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Review Article

Ecomap or Ecomapping in the productive sector: Practical tool for the diagnosis of the environmental situation

Ecomapa o Ecomapeo en el sector productivo: Herramienta practica para el diagnóstico de la situación ambiental

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Abstract **-** The organizations are aware of the need to insert them in this international market, which has as a mandatory requirement to demonstrate a solid environmental performance in correspondence with the expectations of the interested parties and the transparency of their information. The application of environmental management tools constitutes a fundamental element within modern business strategies, since they allow improving the environmental performance of a company, without affecting its profitability and even increasing it, since its adoption implies concepts of quality and technical efficiency. The Ecomaps allow analyzing, managing and communicating on the management of resources, water, energy, materials and supplies, as well as the management of waste, emissions, discharges and risks in a productive or functional activity, in environmental matters. The main objective of this review article is to qualitatively analyze the scientific literature available in the Science Direct, Scielo, Redalyc databases and official Web pages, using as search words: environment, industrial, ecomap, company, sustainability. Relevant information related to the proposed objective was obtained, which is presented in 3 sections: Diagnosis of the environmental situation in companies, Ecomap or Ecomapping, Types of Ecomaps. Ecomapping is a step-by-step process to collect useful information and trigger immediate environmental actions. The ecomaps verify the processes and behaviors of the collaborators and induce immediate improvements.

Keywords: PHVA cycle, industrial pollution, environmental diagnosis, Ecomapping, Ecomap.

Resumen **-** Las organizaciones son conscientes de la necesidad de insertarse en este mercado internacional, que tiene como requisito obligatorio demostrar un sólido desempeño ambiental en correspondencia con las expectativas de los interesados y la transparencia de su información. La aplicación de herramientas de gestión ambiental constituye un elemento fundamental dentro de las estrategias empresariales modernas, ya que permiten mejorar el desempeño ambiental de una empresa, sin afectar su rentabilidad e incluso incrementarla, ya que su adopción implica conceptos de calidad y eficiencia técnica. Los Ecomapas permiten analizar, gestionar y comunicar sobre la gestión de recursos,

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agua, energía, materiales y suministros, así como la gestión de residuos, emisiones, vertidos y riesgos en una actividad productiva o funcional, en materia medioambiental. El objetivo principal de este artículo de revisión es analizar cualitativamente la literatura científica disponible en las bases de datos y páginas web oficiales de Science Direct, Scielo, Redalyc, utilizando como palabras de búsqueda: medio ambiente, industrial, ecomapa, empresa, sostenibilidad. Se obtuvo información relevante relacionada con el objetivo propuesto, que se presenta en 3 apartados: Diagnóstico de la situación ambiental en las empresas, Ecomapa o Ecomapeo, Tipos de Ecomapas. El Ecomapeo es un proceso paso a paso para recopilar información útil y desencadenar acciones ambientales inmediatas. Los ecomapas verifican los procesos y comportamientos de los colaboradores e inducen mejoras inmediatas.

Palabras clave: Ciclo PHVA, contaminación industrial, diagnóstico ambiental, Ecomapeo, Ecomapa.

Introduction

In today's world, the tangible assets of an organization are not the only recognized assets. Coordinated activities are carried out in order to direct and control an organization, which may include the establishment of policies, objectives and processes (He et al., 2021; Ruiz et al., 2019; Bedoya et al., 2017). It is not only about productions and quality, price and innovation; an element of competitiveness is also constituted by environmental behavior and the need for companies to enter the international market (Ayinde et al., 2021; Cozzolino & Moroni, 2021).

The organizations are aware of this and of the need to insert them in this international market, which has as a mandatory requirement to demonstrate a solid environmental performance in correspondence with the expectations of the interested parties and the transparency of their information. Thus, information related to the environment is a top issue on international agendas that also has an impact on organizations (Moussa et al., 2021; Mungai et al., 2020).

The application of environmental management tools constitutes a fundamental element within modern business strategies, since they allow improving the environmental performance of a company, without affecting its profitability and even increasing it, since its adoption implies concepts of quality and technical efficiency (Ruiz et al., 2019). However, the total solution of the environmental problems generated represents a considerable financial investment such as risk capital with the costs associated with it. Several factors are needed for an increase in the profitability of companies to be perceived with the adoption of environmental management strategies (Villalba et al., 2017). These factors include current environmental legislation, consumer reaction, public opinion and the effect that this investment has on other competing companies (Bag et al., 2020; Braig & Edinger, 2020; Chege & Wang, 2020; Rafiq et al., 2020).

At the end of the 80s of the last century, many countries became aware of the need to preserve and protect the environment and to exploit their natural resources with sustainability criteria. This new attitude represents a challenge for modern industries, turning it into an added value that gives them a competitive advantage by successfully marketing their products and by guaranteeing public opinion that, although they carry out activities that may degrade the environment, they are managed with criteria suitable (Jaimes, 2018). In this sense, the global industrial network has been progressively adopting the use of Environmental Management Systems (Chowdhury et al., 2021; Movilla et al., 2020).

Concern for environmental problems is becoming ever greater in current contexts. The causes and consequences of socio-environmental problems inherent to world economic development, a rouses interest in considering environmental criteria as part of the business management developed by organizations in search of sustainable development, accompanied by social responsibility practices (Sardana et al., 2020).

The challenge is today within the production process, as it is possible to make changes that reduce waste and the consumption of resources such as water and energy. In companies, changes in favor of the environment or efficiency can then be translated into economic benefits (Santos et al., 2019; Severiche et al., 2016). It is at such a time that we will be on the way to a more durable competitiveness: sustainable competitiveness, since the main way to achieve sustainable development is through the application of cleaner production technologies (Chen et al., 2020; Sheldon & Norton, 2020). For all that has been stated so far, the objective of this work is to review the Ecomaps as a practical tool for diagnosing the environmental situation in the business productive sector.

Diagnosis of the environmental situation in companies

Environmental management seen from various points is a very important instrument for continuous improvement aimed at the execution, management and planning of the activities to be carried out in the production processes (Ciruela et al., 2020). Many industries generate serious environmental problems, due to the great quantity and diversity of their production processes and their polluting nature, which has increased the concern for maintaining and improving the quality of the environment (da Silva et al., 2021; Mosteanu, 2020).

Simultaneously, the critical position of the host communities of the negative effects of industrial production, such as: the crisis of garbage and hazardous waste, the green house effect, acid rain and the depletion of the ozone layer, has forced companies to make decisions to remedy the situation of social rejection generated by the industrial sector (Witek-Crabb, 2019). These solutions have been manifested through various lines of action, among which are the establishment of controls, the development of policies and legislation on environmental matters that seek to protect the world environment, the dissemination of training and information campaigns, the establishment of programs of environmental education and the adoption of environmental management tools by companies (Le Duc, 2020; Haibo et al., 2019; Arghand et al., 2018).

Understanding the context of an organization is a process that determines the factors that influence its purpose, objectives, and sustainability (Fuyan et al., 2020). It considers internal factors such as the values, culture, knowledge and performance of the organization. It also takes into account external factors such as legal, technological, competitive, market, cultural, social and economic environments (Isensee et al., 2020; Shahzad et al., 2020).

At the production level, the Cleaner Production tools used for the analysis of findings are the eco-map, eco-balance, environmental accounting, lifecycles, material matrices and energy use, material flow analysis, environmental audits, eco-designs and eco-labels (Wyrwicka & Chuda,

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2019). These tools are techniques or methods that allow to exercise control in determining the current environmental status of a process or service, in order to strategically support the use of resources, thus generating a preventive proposal that includes actions aimed at support the processes, re-evaluate the objectives, goals, verify and exercise control in environmental management, in addition to providing valuable information for decision-making, thus generating an impact on the environment with less risk and generating an integration of the processes that would lead to the reduction of waste and emissions. What is simply summarized in social, environmental and economic benefits (Panameño et al., 2019; Pereira et al., 2018; Koroljova & Voronova, 2007).

Ecomap or Ecomapping

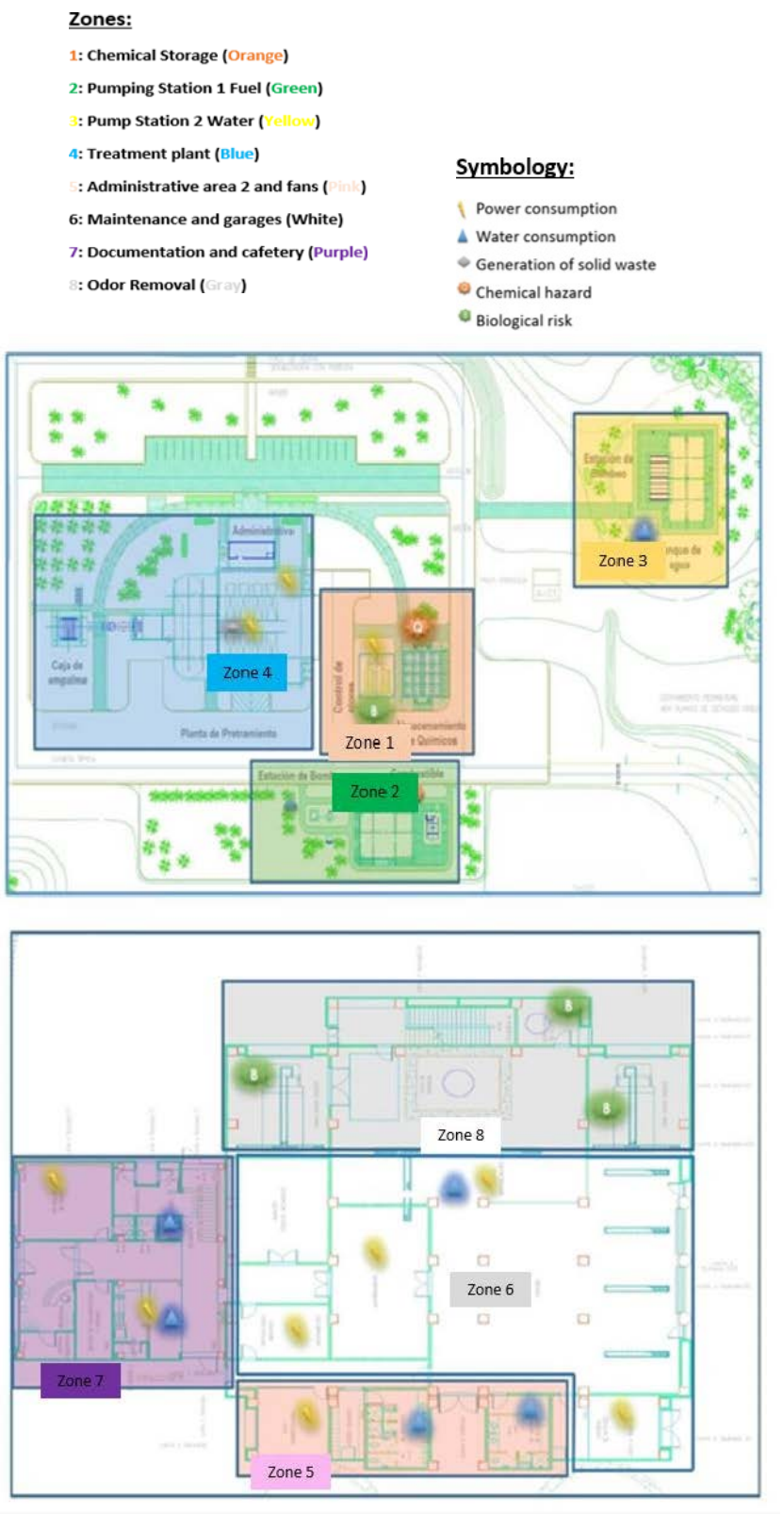
The Ecomaps allow analyzing, managing and communicating about the management of resources, water, energy, materials and supplies, as well as the management of waste, emissions, discharges and risks in a productive or functional activity, in environmental matters. As its name indicates, it corresponds to a graphic representation of the critical points of the place through which the are/as with higher consumption, waste generation and/or storage, inappropriate management, are as that present environmental risks and the health of workers or beneficiaries, among others (Acevedo & Severiche, 2013).

Likewise, it is a tool that allows the application of inventories in a planned way in order to establish variables that show the relevant aspects based on the industrial activities that affect the environment. Visualize the physical reality of the activities and the environmental impacts involved to be studied. It is a simple and easily applied strategy that allows a quick inventory of practices and multiple variable problems through the use of figures. Ecomaps are diagnostic tools, focused on the entity as a whole and of a qualitative type according to the type of information they produce (Carabaño et al., 2017).

Additionally, it is a schematic method that creates a "snapshot" by using symbols on a simple site plan. The visual approach makes Ecomapping easy to understand and a useful support tool to increase house hold awareness of the environmental impacts of house hold activities. It also allows more people to get involved at an early stage without requiring a great deal of specialized knowledge (Carpenter et al., 2007).

This type of diagnosis offers the possibility of a correct environmental management and the improvement of many aspects in relation to the environmental area. This is a tool that is based on the collection of information, not only on the location of the different sources that can generate contamination, but also on those sectors that are located in points of high risk of contamination. In each of these maps, the entrances and exits are identified, the potential dangers, and if there is a problem of particular interest, a specific map is made for this problem, they can be used as part of the documentation of the company's environmental management system, and they must be made in such a way that they can be reusable and that they can be updated over the years. In Figure 1, an example of the appearance of an Ecomap is illustrated, initially detailing the zones or areas and the symbology for the input and output environmental aspects (López et al., 2021).

Figure 1. Example of an Ecomap



Source: Taken from Severiche et al. (2017)

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In short, the Ecomap recognizes the potential dangers of different situations and a specific map is drawn up. For example, the interaction of the company's activity with the nearest community, land use, water consumption and discharge, waste management and storage and raw materials, among others, allowing the visualization of the facilities for each process of the cycles wine reproductive system, in it the areas where there is the greatest environmental contamination, either to water or atmospheric sources, were determined (Zhu, 2014).

Types of Ecomaps

Among the advantages that are associated with the use of Ecomaps is that anyone in the company can use it as a support for their work and training, and do so without the need for complicated procedures that make it difficult to apply (Severiche et al., 2017). In each of these maps, the entrances and exits, the potential dangers are identified, and if there is a problem of particular interest, a specific map is drawn up for this problem. Thus, there may be different types of Ecomaps depending on their source studied. Among the main ones are:

• Neighborhood map: this map places the urban or rural context of the company or productive activity. Among the key aspects that this type of maps should show are the areas of interaction between the company and its neighbors, the use of the land (indicate if it corresponds to the regulations). The generation of traffic due to the activity of the company, and the general situation of the company in the neighborhood. In this Ecomap you can also identify those points of conflict with the neighborhood, which, being critical for the company, merit the development of a new Ecomap in this regard (Zuniga et al., 2021).

• Water Map: this Ecomap investigates everything regarding the water resource, especially the points of consumption and disposal. It investigates the point where there is more water consumption, which processes are the ones that can most contaminate the resource, possible accidents, waste and bad practices, and areas of savings, among other aspects. Thus, in this Ecomap, possible threats to water sources due to accidents, and the conditions of storage are as near water sources can be identified (Rahim & Raman, 2015).

A. Pipe system
B. Waste areas
C. Discharges
D. Critical area – possible threat to water sources

• Waste Map: this Ecomap seeks to show what the handling of materials is and where waste exists, in order to identify alternatives for the prevention and minimization of waste. Then, the raw material storage areas, the solid waste generation points, the disposal sites, the direction of the flows, the types of waste, and the amount of waste generated should be plotted (Ferronato &Torretta, 2019).

• Energy Map: this Ecomap identifies the points of energy consumption and generation. Among the points that must be identified are the places of consumption, places of excessive lighting, places of heat loss, machinery with excess capacity, connections that are defective, and emissions from energy use. In addition, it must be described what types and how much energy is

consumed in the company's facilities (Kurdve et al., 2012).

• Other Ecomaps: ecomaps can be made depending on the critical points of the company. For example, noise, air quality, among others. In the realization of the Ecomaps symbols with a clear meaning should be used, which serve to differentiate the different situations within the plant (Bruzzi et al., 2011).

Ecomapping can also be comprehensive. Therefore, it is understood that factors associated with water, energy, waste, noise and the most important characteristics of the plant can be plotted on a single plane (Singh et al., 2021). Once the ecomaps have been made, and the information collected from this process has been recorded, a work program should be carried out where solutions to the problems indicated on each map are proposed (Aktaş et al., 2021). In addition, it should be taken into account that the Ecomaps can be used as part of the documentation of the company's Environmental Management System and must be made in such a way that they can be reusable and that they can be updated over the years (Abdel et al., 2016). We can say then, that the elaboration of the Ecomaps helps us, like the initial environmental review, to make us an initial visualization of the company's environmental priorities. The ecomaps verify the processes and behavior of the collaborators and induce immediate improvements on their part (Baquero, 2020).

Conclusions

The different maps (water, energy, air and waste) create a useful set of graphical information for multiple players and immediately lead to programs of environmental action. As 80% of environmental information is location-based, the Ecomap shows what is happening and where. Ecomapping is the ideal strategy to understand environmental issues, material flows, opinions and issues associated with the site. Ecomapping is a step-by-step process to collect useful information and immediately trigger environmental actions. The ecomaps verify the processes and behavior of the collaborators and induce immediate improvements on their part, among them, we have:

• Unnecessary energy consumption
• Incorrect waste separation
• High consumption of raw materials and fossil fuels
• Inappropriate handling of harmful substances
• Breach of established processes and procedures
• Absence of filters, emission reduction
• Leaks (tanks, water, pressurized air)
• Incorrect storage, fluids on the ground
• Inadequate facilities
• Old facilities
• Employees have not been efficiently instructed on environmental, safety and health aspects.

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References

Abdel-Razek, Y. A., Abu-Diab, A. A., El-Kassas, H. I., El Miniawy, A. M., & Bakhit, A. A. (2016). Study of some requirements of the environmental management system at the test-work facilities of the Egyptian black sands at Abu Khashaba and Rasheed. *International Journal of Advanced Research*, *4*(5), 552-562.

Acevedo Barrios, R. L. & Severiche Sierra, C. A. (2013). Evaluation of environmental impacts in a water quality laboratory. *Producción+ Limpia*, *8*(2), 32-38.

Aktaş, N. & Demirel, N. (2021). A hybrid framework for evaluating corporate sustainability using multi-criteria decision making. *Environment, Development and Sustainability*, 1-28. https://doi.org/10.1007/s10668-021-01311-5

Arghand, B., Poorhashemi, S. A., Roshandel, R., & Zare, A. (2018). International convention to decrease conflict between energy supply and environmental protection. *Ukrainian Journal of Ecology*, *8*(1). 808-818.

Ayinde, L., Orekoya, I. O., Adepeju, Q. A., & Shomoye, A. M. (2021). Knowledge audit as an important tool in organizational management: A review of literature. Business Information Review, https://doi.org/10.1177/0266382120986034

Bag, S., Wood, L. C., Xu, L., Dhamija, P., & Kayikci, Y. (2020). Big data analytics as an operational excellence approach to enhance sustainable supply chain performance. *Resources, Conservation and Recycling*, *153*, 104559.

Baquero, L. (2020). Aproximaciones teóricas y metodológicas respecto a las estrategias de producción limpia en la industria de alimentos. *Ingenio Libre*, *8*(18). https://doi.org/10.18041/2322-8415/ingelibre.2020.v8n18.6953

Bedoya, E., Severiche, C., Sierra, D. & Meza, M. (2017). Diagnosis of solid waste management in the petrochemical-plastic sector of Cartagena de Indias, Northern Colombia. *International Journal of Engineering and Applied Sciences*, *4*(6), 257444.

Braig, P., & Edinger-Schons, L. (2020). From purpose to impact- an investigation of the application of impact measurement and valuation methods for quantifying environmental and social impacts of businesses. *Sustainable Production and Consumption*, *23*, 189-197.

Bruzzi, L., Boragno, V., Serrano-Bernardo, F. A., Verità, S., & Rosúa-Campos, J. L. (2011). Environmental management policy in a coastal tourism municipality: The case study of Cervia (Italy). *Local Environment*, *16*(2), 93-113. https://doi.org/10.1080/13549839.2011.558075

Carabaño, R., Hernando, S., Ruiz, D. & Bedoya, C. (2017). Life Cycle Assessment (LCA) of building materials for the evaluation of building sustainability: the case of thermal insulation materials. *Revista de la construcción*, *16*(1), 22-32. https://dx.doi.org/10.7764/RDLC.16.1.22

Carpenter-Aeby, T., Aeby, V. G., & Boyd, J. S. (2007). Ecomaps as Visual Tools for Deconstructing Reciprocal Influences: Triage with Disruptive Students at an Alternative School. *School Community Journal*, *17*(2), 45-72.

Chege, S. M., & Wang, D. (2020). The influence of technology innovation on SME performance through environmental sustainability practices in Kenya. *Technology in Society*, *60*, 101210. https://doi.org/10.1016/j.techsoc.2019.101210

Chen, T., Kim, H., Shu-Yuan, S., Tseng, P., Lin, Y. & Chiang, P. (2020). Implementation of green chemistry principles in circular economy system towards sustainable development goals: Challenges and perspectives. *Science of the Total Environment*, *716*, 136998. https://doi.org/10.1016/j.scitotenv.2020.136998

Chowdhury, R., Khan, A., Mahiat, T., Dutta, H., Tasmeea, T., Bashira, A., ... & Sujauddin, M. (2021). Environmental externalities of the COVID-19 lockdown: Insights for sustainability planning in the Anthropocene. *Science of The Total Environment, 783*. 147015. https://doi.org/10.1016/j.scitotenv.2021.147015

Ciruela-Lorenzo, A., Del-Aguila-Obra, A., Padilla-Meléndez, A. & Plaza-Angulo, J. (2020). Digitalization of Agri-cooperatives in the Smart Agriculture Context. Proposal of a Digital Diagnosis Tool. *Sustainability, 12*(4), 1325. http://dx.doi.org/10.3390/su12041325

Cozzolino, S., & Moroni, S. (2021). Multiple agents and self-organisation in complex cities: The crucial role of several property. *Land Use Policy, 103*, 105297. https://doi.org/10.1016/j.landusepol.2021.105297

da Silva, P., de Oliveira, G., Ferreira, J. & Pujol, H. (2021). Evaluation of economic, environmental and operational performance of the adoption of cleaner production: Survey in large textile industries. *Journal of Cleaner Production, 278*, 123855. https://doi.org/10.1016/j.jclepro.2020.123855

Ferronato, N., & Torretta, V. (2019). Waste Mismanagement in Developing Countries: A Review of Global Issues. *International Journal of Environmental Research and Public Health, 16*(6), 1060. https://doi.org/10.3390/ijerph16061060

Fuyan, L., Yang, X., Yu, M., Shen, J., Shi, J., & Chen, C. (2020, December). Research on Diagnosis and Evaluation of Physical Assets of Power Grid Enterprises Based on Combined Weight TOPSIS Theory. In IOP Conference Series: Earth and Environmental Science (Vol. 617, No. 1, p. 012009). IOP Publishing.

Haibo, C., Ayamba, E. C., Agyemang, A. O., Afriyie, S. O., & Anaba, A. O. (2019). Economic development and environmental sustainability - the case of foreign direct investment effect on environmental pollution in China. *Environmental Science and Pollution Research, 26*(7), 7228-7242.

He, Y., Ding, X., & Yang, C. (2021). Do environmental regulations and financial constraints stimulate corporate technological innovation? Evidence from China. *Journal of Asian Economics, 72*, 101265. https://doi.org/10.1016/j.asieco.2020.101265

Isensee, C., Teuteberg, F., Griese, K. M., & Topi, C. (2020). The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review. *Journal of Cleaner Production, 275*, 122944. https://doi.org/10.1016/j.jclepro.2020.122944

Jaimes-Morales, J. (2018). Sistema de gestión de seguridad y salud en el trabajo: una revisión desde los planes de emergencia. *IPSA Scientia, Revista científica Multidisciplinaria, 3*(1), 23-29. https://doi.org/10.25214/27114406.920

Koroljova, A. & Voronova, V. (2007), Eco-mapping as a basis for environmental management systems integration at small and medium enterprises", *Management of Environmental Quality, 18*(5), 542-555. https://doi.org/10.1108/14777830710778300

Kurdve, M., Wendin, M., Bengtsson, C., & Wiktorsson, M. (2012). Waste flow mapping: improve sustainability and realize waste management values. In *Electronic Proceedings of Greening of Industry Network Conference* (Vol. 22).

Le Duc, A. (2020). *The Multiple Contexts of the Environmental Crisis*. Available at SSRN 3812050. https://dx.doi.org/10.2139/ssrn.3812050

López-Alcarria, A., Poza-Vilches, M. F., Pozo-Llorente, M. T., & Gutiérrez-Pérez, J. (2021). Water, Waste Material, and Energy as Key Dimensions of Sustainable Management of Early Childhood Eco-Schools: An Environmental Literacy Model Based on Teachers Action-Competencies (ELTAC). *Water, 13*(2), 145. https://doi.org/10.3390/w13020145

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Mosteanu, N. R., Faccia, A., Ansari, A., Shamout, M. D., & Capitanio, F. (2020). Sustainability Integration in Supply Chain Management through Systematic Literature Review. *Calitatea, 21*(176), 117-123.

Moussa, T., Kotb, A., & Helfaya, A. (2021). An Empirical Investigation of UK Environmental Targets Disclosure: The Role of Environmental Governance and Performance. *European Accounting Review*, 1-35. https://doi.org/10.1080/09638180.2021.1890173

Movilla-Pateiro, L., Mahou-Lago, X. M., Doval, M. I., & Simal-Gandara, J. (2020). Toward a sustainable metric and indicators for the goal of sustainability in agricultural and food production. *Critical reviews in food science and nutrition*, 1-22. https://doi.org/10.1080/10408398.2020.1754161

Mungai, E. M., Ndiritu, S. W., & Rajwani, T. (2020). Raising the bar? Top management teams, gender diversity, and environmental sustainability. *Africa Journal of Management, 6*(4), 269-294. https://doi.org/10.1080/23322373.2020.1830688

Panameño, R., Gutiérrez-Aguilar, C., Angel, B., Fábio-César, S., Kiperstok, A. (2019). Cleaner Production and LCA as Complementary Tools in Environmental Assessment: Discussing Tradeoffs Assessment in a Case of Study with in the Wood Sector in Brazil. *Sustainability 11*(18), 5026. https://doi.org/10.3390/su11185026

Pereira, C., Prata, D., Santos, L. & Monteiro, L. (2018). Development of eco-efficiency comparison index through eco-indicators for industrial applications. *Brazilian Journal of Chemical Engineering, 35*(1), 69-90. https://doi.org/10.1590/0104-6632.20180351s20160370

Rafiq, M., Zhang, X., Yuan, J., Naz, S., & Maqbool, S. (2020). Impact of a balanced scorecard as a strategic management system tool to improve sustainable development: measuring the mediation of organizational performance through PLS-smart. *Sustainability, 12*(4), 1365. https://doi.org/10.3390/su12041365

Rahim, R., & Raman, A. A. (2015). Cleaner production implementation in a fruit juice production plant. *Journal of Cleaner Production, 101*, 215-221. https://doi.org/10.1016/j.jclepro.2015.03.065

Ruiz-Cabezas, M. R., Briceño-Ariza, L. J., Severiche-Sierra, C. A., & Duran-Charris, L. J. (2019). Marco Jurídico de la Gestión Ambiental para PyMEs Agrícolas: Contexto Caribe Colombiano. *Revista ESPACIOS, 40*(32).

Ruiz-Cabezas, M., García-Moreno, A., & Martínez-Zabaleta, M. (2019). Gestión ambiental para la innovación y competitividad de las organizaciones ecoturísticas en áreas protegidas. *IPSA Scientia, Revista científica Multidisciplinaria, 4*(1), 21-32. https://doi.org/10.25214/27114406.944

Santos, J., Muñoz-Villamizar, A., Ormazábal, M., & Viles, E. (2019). Using problem-oriented monitoring to simultaneously improve productivity and environmental performance in manufacturing companies. *International Journal of Computer Integrated Manufacturing, 32*(2), 183-193. http://dx.doi.org/10.1080/0951192X.2018.1552796

Sardana, D., Gupta, N., Kumar, V., & Terziovski, M. (2020). CSR 'sustainability'practices and firm performance in an emerging economy. *Journal of Cleaner Production, 258*, 120766. https://dx.doi.org/10.1016/j.jclepro.2020.120766

Severiche, C. A., Gómez, E. M. & Jaimes, J. (2016). La educación ambiental como base cultural y estrategia para el desarrollo sostenible. *Telos: Revista de Estudios Interdisciplinarios en Ciencias Sociales, 18*(2), 266-281.

Severiche-Sierra, C., Valest-Bustillo, M.K., Jaimes-Morales, J., Bedoya-Marrugo, E., & Cruz, R.D. (2017). Environmental impact assessment at a Colombian Caribbean waste water treatment plant. *Contemporary engineering sciences, 10*(27), 1343-1350. https://doi.org/10.12988/ces.2017.710134

Shahzad, M., Qu, Y., Zafar, A. U., Rehman, S. U., &Islam, T. (2020). Exploring the influence of knowledge management process on corporate sustainable performance through green innovation. *Journal of Knowledge Management, 24*(9). 2079-2106. https://doi.org/10.1108/JKM-11-2019-0624

Sheldon, R. A., & Norton, M. (2020). Green chemistry and the plastic pollution challenge: towards a circular economy. *Green Chemistry*, *22*(19), 6310-6322.

Singh, M. P., Chakraborty, A., Roy, M., & Tripathi, A. (2021). Developing SME sustainability disclosure index for Bombay Stock Exchange (BSE) listed manufacturing SMEs in India. *Environment, Development and Sustainability*, *23*. 399–422. https://doi.org/10.1007/s10668-019-00586-z

Villalba, V., Vargas, L., Bedoya, E, & Severiche, C. (2017). Work absenteeism in workers of an agrochemical manufacturing plant. *IPSA Scientia, Revista científica Multidisciplinaria*, *2*(1), 10-20. Recuperado a partir de https://latinjournal.org/index.php/ipsa/article/view/914

Witek-Crabb, A. (2019). CSR maturity in Polishlisted companies: A qualitative diagnosis based on a progression model. *Sustainability*, *11*(6), 1736. https://doi.org/10.3390/su11061736

Wyrwicka, M. K., & Chuda, A. (2019). The diagnosis oforganizational culture as a change's factor in the context application of design thinking. *LogForum*, *15*(2). 279-290. http://dx.doi.org/10.17270/J.LOG.2019.319

Zhu, X. (2014). GIS and Urban Mining. *Resources*, *3*(1), 235–247. https://doi.org/10.3390/resources3010235

Zuniga-Teran, A. A., Mussetta, P. C., Ley, A. N. L., Díaz-Caravantes, R. E., & Gerlak, A. K. (2021). Analyzing water policy impacts on vulnerability: Cases across the rural-urban continuum in thearid Americas. *Environmental Development*, *38*, 100552. https://doi.org/10.1016/j.envdev.2020.100552