

# Proposal for an Environmental Management System with Clean Production

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**To cite this article:**

João Pedro Braga Teixeira. Proposal for an Environmental Management System with Clean Production. *American Journal of Environmental Protection*. Vol. 11, No. 3, 2022, pp. 74-81. doi: 10.11648/j.ajep.20221103.13

**Received:** May 20, 2022; **Accepted:** June 2, 2022; **Published:** June 14, 2022

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**Abstract:** Several factors, such as the current environmental degradation, the increase in legal penalties and the growing awareness of the market, have disseminated in organizations the need to implement an Environmental Management System (EMS), mainly seeking to comply with the relevant legislation and improve its image with the market. However, in order only to obtain the desired certification against ISO 14001, many companies do not take advantage of this opportunity to adopt modern and proactive environmental technologies, such as Clean Production (PL), capable of optimizing the use of resources and preventing pollution. The implementation of the PL provides greater cost reduction and increased profitability, as, in addition to favoring source control measures, it seeks greater eco-efficiency in the use of natural resources. PL addresses the complete cycle of products or processes, identifying opportunities and solutions in relation to the challenge of avoiding or minimizing inherent waste, reducing costs with its treatment and destination, adding value throughout its production chain. This article presents a proposal for the implementation of an EMS, considering the requirements and format of ISO 14001, integrated with the principles of PL, at all stages of the system. At the end, a differential synthesis of this proposal in relation to the traditional EMS is also presented.

**Keywords:** Environmental Management System, ISO 14001, Clean Production

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## 1. Introduction

The environmental issue has become one of the most discussed issues in recent decades, due to the alarming levels of pollution and waste generation, in addition to the accelerated scarcity of natural resources. In the meantime, government laws emerged that led companies, without a defined environmental policy, to incur similar penalties and high costs with the treatment of their waste and processes of recovery of degraded areas. In addition, the current globalized economy has created barriers and requirements for business survival and competitiveness, such as international agreements and green certifications. It is worth mentioning that society in general has also pressured companies, boycotting the sale of products that directly or indirectly may contribute to the degradation of the environment [1].

In this way, as the environmental factor became a mandatory reality in business management, it was necessary to incorporate it into the production process, no longer seen as a burden for the industry to become a factor of

competitiveness in the globalized market. In this scenario, the international standards of the ISO 14000 series emerged, which have been offering organizations to meet the growing demand of society and the market in relation to pollution and the use of natural resources. The implementation of an Environmental Management System (EMS) brings to the company, in addition to certification against the aforementioned standard, the improvement of the image with the various social sectors and the guarantee of a continuous program of improvement of the environmental and organizational performance, adding values to the company's business [1].

ISO 14001 specified the following requirements for implementing an EMS [2]:

- 1) ENVIRONMENTAL POLICY: text referring to the nature of the organization and the environmental impacts of its activities, products or services, including commitments to continuous improvement, pollution

prevention and compliance with relevant environmental legislation.

- 2) **PLANNING**: environmental aspects of activities, products and services; legal obligations and other requirements; environmental objectives, goals and programs.
- 3) **IMPLEMENTATION AND OPERATION**: structure and responsibilities; training and awareness; Communication; documents control; operational control; emergency preparedness and response.
- 4) **VERIFICATION AND CORRECTIVE ACTION**: monitoring and measurement; conformity assessment; non-compliance and corrective and preventive action; records control; and internal audit.
- 5) **CRITICAL ANALYSIS BY MANAGEMENT**: periodic analysis of the EMS implementation cycle, pointing out possible changes in the Environmental Policy, objectives or other elements of the system.

Although companies are directing efforts to implement an EMS, the vast majority, however, do not take the opportunity to comprehensively evaluate their processes and include, in the context of system implementation, the adoption of environmental technologies that would allow a better use of their resources and more effective control of their activities. This reactive posture still occurs, as the sole purpose of these companies would be to avoid regulatory penalties or just implement an EMS to obtain the much-desired ISO 14001 environmental certification and the visibility that it promotes [1].

Thus, even after implementing their EMS, many companies are still limited to complying with the legislation, employing traditional practices of environmental protection, called “end of pipe”. These techniques are limited and admit the residue as an unavoidable fact, taking as a certainty the need for treatment, generating added costs to the production. Faced with this, a new proactive culture urges the business community to change its posture and thinking. The new idea would be to direct the solution of problems to their source, that is, to privilege measures to prevent pollution and eliminate or minimize the generation of waste [1].

The philosophy of Clean Production (PL) emerges with these characteristics, providing companies with greater cost reduction and increased profitability, adopting not only source control measures, but also the search for greater eco-efficiency in the use of natural resources. PL addresses the complete cycle of products or processes, identifying articulations along the production chain to add solutions to the challenge of minimizing the waste generated and maximizing economic gains [3]. The idea is to replace the so-called “end-of-pipe” practices (which act only in the treatment or disposal of waste), using, with efficiency, renewable, non-harmful materials and energies, conserving biodiversity, and adopting, as a priority, the rational posture of use, so that product and process needs are reduced and satisfied [4].

The literature addresses the following principles and techniques of Clean Production [3, 5, 6]:

- 1) **PRECAUTION**: provides that the burden of proof is

borne by the polluting agent, who must demonstrate that their products or activities will not cause environmental damage.

- 2) **PREVENTION**: suggests prioritizing actions at the beginning of the production process to avoid the generation of waste at source, instead of treating it. Thus, prevention replaces control.
- 3) **DEMOCRATIC CONTROL**: companies must provide information about their emissions, use of toxic substances, reduction plans, and even the composition of their products.
- 4) **ZERO EMISSION**: provides for a spatial organization of industries in integrated systems where everything has its use, that is, the “waste” of each process becomes inputs from others.
- 5) **BIOMIMETISM**: an industry strategy that imitates the sustainable cycles of nature, based on the fact that there are no open processes in it, but cyclical transformations that eliminate waste and toxicity. It is the main element of Zero Emission Systems.
- 6) **MATERIAL REPLACEMENT**: also called Product Change, it proposes the elimination of the use of toxic substances and the reduction of the use of scarce elements, replacing them with alternative raw materials with similar functions, recyclable or renewable.
- 7) **DEMATERIALIZATION**: waste reduction strategy based on reducing the weight of packaging or secondary materials associated with products.
- 8) **ECONOMIC FUNCTIONALITY**: considers the economic functions and environmental versatility of products and processes, such as the durability of materials and ease of replacement.
- 9) **INFORMATION OPENINGS**: presupposes the transparency of information by the companies, encouraging the practice of benchmarking and the publication of reports, contributing to the raising of environmental standards and the competitiveness of the companies involved.
- 10) **LIFE CYCLE ANALYSIS (LCA)**: evaluates the complete cycle of a product or process, from extraction from nature, manufacturing, transport, distribution, use and reuse, recycling, to final disposal, identifying opportunities at each stage that lead to environmental improvements.
- 11) **ECODESIGN**: is the process of developing or designing a product or process with ecological formats and functions, so that it is less harmful to the environment.

Regarding the application of LP principles, the following sequence of actions is verified [4]:

- a) **SOLVE THE PROBLEM AT THE SOURCE**: modifications to the product (eco-design); changes in processes (new technologies, equipment and operations); changes in inputs (new materials or use of alternatives); and good operational or housekeeping practices (improvement and standardization of

procedures and management practices).

- b) REUSE, REUSE OR REGENERATION: Internal Recycling, that is, the reintegration of by-products into the original production process or into another process within the company itself.
- c) EXTERNAL RECYCLING: recovery of material and energy outside the production process. This practice is the least recognized by the PL, since it admits the generation of waste to later carry out its handling, thus not contributing to its minimization.

The objective of this article is to present a proposal for the implementation of an Environmental Management System (EMS), according to the requirements of ISO 14001, integrating the principles of Clean Production (PL) at each stage of the system.

## 2. Methods

For the elaboration of the proposal of this work, the structure of the requirements of ISO 14001 was taken as a basis. Thus, at each stage of the implementation of the EMS, insertions and/or integration of the principles were made and LP techniques, when possible, based on the sequence of actions discussed in the previous chapter.

## 3. Results

### 3.1. Initial Environmental Assessment

According to ISO 14004 [7], this first step is necessary, as it allows defining the current position of the organization in relation to the environment. The Initial Environmental Assessment aims to survey the situation in all areas, in relation to the requirements of ISO 14001, the existing facilities and difficulties for the implementation of the EMS. Initially, it is recommended that the organization make available the following documents:

- 1) Company data: a document containing: corporate name, trade name, address, geographic location, telephone and fax numbers, CNPJ, state registration, field of activity, size classification, products or services, number of employees and outsourced workers, work regime, certifications, licenses, annual billing and contracts maintained.
- 2) Organizational chart of the company: description of the company's organizational system, showing directors, managers, supervisors and other employees;
- 3) Components of Ecotime: definition of a working group with trained employees to coordinate all phases of implementation and maintenance of the EMS. For this, a simple spreadsheet, such as Table 1 below [8] can be used.

*Table 1. Ecotime Components.*

Name	Function in EMS	Position in the company	Formation

According to ISO 14004, to carry out this initial assessment, the company can use questionnaires, interviews, checklists, direct inspections and measurements, evaluation of records and benchmarking practices. In addition, this assessment can cover [7]:

- 1) The legal and regulatory requirements for the sector;
- 2) Environmental aspects that generate or may generate significant environmental impacts;
- 3) Performance against internal and external criteria, codes, principles and guidelines;
- 4) The company's existing environmental management practices and procedures;
- 5) Existing policies regarding procurement and contracting;
- 6) Information from previous incidents involving non-conformities;
- 7) Opportunities for competitive advantages;
- 8) Stakeholders' views;

In the proposal of this article, it is suggested the application by Ecotime of an Initial Checklist, through interviews, which must contain all the questions foreseen by ISO 14001 and 14004, increased by the principles of PL. Ecotime must analyze the data obtained in this list and make its conclusions and recommendations. Afterwards, they must arrange a new meeting with the interviewees, to validate the preliminary results, in addition to collecting new suggestions from the group. Finally, a final report of the Initial Environmental Assessment must be prepared, which is the starting point for the identification of associated environmental aspects and impacts [1].

### 3.2. Environmental Aspects and Impacts

The present proposal considers this stage as the most important of the system, as it offers the most opportunities to insert the principles of PL in the EMS. Thus, in addition to what ISO 14001 requires, a method for assessing environmental impacts and operational controls with PL techniques is proposed. Therefore, the proposal recommends performing the following sub-steps:

- a) Identification of Environmental Aspects and Impacts

Based on the data from the Initial Environmental Assessment, Ecotime must list in more detail all the organization's activities involved in operational, administrative, internal and external maintenance processes, warehouses, transport, among others. Then, list as many environmental aspects as possible associated with each selected activity. Then, with the help of data from the literature and field experiences, Ecotime should list as many environmental impacts as possible, real and potential, positive and negative, associated with each identified aspect, as shown in Table 2 [7]:

*Table 2. Environmental Aspects and Impacts.*

Activities	Environmental aspects	Environmental impacts

The principle of PL “Democratic Control” can be

considered at this stage, as it requires the company to make information about its emissions available, allowing the community access to its pollution records, to ensure that interested parties are involved in decision-making. In this way, it is recommended that Ecotime establish a dialogue with the community and other interested parties, in order to externalize this work and gather consensual data on its environmental impacts and ways of mitigation. Thus, the participation of everyone in these decisions, in addition to contributing to the definition of plans to reduce significant impacts, can improve

the organization's image in general, reducing complaints and eliminating lawsuits.

#### b) Assessment of the Significance of Environmental Impacts

This step aims to define a method of assessing the importance of environmental impacts, taking into account compliance with legislation, the difficulties and costs of altering the impact, the concerns of interested parties and the company's public image. For this, it is proposed to apply an Environmental Impact Assessment Method with Clean Production (MAIAPL), as shown in Table 3 [1, 9, 10].

*Table 3. Assessment of the Significance of Environmental Impacts.*

Environmental aspects	Environmental impacts																				
	Physical medium						Middle biotic	Middle anthropic	Impact assessment												
	Soil	Air	Water																		
	Changes physical properties	Chemical contamination	Scarcity of mineral deposits	Air pollution	Noise pollution	Pollutes surface waters	Pollutes groundwater	Water scarcity	Interference in fauna	Interference in flora	Alters operator health	Security risks	Damage to equipment	Increases operating costs	Quantity	Situation	Applicable legislation	Opportunity of PL	Severity	Frequency	Impact value

In this proposal, all impacts already identified are evaluated and quantified, considering the following characteristics:

- 1) Quantity: numerical value resulting from the simple sum of impacts to the physical environment (soil, air and water), biotic and anthropic;
- 2) Situation: Numeric value that quantifies the description of the activity type. If it is normal, it is equal to 1, abnormal is equal to 2, and if it is risky, it is equal to 3;
- 3) Applicable legislation: numerical value that quantifies the relationship with environmental legislation. If not applicable it is equal to 1, and if applicable it is equal to 2;
- 4) PL opportunity: numerical value that quantifies the possibility of using Clean Production to mitigate the impact. If there is no opportunity it is equal to 1, and, if there is, 2;
- 5) Severity: numerical value that quantifies the severity of the impact on the environment. If it is high is equal to 3, average is equal to 2 and low is equal to 1;
- 6) Frequency: Numbers of times per period considered that the impact occurs or can occur. If it is high is

equal to 3, average is equal to 2 and low is equal to 1;

7) Impact Value: numerical value resulting from the simple multiplication of the previous items;

8) Significance: result that depends on the Impact Value (VI). A value should be assigned for VI, which defines the limit of the impact classification, and should be based on the experience of the Ecotime components, field reports, analogy to the literature and the specific situation of each company. In this way, the impact is SIGNIFICANT if VI is greater than or equal to the allocated limit value, and NOT SIGNIFICANT if VI is less than this value.

#### c) Definition of Operational Controls and Emergency Plans

With each activity that generates significant environmental impacts, operational controls and emergency plans must be established to ensure that the company's environmental objectives and targets are achieved [2]. Table 4, which complements Table 3, can be used by inserting a last column to list the operational controls and emergency plans corresponding to each of the aspects identified as generating significant environmental impacts.

*Table 4. Operational Controls and Emergency Plans.*

Environmental Aspects (only those that generate significant impacts)	Environmental impacts	Impact value (VI)	Operational Controls and Emergency Plans

At this stage, there are many opportunities to introduce PL techniques to act on environmental aspects that generate significant impacts. The following Figure 1, the alternatives of

Control in Source, such as modifications of technology or processes, good operating practices (housekeeping), and modifications to the inputs or in products (eco-design). When

control actions at source are not possible, reuse and recycling of by-products and waste are adopted, inside or outside the company. Finally, with no more PL alternatives left and just to meet the legislation and requirements of ISO 14001, the company must define its Operational Controls based on traditional waste treatment techniques, called "End of Pipe". These last practices also follow an order of actions, where it is necessary to make the separation and classification of waste, which, depending on its type, can be sent for treatment, sold, recovered, incinerated or disposed in the environment [8].

Order of priority	PL alternatives for waste minimization	
First	Process and technology	Technology modification
		Process modification, inclusion or exclusion of steps/systems
		Process lay out adjustments
		Process automation
	Housekeeping	Optimization of operational parameters
		Standardization of procedures
		Improving the purchasing system
		Improved information system
	Inputs and products	Replacement of raw material or supplier
		Improvement in the preparation of raw materials
		Packaging replacement
		Product modification
2nd	Reuse and recycling	Logistics associated with by-products and waste
		Reuse and internal recycling
		Reuse and external recycling

**Figure 1.** PL Alternatives for Waste Minimization [8].

### 3.3. Legal and Regulatory Requirements

At this stage, the company must lift all legal requirements, laws and regulations applicable to its activities, products or service, such as operating licenses, laws specific to products used and their field of activity, general environmental laws, authorizations and permits [7]. Because of its characteristics, there are no proposals for insertion of Clean Production in this stage. Compliance with these requirements is the minimum required by ISO 14001 for the implementation of an EMS.

### 3.4. Environmental Policy

Following the requirements of ISO 14001, an environmental policy should be appropriate to the nature of the company, its environmental aspects and impacts, committed to continuous improvement, pollution prevention

and compliance with legislation, and guide the setting of environmental objectives and targets. This policy should be documented and communicated to all own and outsourced employees, and be available to the public [7].

It is proposed, in addition to ISO 14001, that commitments to the use of the principles of PL be included in the text of the Environmental Policy. Thus, expressions such as "minimize or eliminate negative environmental impacts", "prevent pollution at source" and "conserve natural resources" cannot be lacking in the text. Figure 2 presents a general example of how to adopt an Environmental Policy focused on the principles of Clean Production. Obviously, each company should have a different policy, appropriate to its nature, and therefore present other more specific commitments, besides those mentioned in this model [1].

Implement a management program, with defined procedures to evaluate its environmental performance, through the establishment of objectives and targets, aiming at pollution prevention, conservation of natural resources, health and safety of all.
Continuously update and improve its activities, adopting procedures and control techniques in the sources of pollution, in order to eliminate or minimize significant adverse environmental impacts, internal and external to the plants of its customers.
Train and raise awareness among all employees to perform their activities effectively and responsibly in the face of the environment and environmental technologies based on Clean Production.
Establish and maintain control of documents and means of communication of their environmental behavior for all its employees and the general public, anticipating and transpiring information about its processes and products, and allowing access to the community to assist in decision making.

**Figure 2.** Example of Environmental Policy with PL Commitments.

### 3.5. Objectives, Goals and Programs

Once the Environmental Policy is established, the Environmental Objectives must be defined to meet each of the commitments made in this policy, and their respective Environmental Goals. It also suggests defining, for each goal, Environmental Performance Indicators. Then, actions must be established to achieve the Environmental Goals, the Responsible for the action and also the Deadline for its completion. The consolidation of this data can be done in a single spreadsheet, called the Environmental Management Program (PGA), as shown in Table 5. It is also recommended to insert a Status column of the actions to serve as a follow-up of the PGA [1].

**Table 5.** Environmental Management Program.

Environmental Policy commitments	Environmental objectives	Environmental goals	Performance indicators	Actions	Accountable	Term	Status

Dynamically, the PGA executes and updates the Environmental Policy through regular and periodic reviews, to meet the commitments that count in its text. In the following

subsections, we propose guidelines on how to transform the commitments made by the Policy into its environmental objectives, its respective goals and indicators, in addition to

the definition of actions [1].

a) Reduction of Negative Environmental Impacts

For this commitment, it is necessary that each environmental aspect identified as generating significant negative impact has one or more PGA objectives associated with it, with its respective reduction goals. For each goal, an environmental performance indicator should be defined that can be measured and monitored. The order of priority to act on the aspects follows the value of their impact (VI), the u is, first will be attacked the most significant environmental impacts and then the least significant ones. For each goal, actions are established, which can be planned and executed according to the Operational Controls and Emergency Plans defined in Table 4 and the PL techniques in Figure 1.

It is noteworthy that in this phase, in addition to the aspects related to the generation of waste, should also include others, such as those related to quality, safety and health. Therefore, it is recommended that Ecotime involve those responsible for the other programs, in order to build a PGA with a format and an integrated management system, that is, addressing the management of the Environment (ISO 14001), Quality (ISO 9001) and Occupational Safety and Health (OHSAS 18001).

b) Training and Awareness

This commitment should be associated with your goals and goals of equal content. Therefore, in the actions, it is recommended that a training schedule be established, containing its target audience, and addressing at least the following topics:

- 1) Program Overview: aims to promote awareness about the strategic importance of Environmental Certification for the company and the motivations to implement the EMS, with the purpose of obtaining the commitment of all and harmonization with Environmental Policy;
- 2) Legal and regulatory aspects: to educate and promote awareness of environmental issues in general, the laws and regulations inherent in the sector, to ensure the commitment of all, the fulfillment of goals and individual responsibility;
- 3) ISO 14000 and Clean Production: aims to educate about the requirements of an EMS and the steps necessary for implementation, the context of Clean Production, the advantages, techniques, and the main differences in relation to the traditional End of Pipe system;
- 4) Skills improvement: aimed at all employees who have responsibilities in the PGA, in order to provide the necessary training to execute the actions of the program, reviewing and improving all processes in which they are involved.

c) Communication and Document Control

To meet this commitment, ISO 14001 provides that the company establishes and maintains a control of documents and internal communication procedures, between the various levels of the organization, to inform about its environmental behavior. By inserting the principles of Clean Production, it is also recommended to meet the following requirements:

- 1) Anticipation of information to internal and external stakeholders about their products and activities,

assuming the burden of proving and demonstrating that they do not cause harm to the environment (Precautionary Principle);

- 2) Permission of community access to their records of pollution and waste emission, in order to obtain the participation of all in decision making (Principle of Democratic Control);
- 3) Provision of transparent and open information to the general public, with incentives to benchmarking and publications of environmental reports, in order to increase its competitiveness of the company (Principle of Information Opening).

### 3.6. Measurement and Monitoring

This stage of the methodology constitutes the evaluation of the company's environmental performance. Therefore, procedures need to be defined to measure and monitor PGA performance indicators. Compliance with this requirement is the minimum required by ISO 14001 to deploy the EMS. There are no PL insertion proposals at this stage.

### 3.7. Corrective and Preventive Actions

From the evaluation of environmental performance made in the previous stage, non-conformities should be investigated and corrective and preventive actions implemented in order to eliminate or minimize the impacts caused. Any change in procedures resulting from the actions taken should be recorded [7].

It is recommended that corrective and preventive actions are also directed to the solution of problems at source, that is, influenced by the principles of PL, in order to correct existing procedures or implement new ones. At this stage, the same techniques suggested in Figure 1 can be used, such as technology modifications in the processes, in the materials or in the products, the practice of housekeeping, reuse and recycling [1].

### 3.8. Internal Audits

This step is intended to carry out periodic audits, to determine whether EMS is as planned or is being properly implemented and maintained. It is recommended that the company define an annual schedule of internal audits. Also ensure that auditors, own or third parties, are impartial and have been properly trained, in accordance with ISO 14010 (Guidelines for Environmental Audit).

We also recommend that EMS auditors receive specific training on the principles and techniques of Clean Production, or to specialize in related programs. In this sense, in addition to contributing positively to a good implementation of the EMS, they will help to internalize and disseminate the concepts of PL.

### 3.9. Critical Analysis of the EMS

Periodically, the EMS should be critically analyzed to ensure its continued compliance, adequacy and effectiveness. This process should be done on the basis of audits and should

point out the possible needs for changes in policy, objectives and other elements of the system, always in order to identify opportunities for improvement. According to ISO 14004 [7], this analysis should contain:

- Analysis of objectives, goals and environmental performance;
- Results of audits;
- Evaluation of Environmental Policy in relation to: changes in legislation; changes in the expectations and requirements of stakeholders; changes in company products or activities; scientific and technological advances; experiences gained from environmental incidents; market preferences; reporting and communication.

Finally, in order to evaluate the effectiveness of this proposal for the implementation of EMS with Clean Production, it is also recommended a careful analysis of the principles of PL that were integrated in each step, evaluating

their adequacies and conformities.

### 3.10. Proposal Summary

Table 6 presents a differential synthesis of the proposal of this work, which are the increments of PL and the implementation of an EMS. In this table, the equivalence of the items required by the traditional ISO 14001 is compared with the items of the proposal, now called ISO 14001 with PL, where, in each step, the pl increments are described.

It is noteworthy that, in addition to chronological order, the names of some items of traditional ISO 14001 were changed for its version with PL. This was done to obey the sequence that is proposed in this research, to allow the integration of the ideas allocated in the steps. Despite the changes, this proposal ensures that, in addition to PL increments, all requirements of the traditional version of ISO 14001 are met.

*Table 6. Synthesis of the EMS Implementation Proposal with PL.*

ISO 14001 usual	ISO 14001 with PL	PL increments
Environmental Policy	Environmental Policy	Insertion of PL commitments in the drafting of the policy: a) Control at source; b) PL training; c) Precautionary Principle; d) Democratic control; e) Opening information.
Planning	Initial Environmental Assessment	a) Ecotime training proposal; b) Proposal of a Checklist for initial environmental diagnosis with PL issues; c) Proposal for a final report of this evaluation with recommendations of PL.
Environmental Aspects	Identification of Aspects and Impacts Impact Significance Assessment	Proposal for dialogue with the community to assist in decision-making (Principle of Democratic Control) Proposal of an evaluation model plus an opportunity identifier item of PL, MAIAPL.
Operational Control; Emergency Response	Operational Controls and Emergency Plans	Proposal for the use of PL techniques, such as: a) Modifications of technology and processes; b) Good operating practices (housekeeping); c) Change in the inputs and products; d) Reuse and recycling, internal and external.
Objectives, Goals and Programs; Implementation and Operation; Structure and Responsibility	Objectives, Goals and Programs Reduction of Negative Environmental Impacts	Proposal of the Environmental Management Program (PGA), according to the items below Guidance on the use of the s opportunities of PL, item to achieve the goals of the Environmental Policy to reduce negative impacts.
Competence, Training and Awareness	Training and Awareness	Proposal of training on the principles and techniques of PL, meeting the commitments of the Environmental Policy.
Communication; Documentation; Document Control	Communication and Document Control	Proposal for the application of PL principles, such as precaution, democratic control and information opening, meeting the commitments of the Environmental Policy.
Monitoring and Measurement; Conformity Assessment; Corrective and Preventive Action; Records Control	Measurement and Monitoring; Corrective and Preventive Actions	Proposal of implementation of actions using PL techniques, such as modifications of technology and processes, changes in the inputs and products, housekeeping, reuse and recycling.
Internal Audit	Internal Audits	Proposal for PL training and specialization for internal auditors
Critical Analysis by Management	Critical Analysis of the EMS	Includes the analysis of the effectiveness of the proposal, specifically in relation to PL increments.

## 4. Conclusion

The objective of this article was to present a methodological proposal for the implementation of an Environmental Management System, according to the requirements of ISO 14001, and the principles of Clean Production were inserted at each stage of the system. The motivation for such research

occurred due to several factors, such as the current degradation of the environment, the increase in legal penalties and the growing awareness of markets and consumers who began to demand environmentally correct products and processes. It is worth adding to the fact that many companies are not knowing the principles and techniques of PL, missing the opportunity to implement modern and proactive technologies at the time of the implementation of their EMS.

The proposal was presented, according to its objective, and a step-by-step of the stages of implementation of a EMS with PL was made available to the reader, whose structure is focused on pollution prevention, optimization of resource use and elimination of waste generation. At the end, a synthesis of the proposed methodology was made, comparing the requirements of traditional ISO 14001 with ISO 14001 with PL.

Ultimately, it is observed that there was good adherence of the proposal presented here, and ISO 14001 is compatible with the insertion of the pl principles, making at the end a more complete, detailed and proactive EMS. As a suggestion for further research, it is recommended to test this proposal by applying this EMS with PL in companies of various natures.

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