliferation of bacteria,

food remains allows the proliferation of rats and cockroaches making the environment unhealthy and harmful to health.

Shitsuke (Sense of Self-Discipline): it is the sense that allows the person to become responsible, helps to fulfill deadlines, conducting a self-management and promoting a work of excellence for organization. It stirs up culture, reshaping ideas and behavior of people in general.

### 2.3 ORGANIZATION OF SCHOOL SPACE

In the organization of the school space, three dimensions must be taken into account: Physical dimension: that refers to physical space, furniture, lighting, ventilation. Functional dimension: which correspond to the various functional forms that the environment can acquire. Time dimension: the way to organize time [10]. The director must guarantee infrastructure and the conditions of a hygienic, pleasant and safe environment.

The school organization is formed by a set of interactions [11]. The waste and lack of organization, poor use of time, employee demotivation, stress are one of the main causes of decline in job performance.

The 5S program can be used as a tool to organize the school space. Providing quality in various sectors of the school and positive changes in the use of material [12].

The effects of using the 5S program are satisfactory and the implementation of this program assists and promotes the change in the behavior of students, teachers and school staff. What changes there were, after the applications of the program. more accessibility to the material plus efficiency in administrative services.

In view of all these issues mentioned above, this paper presents the proposal to evaluate the implementation of the 5S program in a private elementary school in the city of Manaus-Am. The method adopted for the development of the work was the one of research, with qualitative character.

The main tools used to improve processes in schools are the analysis of the real needs of the school and the application of the tools to solve the problems encountered.

### 2.4 DIAGRAM OF ISHIKAWA

The Ishikawa tool is a graphical tool that helps to manage and perform quality control in several productive processes, whose main objective is to identify the causes and effects of a given problem [13].

It was idealized by chemist Kaoru Ishikawa (1915-1989), born in Tokyo and an industrial family. He worked as a naval technician in the army (1939-1941), later in the "Nissan Liquid Fuel Company" until 1947, lectured at the same university that graduated (University of Tokyo) in engineering, in 1947 entered to the group of researchers, the Japanese Union of Scientists and Engineers (JUSE), whose principle is to research quality control (ASQ, 2019). Developed by Americans, Ishikawa incorporated and developed management concepts from Dr. William Edwards Deming and Dr. Joseph Moses Juran for the Japanese system.

Perhaps Ishikawa's most important contribution was his role in the growth of Japanese quality strategies. Which are specifically Japanese characteristics. Developing courses taken by executives and managers.

Cause and effect, known as Ishikawa diagram is an easy-to-handle tool for analyzing and developing problems (JUSE, 1962). Very important for several processes, identifying problems and how to prevent them.

### 2.5 BRAINSTORMING

Brainstorming is a tool used to encourage creativity, the purpose of this tool is to seek ideas to solve a problem [14]. It is a technique used in group dynamics that explores the creativity and ability of that particular group according to their interests. Brainstorming is applied as a quality tool crafted as group dynamics, teamwork flows as ideas are exposed, the climate of involvement and motivation generated ensures quality in the decisions made by the group.

Alex Faickney Osborn (1888-1966) Born in the Bronx in New York, he was an advertising executive and was the creator of an important creative technique called Brainstorming. The main objective of this technique is to promote creativity in a group [15].

Brainstorming is a tool used for problem solving of a given group, promoting and stimulating creativity is selected a problem and ideas are exposed to solve this problem [16].

## III. TOOLS AND METHODS

The methodology used to carry out this work was a descriptive case study of a qualitative approach. It was developed with a field research that describes the proposed implantation of the 5S program in a school of Infantile Teaching in the city of Manaus-Am. It focuses on identifying situations, events and organizations as a

type of research for qualitative research. In this approach, all the facts and phenomena are significant and relevant, being worked, mainly, through questionnaires, observations, data collection and case studies.

In this case what are the steps of applying the 5S program in a kindergarten? The collection period was from April to June 2019. This period covers the bibliographic survey, and the proposal for the execution of the program in the school.

The work carried out the following steps: Diagnosis of the situation, formalization of the research, pre-implantation research, through a questionnaire, meeting with employees, lecture about the 5S program, choice of the sector, proposal for implementation and compilation of the data.

The diagnostic stage of the situation was an on-site visit to evaluate the situation of the school in relation to its physical spaces. The formalisation of the research through the authorization of the school with the direction, for the pre-implantation research was used a questionnaire containing five closed questions. The implementation of the program followed the following steps as shown in figure 1 below:

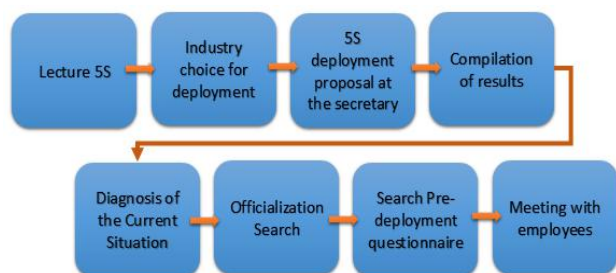


Fig. 1: Steps of the 5S Program Implementation Process

The main methodological tools used to support the implementation of the plan were: Data collection, through the questionnaire of closed questions, the use of the tool of the cause and effect diagram, following the method of Ishikawa, Brainstorming.

### 3.1 DATA COLLECTION THROUGH QUESTIONNAIRE CLOSED QUESTIONS

The objective to apply the questionnaire is to identify the knowledge of the employees in relation to the 5S program. Because it is a study tool that facilitates an indirect approach with employees, the questions are based on their experiences with the quality tool.

For this, five closed questions were elaborated, which approached the knowledge and interest of the tool, the informant chooses his answers according to the three

options, objective, although narrow the freedom of the answers, makes the researcher's understanding easy. The questionnaire was the main instrument in this study and is found in the annex.

With the questionnaire, the booklet was presented (in an annex) guiding the essence of the research, its particularities and the necessity of the program for the school, expressing the interest of the collaborators, so that it responds and returns within a pre-established period.

### 3.2 APPLICATIONS OF THE ISHIKAWA TOOL

We use the Ishikawa Diagram quality tool to identify which unwanted results. The process works to assess the degree of user dissatisfaction. Figure 2 show Ishikawa, the purpose is to describe the cause and effect of the problem found in the teaching service.

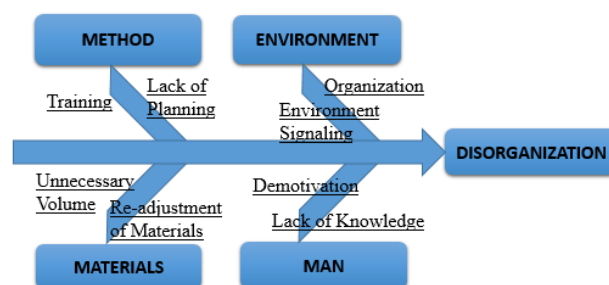


Fig. 2: Cause and Effect Diagram

### 3.3 BRAINSTORMING

In the meeting Brainstorming was presented, to awaken the creativity of the collaborators, the concepts of the dynamics were to explore ideas related to some problems, so the participants could interact exposing their opinions, letting them flow, without criticism. After the debate, the ideas were clarified according to the author's point of view, avoiding the emergence of interpretations. The proposed ideas were annotated so that they could be evaluated and revised, eliminating duplicates. By consensus among the participants, we exclude non-purpose ideas and those selected, the most variable should be registered in visible places such as: painting, poster, etc.

### 3.4 CASE STUDIES APPLIED TO SCHOOL PROCESSES

Since the objective is to answer questions that are characteristic of a specific context, the approach chosen to conduct this research is qualitative, this type of research seeks to answer very particular questions on a level of reality. For the qualitative approach to be based on the dynamic relationship, all facts are important,

mainly through the questionnaire, booklets, observations, ethnographic studies and case studies.

Functional spaces in countries like Japan are quite common to have a process standardization.

The secretariat is an important functional space of the school. The secretary is responsible for student documentation, files and processes as well as the issuance of letters, issuance of statements and certificates.

The case study studies an event in action and is defined by recognition rather than by theoretical definition. Besides observing and describing, it is necessary to analyze, give opinion, so that the reader knows that the opinion of the researcher is being given and that there may be other inferences.

Therefore, considering the objectives of this research and that there is no intention to generalize results, but contribute to the knowledge and understanding of a specific context, promote reflections and decision making, this study is characterized as a case study.

### 3.5 CHARACTERISTICS OF THE STUDY APPLICATION SCENARIO

It is a private kindergarten school, located in the eastern part of Manaus-AM, which has been in education for twelve years. He currently has twenty-eight students and eight collaborators. The microenterprise is family run, and operates in the morning and evening periods, has adequate infrastructure and didactic materials according to its teaching proposal.

Mission: To provide excellent teaching to its students through invocation and interactivity. Vision: To meet the needs that the teaching scenario requires. Values: Commitment, respect, solidarity, creativity, providing quality services to the community in general.

## IV. PROPOSAL FOR THE IMPLEMENTATION OF THE 5S PROGRAM IN SCHOOL OF CHILDREN'S EDUCATION

It was contacted that the school does not have a quality program. For this purpose, a proposal for the implementation of the 5S program was elaborated, in order to highlight the benefits and benefits that the tool provides to the work environment.

### 4.1 PLANNING

The action planning steps of the proposal to implement the 5s program in the school were:

Step-1 Diagnosis of the Situation: The diagnosis was made with an on-site visit where all sectors were observed, and the information noted for the formulation of the action plan.

Step 2 Research Officialization: After the formalization of the school to participate in the research was scheduled a date to return a meeting with all school staff to present the project. This meeting had the objective of arousing the employees' interest in the 5S quality program.

Step-3 Pre-implantation research: A questionnaire was applied with all the employees of the school to evaluate if the school already had a quality program, to investigate if the employees know about the 5S program, were questioned about improvements in the work environment and their pre-disposition to future changes.

Step-4 Meeting with employees: After the questionnaire was completed, a meeting was scheduled with all employees to define which sector the program would be applied to.

Step-5 Lecture about the 5s program: A lecture was distributed with the distribution of booklets for the employees highlighting the fundamentals of the 5S program and how it will be applied in the school. The importance of the lecture is to train multipliers of this quality program. The use of printed educational materials to share knowledge is common practice in quality programs. Manuals containing content of the 5S program, leaflets and booklets are able to promote expressive results for participants in educational activities.

Step-6 Choice of the sector: After the lecture a meeting was held where a vote was proposed to choose in which sector the 5s program would be applied. The sector chosen was the secretariat, as it was quite disorganized. A group dynamics was performed using the Brainstorming tool where the employees put their ideas to solve the problem of the secretary's disorganization, the ideas were filtered and after that a point was made.

Step-7 Deployment: the deployment proposal.

### 4.2 EXECUTION SCHEDULES

The timeline is the graphical arrangement of the time that was spent in the execution of the project, according to the activities to be accomplished. It serves to assist in the management and control of this work, allowing a quick visualization of its progress Figure-3 Execution schedule.



Stage	Assignment	Period	Responsible	Status
1	Diagnosis of the situation	April	Researcher	Completed
2	Research Officialization	April	School management	Completed
3	Pre-deployment research	May	Researcher	Completed
4	Meeting with employees	May	School management	Completed
5	Lecture 5S	May	Researcher	Completed
6	Industry choice	May	Workers	Completed
7	Proposal	June	Researcher	Completed

Fig. 3: Execution schedule

### 4.3 STAGES OF IMPLEMENTATION OF PROGRAM 5S

A lecture was given explaining in detail the 5S program, the importance of the tool for the work environment, guiding the implementation stages to the employees according to the need, in the scenario of the secretariat. The resources used for this talk were: Data show, sound box, microphone, notebook.

**SEIRI- Sense of Use** - To get the good sense of use we have to organize the material of work and separate the unnecessary things and directs them to where they can be used, conserving the materials useful.

The proposed sense of use was divided into two stages: recognition and action.

**1st stage recognition:** in this stage a diagnosis was made in the registry in order to identify objects that do not have utility for this sector and separate them according to their classification: donation, repair, recycling or disposal.

**Step 2 action:** In this stage was presented the school's management a list of materials not used in the secretariat. The management was responsible for forwarding the material for donation, repair, recycling or disposal.

**SEITON- Sense of Organization** - To reach this sense of organization we have to organize the materials that will be used most often always available in a suitable place. The well-organized material avoids the act of looking for what is a waste of time. Thus, the ordering of this material optimizes the time by improving the quality of the secretarial work.

In this phase the sector will be organized based on the definition of specific space for each object, the objects and places where they should be stored, identified with labels, thus promoting a standardization and facilitating the access of the employees to the materials and also improving the flow in the work with this will not waste time looking for the objects or the files because they are tagged and flagged.

**SEISO- Cleaning Sense** - Preserving the clean working environment is essential for quality of life, as a healthy environment promotes health and well-being. The concept is to show employees that keeping the office clean, guarantees quality in the service offered and that when receiving new employees, suppliers and students the environment is pleasant and free of impurities, which can hamper the development of the routine of tasks.

**SEIKETSU- Hygiene Sense** - The prevailing thinking in this stage is: For quality to be standardized and looked after. Health and well-being are important to maintain quality in the secretariat's services. It is also important to take care of mental health and promote a harmonious and quiet work environment caring for interpersonal relationships at this stage is also important, avoiding extravagant behaviors, which compromises good fellowship with co-workers.

**SHITSUKE- Self-Discipline** - The practice of this sense is based on maintaining the concepts acquired with the 5S quality program to implement this phase was given suggestions to the secretariat staff:

- Separating organic waste from recyclable;
- Comply with the norms established by the "5S";
- Delivering deadlines and dates of delivery of tasks and tasks;
- Properly wear the uniform;
- Greet everyone in a polite manner;
- Respect and talk whenever there is a difference of opinion;

Shitsuke is important to maintain the 5S program because with self-discipline the employee can maintain the quality of the services provided by the secretariat and practice this quality program on a regular basis.

## V. ANALYSIS OF RESULTS AND INDICATORS

The 5S program proposal provides an analysis of the results when implementing the quality tool to achieve the objectives proposed by the researcher. The purpose of the implementation proposal is to maximize the teaching service and eliminate the problems encountered according to the cause and effect tool.

In the secretariat was identified a great flow of employees, a positive aspect, since we can solve in a practical way the problems encountered. With this the following senses were proposed: SEIRI (Utilization), SEITON (Organization), SHITSUKE (Self-discipline).

Figure 4 below shows the registry of some places proposed for deployment:



Fig. 4: Places proposed for deployment

**SEIRI (sense of use):** Identify objects with labels, to avoid the act of searching and wasting time, because they are labeled and flagged.

**SEITON (sense of Organization):** Separate necessary materials, keeping only the materials useful. Recycle bin with organic and recyclable waste identification to facilitate pickup and keep the environment clean.

**SHITSUKE (sense of self-discipline):** To have quality you need to standardize, take care of mental health and interpersonal relationships is important at this stage. Having good habits and adapting to change are key to deployment.

In the study it was identified that the school does not do any satisfaction research with the employees and clients, it was suggested that the manager apply a research before the implantation so that we could measure the degree of satisfaction of before and after in relation to the school environment. All the proposals have been accepted, but will be implemented during the holidays. By June is the holiday month and the end of the semester, it would not be possible to implement. Even considering the 5S program of low cost and easy application, it was not possible to implant in this period. After implementation, continuous improvement in the secretariat sector is expected.

## VI. FINAL CONSIDERATIONS

The implementation of the 5s program seems to be easily applicable in organizational environments, however, experience has shown that it is not enough to execute the senses at random, it is necessary planning, commitment and change of habits within the organizational system. It can be said that the implementation of the 5s program becomes complex because even if it is necessary, people still have difficulties adapting or are not willing to change. Thus,

the staff must be in agreement with what this quality program proposes to perform, as deep changes in attitudes and behaviors are required, focusing on improvements in the organizational processes that will occur only with the effective participation of all employees of the company organization.

Therefore, since it was a small school and without many financial and personnel resources, after a meeting with the management of the school, it was decided to propose the implementation of only three of the senses of the 5s program, SEIRI, SEITON and SHITSUKE, since the other two senses, SEISO and SEIKETU, would bring greater expenses, the school did not have these resources.

It is hoped that with the implementation of SEIRI, the school will develop a sense of conscientious use of expedient materials, discarding the unnecessary and adopting measures to combat waste, managing to keep only what is necessary in its work environment and thus generating economy expenses with these record materials. With the implementation of SEITON, the objective is to optimize space, organizing the materials and furniture in order to obtain a more pleasant environment, streamline the flow of people and facilitate access to documents, folders and records.

With SHITSUKE, the development of the sense of responsibility, commitment and organization of the employees of the school is desired. This sense needs to be worked out with employees, since all other senses need willing, motivated, and active people to execute them.

It is important to highlight the contribution of the school to this study through the consent and information provided, making feasible the proposal to implement the 5s program. Likewise, it is necessary to emphasize that the implementation of quality programs are necessary for the continuous improvement of organizational environments and that only through work and joint effort can it be possible to abandon old habits and obtain organizational and personal development.

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## REFERENCES

- [1] LOPES, Janice Correia da Costa. Gestão da qualidade. 2014. Tese de Doutorado.
- [2] LIBÂNEO, José Carlos. Organização e gestão da escola. Goiânia: alternativa, p. 123-140, 2001.
- [3] PARO, Vitor Henrique. Gestão escolar, democracia e qualidade do ensino. São Paulo: Ática, 2007.
- [4] LÜCK, Heloísa. Dimensões da gestão escolar e suas competências. Curitiba: Editora Positivo, p. 47-69, 2009.
- [5] LUCINDA, Marco Antônio. Qualidade-Fundamentos e Práticas. Brasport, 2010.
- [6] MACEDO, Elizabeth. Base Nacional Curricular Comum: novas formas de sociabilidade produzindo sentidos para educação. Revista E-curriculum, v. 12, n. 3, p. 1530-1555, 2014.
- [7] DA SILVA, Elaine Patussi; DELES, Katarinny Pinto Sena; DE PAULA, Vérica Marconi Freitas. Implantação do programa 5S em uma escola municipal. Em Extensão, v. 12, n. 2, p. 128-140, 2013.
- [8] ANDRADE, Paulo Hyder da Silva et al. O impacto do Programa 5S na implantação e manutenção de sistemas da qualidade. 2002.
- [9] CAMARGO, Wellington. Controle de qualidade total. 2016.
- [10] TEIXEIRA, Madalena Telles; REIS, Maria Filomena. A organização do espaço em sala de aula e as suas implicações na aprendizagem cooperativa. Meta: Avaliação, v. 4, n. 11, p. 162-187, 2012.
- [11] ZAMBERLAN, Maria Aparecida Trevisan; BASANI, Simone I. Stroka; ARALDI, Marizete. Organização do espaço e qualidade de vida: pesquisa sobre configuração espacial em uma instituição de educação infantil. Educere et educare, v. 2, n. 4, p. 245-260, 2007.
- [12] ORTIZ, Chris A. Kaizen e implementação de eventos Kaizen. Bookman Editora, 2009.
- [13] PALADINI, Edson Pacheco. Gestão da qualidade: teoria e prática. In: Gestão da qualidade: teoria e prática. 2010.
- [14] CAMPOS, Vicente Falconi. TQC: Controle da Qualidade Total (no estilo japonês). Universidade Federal de Minas Gerais, Escola de Engenharia, 1992.
- [15] FEIGENBAUM, Armand Vallin. Controle da qualidade total. Makron Books, 1994.
- [16] CAMPOS, Vicente Falconi. TQC: Controle da Qualidade Total (no estilo japonês). Universidade Federal de Minas Gerais, Escola de Engenharia, 1992.