Industrial waste valorization: Contributions to achieving the SDGs in Brazil

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Abstract

Global population growth, coupled with an increase in consumption and the production of new products, leads to a concerning rise in waste generation, posing negative impacts on the environment and public health. Through innovation in waste valorization, it is possible to promote sustainable development and advance the achievement of the Sustainable Development Goals set by the United Nations. Brazil has emerged as an active participant on the international stage, demonstrating commitment to the sustainability and circular economy agenda. This study explores various cases and insights that illustrate how public policies aligned with the industrial, social, and academic sectors can contribute to the promotion of sustainable development. The findings suggest that more Brazilian states should adopt successful models to boost recycling and the sustainable use of raw materials and natural resources, fostering industrial awareness of the benefits of a circular economy driven by regulations and social participation.

Introduction

Since the industrial revolution, industries have been mass-producing consumer goods, significantly increasing the volume and diversity of generated waste (BITENCOURT et al., 2013). Additionally, over recent years, there has been a rapid increase in the global population, leading to an expansion in the use of services and products and, consequently, a rise in waste generation (GODECKE et al., 2012).

Many developing countries, including Brazil, face challenges with the inadequate management of industrial waste. Improperly managed industrial waste can result in a range of harmful environmental impacts, including increased soil, water, and air pollution, compromising not only the quality of ecosystems but also exacerbating greenhouse gas emissions. These risks, in turn, escalate and intensify global challenges related to climate change (BITENCOURT et al., 2013; GODECKE et al., 2012).

Therefore, the practice of waste valorization is essential for environmental preservation and the pursuit of sustainability. This practice not only reduces the volume of discarded industrial waste and associated risks of environmental contamination but also enables the reduction of energy and non-renewable natural resource consumption. It promotes the reuse of existing resources, contributing to a more practical realization of sustainable development (GAMBALONGA, 2023; MACHADO, 2023). In this context, organizations are encouraged to innovate and seek changes that foster the development of new products and services in a more sustainable manner (YANG et al., 2023).

In the global context, the 2030 Agenda was established in 2015, proposing 17 Sustainable Development Goals (SDGs) aimed at ensuring human well-being without harming the environment. Beyond the proposition of SDGs, it also addresses the means of implementation necessary to achieve these objectives, through 169 established targets (BRASIL, 2022; UN, 2022).

Within the framework of the SDGs, Brazil plays a significant role in sustainable development, showcasing internal advancements in environmental, social, and economic areas and maintaining a consistent presence in international forums. By hosting crucial sustainability conferences such as Rio 92 and Rio+20, Brazil not only solidified the concept of sustainable development but also underscored its dedication to environmental preservation. Rio 92, marked by the approval of crucial documents, and Rio+20, which set the agenda for the coming decades, encompass economic, social, and prominently, environmental dimensions. Brazil stands out for its policies aiming not only at economic growth and social inclusion but also at the active preservation of the environment (BRASIL, 2022).

Brazilian case

In the current dynamics of innovation geared towards a more sustainable future, the government stands out as a catalyzing agent in creating instruments that accelerate the achievement of the Sustainable Development Goals. The urgency of the environmental crisis emphasizes the need for effective actions, and it is through public policies and government initiatives that an environment conducive to the effective implementation of sustainable practices can be created (MARX, 2019; YANG et al., 2023).

Significant progress is evident in Brazilian legislation related to waste management, exemplified by the creation of the ABNT NBR 17100-1 standard by the Brazilian Association of Technical Standards. This standard establishes comprehensive guidelines for the segregation, collection, storage, transport, treatment, and final disposal of waste, aiming not only to reduce the negative impacts caused by them but also to promote sustainability throughout the process (BRASIL, 2023).

An innovative approach in waste management is highlighted by the use of discarded foundry sand (DFS) in applications such as asphalt concrete and landfill cover. According to the Brazilian Foundry Association (ABIFA), the annual generation of DFS exceeds 2 million tons. The substantial quantity produced, coupled with the lack of specific regulations beyond the foundry industry, results in the increased accumulation of this environmental liability in landfills and the consequent accelerated reduction of their lifespan (FERREIRA et al., 2014; OLIVEIRA, 2016). This underscores the urgency in creating more specific standards for the incorporation of this waste, establishing guidelines for its reuse to extend its utilization percentage. Similar to the ABNT NBR 15702 standard (BRASIL, 2009), which defines specific limits for the use of this material in construction-related applications.

In response to this need, several Brazilian states have implemented laws regulating the reuse of DFS as a secondary raw material. The example of the state of Santa Catarina stands out, where through Law No. 17,479, authorization was granted for the use of these residues in other sectors or products. The goal is to promote harmony among elements of economic growth, social equity, and environmental quality (SANTA CATARINA, 2018).

Aligned with this perspective, the state of Minas Gerais, through Law No. 24,444, expresses a preference for the use of DFS in public infrastructure construction projects, highway maintenance, and landfill cover. In addition to promoting the sustainable use of these residues, the legislation establishes rigorous measures, including administrative, civil, and criminal sanctions for non-compliance (MINAS GERAIS, 2023).

Policy recommendations / conclusions

Countries aspiring to embrace circular economy principles face the challenge of harmonizing government incentives for replacing conventional raw materials with alternatives, establishing a process for assessing and authorizing reuse with an emphasis on environmental protection, and raising awareness among all stakeholders about the economic and environmental benefits associated with industrial waste valorization (ALVES, 2012; DA SILVA, 2010).

With the progress of Brazilian regulations focused on waste valorization, it is natural to expect companies to advance in achieving the Sustainable Development Goals. In Brazil, the adoption of Discarded Foundry Sand by industries is still limited due to the scarcity of existing standards so far (FAGUNDES et al., 2010; REUS, 2021). However, this practice is implemented in various countries, and it is possible to follow the example of successful initiatives to drive an increase in the percentage of waste reuse in the country.

Government intervention in the legal process of economic valuation of environmental assets plays a crucial role in promoting the use of alternative raw materials through fiscal incentives, such as increased fees on mining and landfilling. The concept of assigning a financial value to the environment originates from neoclassical environmental economics, which suggests assessing nature in monetary terms, assigning values to natural resources to integrate them economically and protect them (NUSDEO, 2019). Another highly relevant mechanism to encourage reuse practices is the creation of categories defined by contaminant variation limits for specific reuse applications. That is, the use of cleaner waste in lower-risk activities is favored with fewer restrictions, encouraging industries to seek processes resulting in less toxic waste (ALVES, 2012).

This approach aims to balance economic incentives for waste reuse, ensuring that it does not compromise the standards established by environmental legislation. Such a practice is adopted in countries like Denmark, Germany, and the United States, where foundries interested in diverting waste to other industries must follow agreements with the state, conducting tests and preparing reports to certify the waste's compliance with applicable standards (ALVES, 2012; DA SILVA, 2010).

In this context, the role of the United States Environmental Protection Agency (USEPA) stands out. To promote the reuse of DFS, USEPA developed the document "Actions aimed at increasing the beneficial use of foundry sand" (USEPA, 2009a), identifying key challenges for increasing the reuse of DFS and establishing actions to improve waste management. Also, in 2009, the agency compiled in the document "Risk Assessment of Spent Foundry Sands in Soil-Related Applications Peer Review Draft" (USEPA, 2009b) types of DFS safe for reuse, a performance study in various applications, and guidelines for state environmental agencies to support reuse-related practices.

Moreover, it is noted that the increase in the incorporation of foundry waste is directly linked to agreements between foundries and industries, as well as the dissemination of information about the characteristics of the sands. This connection does not occur simply and spontaneously; it is crucial to establish strong partnerships and share knowledge to identify potential users of these wastes. As seen in the case of Australia, where the URS Corporation, a professional engineering, design, and construction management services company, developed a report presenting the advantages of using foundry sand from a technical standpoint. It also listed companies expressing interest in reusing foundry sands in concrete and cement manufacturing, as an additive for composting, and as fill material (ALVES, 2012; DA SILVA, 2010).

Therefore, innovation in the valorization of waste plays a strategic role in achieving the SDGs. SDG 12 stands out as the main link between industrial waste valorization and the SDGs, aiming to ensure sustainable production and consumption patterns, including substantial waste reduction through practices like prevention, reduction, recycling, and reuse. SDG 11 is also directly related to the valorization practice, seeking to make cities and communities more inclusive, safe, resilient, and sustainable, with one specific goal of reducing the environmental impact, including efficient waste management and other environmental aspects. Additionally, waste valorization indirectly contributes to the achievement of SDGs 3, 6, 7, 13, 14, and 15, as reducing environmental impacts leads to improvements in health, quality of life, and the preservation of environmental resources.

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References

ABIFA. Brazilian Foundry Association. (2020). ABIFA Magazine, 32, 12. https://www.abifa.org.br/revista32/#p=12

ABNT. Brazilian Association of Technical Standards. (2022). NBR 17.100-1. https://saturno.crea-rs.org.br/pop/profissional/ABNT_NBR_17100_1_2023.pdf

Alves, B. S. Q., et al. (2012). Environmental feasibility study of the reuse of discarded foundry sands. https://repositorio.ufsc.br/handle/123456789/100741

Bitencourt, D. V., et al. (2013). The issue of urban solid waste. Interfaces Científicas-Saúde e Ambiente, 2.1, 25-36. https://periodicos.grupotiradentes.com/saude/article/view/842

Brazil, Ministry of Foreign Affairs. (n.d.). Agenda 2030 for Sustainable Development. https://www.gov.br/mre/pt-br/assuntos/desenvolvimento-sustentavel-e-meio-ambiente/desenvolvimento-sustentavel/agenda-2030-para-o-desenvolvimento-sustentavel

Brazil, Ministry of Foreign Affairs. (n.d.). Brazil and sustainable development. https://www.gov.br/mre/pt-br/assuntos/desenvolvimento-sustentavel-e-meio-ambiente/desenvolvimento-sustentavel/o-brasil-e-o-desenvolvimento-sustentavel

De Oliveira, M. A. S., & De Miranda, M. G. (2019). Garbage and environmental problems. LexCult: Electronic Journal of Law and Humanities, 3.2, 125-146. http://177.223.208.8/index.php/LexCult/article/view/267/187

Fagundes, A. B., et al. (2010). Paths to sustainability in the Brazilian foundry sector. Production, Operations, and Systems Management Journal, (2), 27. http://adcont.net/index.php/adcont/AdCont2017/paper/view/2639

Gambalonga, B., et al. (2023). Valorization of waste foundry sand aggregates in hot-mix asphalt. Process Safety and Environmental Protection, 173, 277-288. https://doi.org/10.1016/j.psep.2023.03.025

Godecke, M. V., Naime, R. H., & Figueiredo, J. A. S. (2012). Consumerism and the generation of urban solid waste in Brazil. Electronic Journal of Management, Education, and Environmental Technology, 1700-1712. https://periodicos.ufsm.br/reget/article/view/6380/pdf

Gomes, M. F., & Ferreira, L. J. (2018). Public policies and the objectives of sustainable development. Law and Development, 9.2, 155-178. https://periodicos.unipe.edu.br/index.php/direitoedesenvolvimento/article/view/667/560

Law No. 17,479. (2018). http://leis.alesc.sc.gov.br/html/2018/17479_2018_lei.html

Law No. 24,444. (2023). https://www.almg.gov.br/legislacao-mineira/texto/LEI/24444/2023/

Machado, D. M., et al. (2023). Valorization of Brazilian waste foundry sand from a circular economy perspective. Journal of Cleaner Production, 407, 137046. https://www.sciencedirect.com/science/article/abs/pii/S0959652623012040?via%3Dihub

Marx, A. (2019). Public-private partnerships for sustainable development: Exploring their design and its impact on effectiveness. Sustainability, 11(4), 1087. https://doi.org/10.3390/su11041087

Nusdeo, A., & Trennepohl, T. (2019). Contributions of economic analysis of law to environmental protection: the case for promotional norms. In: Themes of Economic Environmental Law. São Paulo (SP): Revista dos Tribunais Publisher. https://www.jusbrasil.com.br/doutrina/secao/3-contribuicoes-da-analise-economica-do-direito-para-a-protecao-ambiental-o-caso-para-normas-promocionais-temas-de-direito-ambiental-economico/1198085216

Oliveira, G. V. (2016). Potential applications for discarded foundry sands: an exploratory study. http://hdl.handle.net/10183/147180

UN Brazil. (2022). Sustainable Development Goals in Brazil. https://brasil.un.org/pt-br/sdgs

Petrassi, A. C., & Van Bellen, H. M. (2017). Waste management: A reflection based on sustainable development goals. In: VIII National Congress of Administration and Accounting-AdCont 2017. http://adcont.net/index.php/adcont/AdCont2017/paper/view/2639

Reus, A. (2021). Geotechnical behavior of foundry sands for pavement applications. Federal University of Santa Catarina Technological Center of Joinville Civil Infrastructure Engineering Course.

Siddique, R., Kaur, G., & Rajor, A. (2010). Waste foundry sand and its leachate characteristics. Resources, Conservation and Recycling, 54(12), 1027-1036. https://doi.org/10.1016/j.resconrec.2010.04.006

UN. Federal University of Santa Catarina Technological Center of Joinville. (2014). Technical and environmental feasibility of soil mixtures with discarded foundry sand. Dos Santos Ferreira, G. C., et al. Transport, 22(2), 62-69. http://dx.doi.org/10.14295/transportes.v22i2.728

Yang, M., et al. (2023). Circular economy strategies for combating climate change and other environmental issues. Environmental Chemistry Letters, 21(1), 55-80. https://doi.org/10.1007/s10311-022-01499-6