Implementing Cleaner Production Technologies: General Aspects

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Abstract. This article presents an overview of the main aspects of cleaner production as a preventive environmental strategy that integrates into production processes to make them more environmentally efficient in terms of the use of resources and raw materials, among others. Reference is made to the general aspects of environmental impact focused on production systems, the origin and general evolution of the concept, as well as its definition, general aspects, advantages and difficulties for its implementation. In general, it is concluded that cleaner production is a strategy that can help to reduce the environmental impact of different production systems; however, activities are needed to disseminate and make it known to various stakeholders, and to emphasize the social, environmental and economic benefits that its application can bring.

1 Introduction

The production of a product implies that raw materials undergo a continuous transformation, which generates waste and emissions during the production process; this leads to inadequate use of the resources used and inefficiency in the process, so the cost of production is higher. On the other hand, waste generation has socio-economic consequences due to the high costs of processing and final disposal, in addition to the environmental consequences that degrade the quality of life and the environment of the various communities inhabiting the land.

Traditionally, pollution is controlled after pollutants have been generated in various production processes, using technologies known as "end-of-pipe" technologies, which usually require a significant and in many cases nonrefundable investment. Several alternative cleanup options, known as "cleaner production strategies," now exist to combat industrial pollution, which have a comprehensive preventive approach that aims to conserve natural resources and improve business productivity and competitiveness. It is worth noting that the main goal of applying these strategies is to optimize production processes with a focus on improving the efficiency of raw material and energy use [1].

Cleaner production is an environmental management strategy applied to processes, products and services that involves optimizing, modifying or changing them; however, its implementation should not be seen as an expense, but rather as an activity that ensures efficiency, productivity and savings. If the process is properly formulated, the

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implementation of cleaner production technologies goes hand in hand with process optimization and cost savings, improved operational efficiency, improved product quality and consistency, reduced waste and therefore reduced costs associated with its proper disposal, and/or improved company image among customers, suppliers, partners, community, financial institutions, etc.

The state of the environment is affected by various causes, which in some cases make the loss of biodiversity irreversible. Environmental degradation and unsustainable exploitation of natural resources are major problems in today's world, as well as inadequate development models that affect the quality of life of current generations and threaten future generations [5].

Scientists note that development is inevitably a process that consumes the resources of the biophysical world to meet human needs; however, various initiatives developed by companies and environmental authorities, among other sectors involved, have been proposed to focus research on optimizing and improving existing business processes and developing new strategies that foster technological innovation and business sustainability, due to the emerging negative environmental impacts.

Entrepreneurs, researchers, educators, and citizens face the challenge of finding mechanisms to assess the impact of human actions on the environment, developing processes to minimize negative impacts, and implementing actions that improve citizen safety, focusing on optimizing and improving existing business processes, developing strategies that promote technological innovation and sustainable development [9].

In this sense, the application of the cleaner production concept has been identified as an option to improve efficiency, competitiveness, and minimize pollution.

2 Materials and methods

In recent years, it has gradually entered the agenda of the business world in industrialized countries and, to a lesser extent, in developing countries. UNEP defines "cleaner production" as the continuous application of a preventive environmental strategy integrated into processes, products and services to improve overall efficiency and reduce risks to humans and the environment [10].

This strategy is based on and supported by various tools that support the environmental systems of organizations by providing specific methods for integrating information to determine the environmental status of the production process and make decisions based on this. Some domestic scientists mention, and about other concepts similar to the concept of clean production, which imply the minimization of waste, prevention of pollution at source, environmental efficiency and green production, and indicate that the key to these concepts is to make enterprises more efficient and less polluting. Foreign scientists point out that clean production takes as its basic principle pollution that does not exist does not need to be eliminated"; in this sense, it is based on the practice of preventive management, often considered a profitable and viable option to combine economy and ecology in the long term [7].

In our view, the term "cleaner production" or "cleaner production" can be understood as synonymous with "pollution prevention technology" as used in developed countries, or "waste minimization technology. Clean technology refers to any product, service or process that provides value by using little or no non-renewable resources, or produces much less waste than traditional sources. Its application is not limited to any sector of economic activity and can be applied to the processes of any product or service of an organization [11].

The implementation of cleaner production concepts requires structures defining the responsibilities and activities to be developed in the company and their relationship with the

environment, which are based on the activities of the overall management system, known as the environmental management system. Based on the practice of the foreign scientist Walton, it is possible to consider work projects linearly, with a beginning and an end: work done, move on to the next. In contrast, continuous improvement requires a circular approach [6].

Environmental management systems are a fundamental mechanism for implementing environmental strategies, including cleaner production; they are useful both for improving processes and products internally and for gaining recognition outside the company based on its environmental standards. Depending on the specific application, these systems can be governed by standards such as ISO 14000, integrated responsibility, environmental agreements and multilateral agreements.

3 Results

Trends in the country is manufacturing sector vary in terms of the intensity of growth, technological progress, use of natural resources and environmental impact of companies in the sector; among the most important sectors are construction, industry and trade. In addition, an indicator of the dynamism of a business is its export potential, which helps identify the main production sectors [8].

Based on the critical analysis presented above, it is important to note that the application of environmental management systems by companies is always voluntary and depends on their recognition as part of the structural strategy of the company.

Therefore, let us present the main environmental performance tools that should be used in the context of the implementation of environmental management system (Figure 1).

Fig.1. Clean production algorithm in the context of environmental management system.

The authors presented an algorithm for cleaner production in the context of environmental management system will determine the sequence of actions in creating a strategy for cleaner production and build a policy of environmental performance.

4 Discussion

Environmental performance strategies require structures that define the responsibilities and activities to be developed in the company and their relationship to the environment, which are based on the activities of the overall management system, known as the environmental management system. Walton argues that it is common to view work projects linearly, with a beginning and an end: job done, move on to the next. In contrast, continuous improvement requires a circular approach [10].

In a broad sense, eco-efficiency and the implementation of cleaner production technologies include pollution prevention, waste minimization or environmental efficiency, highlighting how goods and services can be produced with the least environmental impact, taking into account economic and technological constraints. In this sense, environmental efficiency is seen as the systematic application of environmental strategies to reduce the negative impact companies have on the environment. In manufacturing processes, it includes saving raw materials and energy, eliminating toxic materials, and reducing the amount and toxicity of emissions and waste before completion of the process; in products, it aims to reduce the impact during the product life cycle; and in services, it reducing the environmental impact of a service throughout its lifecycle. All technologies to reduce risks to workers, society, and consumers of products, minimize production costs, end-of-life processing, and reduce the environmental impact of a service [2].

Eco-efficiency is a preventive rather than corrective approach to control and reduce the environmental impact created by the production of goods and services, thereby seeking to achieve sustainable industrial development related to economic efficiency and creating minimal impact, for which several strategies are considered, from the adoption of best practices with small investments to the transition to cleaner technologies that require larger investments. The strategy of environmental efficiency, focused on prevention, involves changing production processes, technologies, methods of operation or maintenance, as well as output products in accordance with the needs of consumers for more environmentally compatible products and services [4].

It is important to emphasize that eco-efficiency does not in all cases require new technologies and equipment; typically, its fulcrum begins simply with good operating practices. According to analytical reports, the most frequently used methods within the framework of cleaner production implementation are, among others, proper operating procedures, material substitution, technological changes, internal recycling. Similarly, it should be noted that implementing cleaner production technologies does not only mean modifying or changing the operational part, but also requires a change in thinking and concept of current environmental management, in addition to the task of changing the behavior of various actors, such as environmental authorities, government officials, business people, non-governmental organizations, among others, so that they move towards more sustainable production and consumption [5].

According to foreign scientist Leal, there are several advantages of implementing cleaner production systems or tools, which are determined by studies in enterprises that have implemented the eco-efficiency approach, where there are advantages such as increased productivity, savings in energy and raw materials, reduced waste and toxic materials, reduced risks, savings in pollution management processes, a more motivated workforce, a focus on continuous improvement, improved safety measures and technology [10].

Some domestic authors note that environmental efficiency is a «win-win» strategy because it protects the environment as well as the consumer and the employee, while improving production efficiency, ensuring economic growth and enhancing companies' competitiveness. They also note that its implementation promotes effective management

and organization, and the need for «continuous improvement» in a company is environmental performance as a basic prerequisite. Among the benefits associated with adopting cleaner production technologies is that organizations that adopt this philosophy reduce the need for end-of-pipe pollution cleaning equipment, because by producing less waste, the cost of preventing, mitigating or eliminating pollution at the source is reduced, and thus the organization will have a higher profit margin and stimulate its economy in one way or another [9].

Having analyzed the results of several studies that have revealed the positive effects of environmental efficiency strategies in different countries and sectors, where he emphasizes that the companies studied have obtained additional economic and environmental benefits, and the improvements were obtained through the application of good operating and industrial safety practices, as well as the compliance with the applicable regulations applicable to each company. Thus, it can be said that sustainable environmental practices can provide the company with technical, organizational, legislative and even economic benefits; in this sense, the reduction of environmental risk, administrative sanctions, health risks and accidents; savings in raw materials, water and energy; increased productivity; improved work processes (safety, hygiene, efficiency); savings in waste management and treatment and emissions; improved company image; technological innovations [5].

5 Conclusion

Cleaner production is a strategy that can help reduce the negative environmental impact of various production systems; however, activities are needed to disseminate information about it and knowledge about it to various stakeholders, and to emphasize the social, environmental, and economic benefits that its application can bring.

The introduction of cleaner production requires the active participation and cooperation of the business sector, since most modern industrial processes do not consider the environmental factor as a priority unless it is mainly related to regulatory requirements or the search for quality certificates.

While a complete replacement of cleaning technologies at the "end of the pipe" is certainly not possible, it is important for academia to help define strategies for cleaner production in the face of current challenges in the quest for environmental sustainability.

References

1. E. Bessonova, R. Battalov. *Innovative development of the Russian economy: Formation of support mechanism based on the world's experience*, Economic Annals-XXI, **180**, **11-12**, 97-109 (2019)
2. F. Compagnucci, A. Gentili, E. Valentini, M. Gallegati, *Robotization and labour dislocation in the manufacturing sectors of OECD countries: a panel VAR approach*, Applied Economics, **51**, **57**, 6127-6138 (2019)
3. R.N.C. Jose, P.P.R Antonio, S.M.J Astrid, *Evaluation of the feasibility of implementing 4.0 industry technologies in the Last Mile processes case: Logistic Operators of the Department of Atlántico,* Iberian Conference on Information Systems and Technologies (2020)
4. R. Kilani,. A. Zouinkhi, E. Bajic, M.N. Abdelkrim. *A disruptive M2M social paradigm for Industry 4.0.* Proceedings - STA 2020: 2020 20th International Conference on Sciences and Techniques of Automatic Control and Computer Engineering, 101-106 (2020)

5. A. Nechaev, A. Rasputina. *Theory of tax variation calculation*, IOP Conference Series: Earth and Environmental Science, **421**, **3**, 032010 (2020)
6. W. Li, Y. Han, J. He. *How Does the Heterogeneity of Internal Control Weakness Affect R&D Investment?* Emerging Markets Finance and Trade, **55**, **15**, 3591-3614 (2019)
7. A.S. Nechaev, O.V Antipina, A.V. Rasputina, M.F. Tyapkina, E.A. Ilyina. *Methods of lease payments calculating in terms of innovations financing,* Montenegrin Journal of Economics, **17**, **1**, 133–149 (2021)
8. L. Pham. . *Does financial development matter for innovation in renewable energy?* Applied Economics Letters, **26**, **21**, 1756-1761 (2019)
9. A.V. Rasputina, A.S. Nechaev, E.A. Ilina, *An analysis of the construction industry and the impact of taxation on its development in the Baltic and Scandinavian countries*, IOP Conference Series: Earth and Environmental Science, **751**, **1**, 012168 (2021)
10. A. Schroeder, Bigdeli Ziaee, C. Galera Zarco, T. Baines. *Capturing the benefits of industry 4.0: a business network perspective,* Production Planning and Control, **30**, **16**, 1305-1321 (2019)
11. M. Vigezzi, *World Industrialization: Shared Inventions, Competitive Innovations, and Social Dynamics,* World Industrialization: Shared Inventions, Competitive Innovations, and Social Dynamics, 24 1-172 (2019)