The importance of feedback in the applicability of the PDCA cycle

A importância do feedback na aplicabilidade do ciclo PDCA

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RESUMO

A questão da destinação final dos resíduos da população é uma preocupação global urgente, os objetivos deste trabalho apresentará o uso da ferramenta da qualidade PDCA, que é uma das ferramentas mais populares para proporcionar a melhoria contínua dentro das organizações. Esta ferramenta da qualidade, divide a administração de processos em quatro etapas, simplificando sua gestão e favorecendo mudanças positivas náo gerenciamento de resíduos sólidos, e neste artigo, aplicar um projeto de melhoria contínua na coleta dos RS no Centro Universitário Fametro, Unidades 1 e 2, em Manaus, Amazonas, apresentar a percepção dos acadêmicos sobre a coleta seletiva e alternativas na redução de RS e aperfeiçoar o processo de coleta e destinação dos RS existente. Será demonstrado os indicadores colhidos nos questionários aplicados nos discentes da IES, em Manaus, Amazonas, com objetivo de avaliar o gerenciamento de resíduos sólidos e aplicar um projeto de melhoria contínua na coleta seletiva de resíduos sólidos na Instituição de Ensino Superior (IES) em análise, apresentar alternativas para minimizar os impactos causados pelo descarte inadequado, com isso integrar a reciclagem nos processos a fim de explorar e proporcionar alternativas nas coletas e o aproveitamento do material reciclado e aperfeiçoar os processos existentes.

Palavras-chave: PDCA; Questionário; Coleta Seletiva

ABSTRACT

The issue of the final disposal of the waste of the population is an urgent global concern, the objectives of this work will present the use of the PDCA quality tool, which is one of the most popular tools to provide continuous improvement within organizations. This quality tool, divides the administration of processes in four stages, simplifying its management and favoring positive changes not solid waste management, and in this article, apply a continuous improvement project in the collection of RS in the Fametro University Center, Units 1 and 2, in Manaus, Amazonas, present the perception of academics about selective collection and alternatives in the reduction of RS and improve the process of collection and disposal of existing RS. It will be demonstrated the indicators collected in the questionnaires applied to the students of the HEI, in Manaus, Amazonas, in order to evaluate the management of solid waste and apply a project of continuous improvement in the selective collection of solid waste in the Higher Education Institution (IES) under analysis, present alternatives to minimize the impacts caused by improper disposal, thereby integrating recycling into processes in order to explore and provide alternatives in the collection and use of recycled material and improve existing processes.

Keywords: PDCA; Quiz; Selective Collect
INTRODUCTION

The high and constant population increase in cities, in large urban centers in general, is accompanied by a series of problems, most notably the generation of urban waste and its final destination (Marchi, 2015). The issue involving solid waste has gained repercussions in Brazil in the last 30 years. Because it is a complex problem and to obtain correct solutions for the appropriate disposal of waste generated by society, cooperation between government, civil society and the private sphere is necessary (Lima, 2012).

Federal Law 12,305/10 addresses one of the biggest challenges, in environmental terms, of public policies aimed at reducing levels of pollution and environmental degradation (Guerra, 2012). With the advent of the law, it appears with means of preventing and reducing waste generation, seeking through its proposals to influence the practice of sustainable consumption habits and necessary instruments to assist in the recycling and reuse of waste.

An organization can be understood as a large process, and within it there are several subprocesses. In this way, good management and use of tangible tools is essential to have quality functioning in each organizational process and consequently in the company as a whole (Barros; Bonafini, 2015). For Tavares (2020), there are two views, one places education as an indispensable tool for sustainable management, the other highlights the implementation of an Environmental Management System on university campuses, as these assume the role of models and pilot projects for environmentally sustainable management. for the society.

For Ferrari et al., (2016), selective collection is a continuous and gradual process whose first step is environmental education to raise awareness among the population and engage individuals in the necessary actions, such as properly separating waste, since without this stage, all selective collection is compromised. Lu (2015) mentions that the PDCA methodology makes it possible to improve and analyze the procedure practiced. The concept of this technique was developed for quality management, but it can be used for any process in an organization.

This article aims to verify and analyze the interventions applied, through the use of the PDCA tool, in a proposed solid waste management methodology at Centro Universitário Fametro, Units 1 and 2, Manaus/Am.
METHODOLOGY

The methodology of this article is based on the improvement of the IES Sustainable Logistics Plan, with a view to meeting the Environmental Management Plan (PGA) to be implemented. The use of a tool commonly used in industrial processes, the PDCA cycle, will be used in the work with a view to contributing to the development and consolidation of improvements in the IES Sustainable Logistics Plan.

Study Location

The project was developed and implemented at the CEUNI-FAMETRO University Center (Units 1 and 2), a Higher Education institution located in the Center-South area of Manaus/AM. Its profile and mission are presented as follows: “based on the Teaching, Research and Extension tripod, with offers of undergraduate and postgraduate courses in broad sense, which defines itself as an IES with a permanent focus on the quality of teaching and socioeconomic inclusion, that guarantees access and permanence in higher education, having as institutional values Quality in Teaching, Ethics, Humanization and Professionalism, with the following mission: Training professionals in Higher Education, with professional ethical values and environmental principles, capable of contributing to development of the Northern Region.”

Image 1: Location of the Fametro University Center, Units 1 and 2 in Manaus/Am.

Source: Google maps
Research design
The methodology was applied in stages, arranged as follows:

a) Descriptive: carried out in meetings with the coordinators of the existing courses in Units 1 and 2, with the objective of disseminating in the academic environment, the improvement in the management process of Solid Waste Management (SWM) at the HEI;

b) Exploratory: with the application of a questionnaire (Table 1) through the “Google Forms” platform, with themes involving selective collection, in this way, their perceptions regarding the topic can be observed, and finally, the analysis of the results and development of the booklet; It is,

c) Expository: where the booklet contains information about how it is carried out and the importance of the participation of the academic community in selective collection.

Table 1: Questions prepared and applied for academics

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Question</th>
</tr>
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<tbody>
<tr>
<td>Academic 01</td>
<td>Get to know the IES Sustainable Logistics Plan</td>
</tr>
<tr>
<td>Academic 02</td>
<td>Understand what solid waste is</td>
</tr>
<tr>
<td>Academic 03</td>
<td>Generally what I do with the solid waste that I generate/discard in Units 1 and 2 of CeUniFametro</td>
</tr>
<tr>
<td>Academic 04</td>
<td>I understand what selective collection of solid waste is</td>
</tr>
<tr>
<td>Academic 05</td>
<td>There are solid waste collectors in Units 1 and 2 of CeUniFametro</td>
</tr>
<tr>
<td>Academic 06</td>
<td>I do not believe that selective collection of solid waste is beneficial to the environment</td>
</tr>
<tr>
<td>Academic 07</td>
<td>I had no difficulty locating the collectors in the hallways.</td>
</tr>
<tr>
<td>Academic 08</td>
<td>I believe that the number of collectors available is sufficient</td>
</tr>
<tr>
<td>Academic 09</td>
<td>I did not find available information on how to separate solid waste in Units 1 and 2 of CeUniFametro</td>
</tr>
</tbody>
</table>
Quiz

To apply the questions, in addition to the “google” forms tool, the Likert Scale (1932) was used, which allows the respondent to indicate their agreement, approval or belief in the questions and at the same time, allows to obtain a scale regarding the interviewee's opinion. In this way, it was possible to verify the degree of understanding of employees who deal directly with waste and HEI academics about solid waste management at the HEI. To achieve the expected result, 4 steps were established, as shown in the following illustration:

Figure: The research methodology applied with the PDCA cycle.

PDCA Cycle

The PDCA cycle is an improvement management methodology focused on quality, it is an interactive and continuous administration mechanism that is based on four stages. The name PDCA corresponds to an acronym borrowed from English, referring to these four management phases (Figure 2).
Where, Plan means, Plan; Do, is to do and/or execute; Check, Check, verify, measure; and Act, Act. Based on the idea that no process is perfect and that improvement is always possible, PDCA offers conditions to manage its operation with a focus on quality.

**Using the PDCA tool**

**Plain**

It includes getting to know the IES facilities, Units 1 and 2, starting with a visit to all the floors that make it up. Note the facilities visited. Furthermore, develop a line of action observing the sequence of actions that should occur during the implementation of the project. Also, meet with the coordinators of the existing courses in the units under study, explaining the need for the effective participation of academics, thus allowing the goals to be achieved with the involvement of everyone. And finally, redo the course of action, if necessary.

**Do**

At this stage, it is necessary to collect and tabulate data on solid waste generated in Units 1 and 2 of the IES. Likewise, check and list the current state of the process of disposal, segregation and final destination of solid waste at the IES, with the purpose of detecting points that require intervention to improve the existing process. Furthermore, it will be necessary to insert a selective collection plan into the IES.
Sustainable Logistics Plan, checking whether there are local companies that purchase segregated materials.

Additionally, promote the participation in selective collection in the academic world, not only at the IES, but to participate as disseminators of a mentality focused on a sustainable environment. Therefore, propose the production of a booklet with environmental tips, which help in understanding the proposed topic and consolidate the work.

**Check**

Frequently check the progress of actions compared to the goals set, in order to resize the activity process, if necessary.

**Act**

Implement the corrective actions raised in the previous phase (Check), thus achieving the scope of the work.

**RESULTS AND DISCUSSIONS**

The proposal presented in this article aims to create an ecologically balanced environment in the academic community, starting from the micro to reduce a macro problem, the practice of selective collection, thus participating in the generation of income through the sale of recyclables, generating revenue for waste picker associations and reducing the environmental impact on landfills. Therefore, if the objective is not achieved, it is necessary to establish new actions in new PDCA cycles, on the main actors of the academic community at the HEI under study.

The main expected result, however, is the change in behavior of members of the academic community studied, acting as multipliers of actions in the implementation of permanent selective collection, serving as a model for society in general.

The results obtained in this work demonstrated the need to take the teaching of legislation that ensures protection and preservation of the environment to the scope of the IES, as a way of educating citizens concerned about the environment, who will be able to alert their families and those with whom they are involved. They live together about their place in life in society, guided by their rights and obligations provided by the legislation of the democratic state in which they are inserted. The encouragement of a
solid, interdisciplinary and attractive Environmental Education (EE) was clearly observed, with the capacity to contribute to the formation of future citizens committed to sustainable development.

Analysis of the positive points and negative points found during the visit to the premises of Units 1 and 2 of the IES.

The first positive point observed during the visits was the encouragement and adherence on the part of the course coordinators, and the participation of their academics in this work. Furthermore, it was found that there are 5 sets of selective collection kits available in Units 1 and 2. Another relevant point that deserves to be highlighted is the existence in the IES Sustainable Logistics Plan, the provision for the involvement of the entire community academic in selective collection.

As for the negative points, it was mainly observed that there are not enough collectors in the areas where students circulate, there is a lack of specific collectors for disposing of batteries, cell phone or notebook batteries, or IT components, in the classrooms the collectors do not provide selective collection. , as there is a single collector for disposing of plastic bottles, Styrofoam, leftover food or fruit, soft drink cans, tissue paper, among others. Same scenario in the corridors of Units 1 and 2, only one collector per corridor to receive any and all discarded waste.

In the convenience area, canteens, tailoring service providers, stationery stores, photocopiers, among others, there is no selective collection in these spaces, everything is mixed and placed in the same segregation area. After the visits, a questionnaire was prepared for academics to obtain a general overview of the academic community's knowledge regarding selective collection (see Table 1 and Table 2).

Academics' Perception Regarding the Selective Collection Implementation Process

In this section, the relationship between academics and common solid waste generated within the IES was evaluated, as a way of appreciating the weaknesses and then proposing improvements to the IES' sustainable logistics plan, which encourage the segregation of common solid waste in the IES. generation point.

The methodology adopted to evaluate the perception of academics was a survey in the form of a structured questionnaire on Google Forms, applied by course coordinators in the units in question (Units 1 and 2 of the IES), and analysis of the
results in a qualitative and quantitative manner, supported by Microsoft Office Excel software. To determine the size of the research sample, the probabilistic type was used, in a stratified manner.

The questionnaire was applied through simple random sampling based on distribution in course coordination, carried out between August 14th and September 8th, 2023, with an excess sample size of 3% surveyed, totaling 225 people participating of the research.

The analysis of Graph 1a shows that 84.7% of interviewees are aware of the HEI’s Sustainable Logistics Plan, and on the other hand, 15.3% are unaware of the existence of such a Plan, and as a suggestion, it should be monitored by managers this lack of knowledge, make the current plan available on its digital platforms, thus allowing all members of the academic community to have access to the IES Sustainable Logistics Plan.

At the same time, when asked about solid waste disposal practices produced by academics, 51.4% dispose of their waste without worrying about separating the recyclable from the non-recyclable. 46.5% of those interviewed stated that they observe the separation of their waste at the time of disposal, 2.21% of respondents dispose of their waste anywhere without taking care to separate the recyclable from the non-recyclable (Graph 1b).

Graph 1: Questions applied to academics: a) Ac01; b) Ac02.

Source: Autors (2023).
When asked whether they understand the meaning of selective collection, 38.9% completely agree, 22.9% partially agree, 5.5% completely disagree and 6.9% completely disagree, in graph f, asked if they do not believe that selective collection of RS is beneficial to the environment, the following percentages can be seen; 72% completely disagree, 13.2% partially agree, 5.5% completely agree, 5.5% do not agree and do not disagree and 2.8% partially disagree.

Graph 2: Questions applied to academics

When asked if they had no problems locating the collectors in the corridors, the percentages were 29.9% fully agreed, 19.4% partially agreed, 18.15% partially disagreed, 16.7% neither agreed nor disagreed and 16% disagreed fully. In graph h, asked if they believe that the number of collectors available is enough, and 28.5% partially disagreed, 22.9% completely disagreed, 20.8% neither agreed nor disagreed, 16% completely agreed and 11.8% % partially agreed.

In graph i), asked if they did not find available information on how to separate RS in the HEI, 29.9% neither agreed nor disagreed, 25% fully agreed, 18.8% partially agreed, 15.3% fully disagreed and 11, 1% partially disagree.

Source: Autors (2023).
Preparation of the Booklet

With the information collected in the answers to the questionnaire applied to academics, a didactic booklet was created, with the purpose of introducing the academic community to the need to implement and participate in selective collection at the HEI, and encouraging them to share knowledge with their families, his friends, to the society in which he lives.

The development of the booklet was based on two distinct moments, a first, based on the questionnaire administered to students, and a second, based on the prior knowledge of the Staff responsible for handling the RS. The booklet is easy to understand, which allows users to quickly identify processes.

Initially, the collectors for each type of waste and their respective colors are presented. Subsequently, the alternative is presented for cases in which there is no all four collectors are available, thus, with only two collectors, recyclable and non-recyclable, is the solution presented by RS policy. Once the collectors are introduced, the most common recyclable and non-recyclable materials constantly found in higher education institutions are presented.
The cover page, or cover, presents an invitation to participate in selective collection, after all, today selective collection is already a reality. This means that the issue of waste is being seen responsibly, both by public and private authorities and by the population.

Inside the booklet, some basic concepts essential to users are presented, so that they can collaborate with the progress of the project. It presents the concepts of waste and types, coming from industries, businesses and homes. The concept of waste, which is subject to treatment and can be processed for future use, as raw material in the manufacture of new products. But, in order for them to be recycled, the waste must be separated appropriately. One of the alternatives to the waste problem is the adoption of the 5Rs principle – rethink, reduce, reuse, refuse and recycle, and is present in the booklet. This principle can be applied to all our everyday attitudes and choices.

Currently, the discussion on environmental education, which is a topic that presents the need to raise awareness in society regarding environmental issues, needs to establish a direction in the selective collection campaign.

It is necessary to work on environmental education at this time, to clarify that consumer culture, in addition to generating waste, is established on false bases: natural resources are at the limit of exhaustion, they exceed environmental limits, that is, natural rules conservation and regeneration, the environmental impact will be harmful to society as a whole. To achieve this objective, it was necessary to develop guidance in the academic community, aimed at reducing waste generation, reuse and recycling, through directing it to its final destination.
According to Carbonari (2011), the main focus of the staff in relation to the implementation of the selective RS collection program is the practice and change of habits of the entire academic community of Units 1 and 2 of the HEI in question. will only be possible through the awareness of academics and IES collaborators about the importance of the topic, causing changes in culturally existing and accepted habits and customs, with the aim of preventing environmental imbalance and wear and tear and putting management into practice project sustainability.

During the execution of the project, the booklet was distributed to employees in all sectors of the HEI, thus providing the opportunity to reach and involve more people in the process put into practice. The booklet was created in accessible didactic language, which provided employees from the Units involved in the project with a strong identification with the topic, leading them to strong reflections.
During the crossing of the results obtained in the questionnaires, applied to the academics, they were compared with the perception of the collaborators from Units 1 and 2, on the RS theme and, it was noted the lack of commitment from the academic community and other collaborators involved in the research in relation to the solid waste they generate. In the same sense, it is highlighted that the participation of the academic population and collaborators of the Units involved is important and fundamental for the implementation and effectiveness of selective collection, as it depends on the action of separating the RS by the generators.

**FINAL CONSIDERATIONS**

The search for continuous improvement in the management of solid waste in Units 1 and 2 of the Fametro University Center in Manaus, Amazonas, must be constant, in this way, together with education, better environmental quality will be achieved in the IES and in the society in which it operates, improving the environment for everyone, attacking the problem of RS in the micro with a view to helping to achieve the solution in the macro, in this way, it is indicated that solid waste management plans can and should be applied in any environment, whether in the company, in HEIs, in communities in general, thus allowing a reduction in the environmental impact caused by RS mixed with the mass of waste in landfills or landfills. In the specific case of the IES, a selective collection pilot project was implemented, offering more information to the academic community and collaborators of the IES under study, surveying academics' perception regarding the importance of selective collection, creating a booklet on selective collection and its distribution among academics and collaborators at the Units, came to crown the project, as its objective was achieved, awakening the vast majority of people's interest in separating their waste in a conscious way.

The IES, being a laboratory where research happens naturally, must implement the RS management plan, where preliminarily, it is possible to test all forms and ways and possibilities of correcting the problems, if necessary the RS management plan. Aiming to improve the model and thus deliver to society a plan capable of being applied in all sectors, as the ideas can be applied in any urban, residential, educational or business environment or in companies, schools, condominiums and homes. After
gaining insight into the problem, it will be possible to apply methods such as PDCA, helping the manager to continually improve solid waste management. In this way, the application of the Institutional PGA shows that through environmental education it is possible to achieve this goal.

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