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Challenges and the Way Forward for Management and Handling of Hazardous Waste

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ABSTRACT

Hazardous waste poses significant threats to human health and the environment, necessitating stringent regulatory management. This study explores the challenges and prospects associated with hazardous waste management, emphasizing the critical need for sustainable practices. Drawing on field observations, stakeholder interviews in India, and extensive literature reviews, the research addresses challenges such as inadequate stakeholder consultation during law enactment, resource constraints, insufficient authorized disposal facilities, and transportation issues. The study underscores the importance of sustainable waste reduction practices through proactive industry engagement and government facilitation of necessary infrastructure. It advocates for streamlined regulatory processes, inter-state cooperation, and responsive authorities to ensure effective hazardous waste management. The research emphasizes the adoption of innovative and sustainable waste reduction methods supported by comprehensive root cause analysis and well-crafted policies to achieve environmental sustainability goals. In conclusion, the study highlights the global applicability of findings, emphasizing collaborative efforts for effective hazardous waste handling and disposal to ensure a clean and pollution-free environment.

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1. Introduction

The escalating pace of industrialization and the widespread combustion of fossil fuels have emerged as primary contributors to the pervasive environmental pollution crisis [1]. Amid the array of pollutants, the generation of hazardous waste stands out as a formidable challenge that demands earnest attention. Defined by its intrinsic potential to pose threats to human health and the environment, hazardous waste is subject to regulatory management [2]. In the context of India, the legal framework governing the handling of hazardous waste is delineated by The Hazardous Wastes (Management & Handling) Rules, 1989, and subsequent amendments [2]. These regulations meticulously classify 38 categories of processes as hazardous, during which hazardous wastes are inevitably generated. The identified processes encompass a spectrum of activities, ranging from petrochemical processing and heavy metal beneficiation to chemical treatments employing hazardous substances and the production of diverse chemical sludges and residues.

In contrast to conventional waste, hazardous waste poses an elevated risk to human health, wildlife, and the overall ecosystem. While many nations have instituted comprehensive legal frameworks for the management of hazardous waste, there exists a disparity, with some countries yet to enact such legislation [3]. Despite the global variance in legal frameworks, the universal imperative to curtail hazardous waste production remains pressing. The advocacy for recycling, reuse, and recovery emerges as a pivotal strategy to substantially diminish the volume of hazardous waste. Complementary to these efforts is the endorsement of co-processing, a sustainable waste management approach that involves using hazardous waste as an alternative fuel in boilers and furnaces. For instances where these methods prove impractical, the proper disposal of hazardous waste in Treatment Storage and Disposal Facilities (TSDFs) becomes imperative.

Internationally, an array of reviews, studies, and seminars have been initiated to heighten awareness and explore innovative methods for the effective handling and management of hazardous waste. The intensification of industrial activities has invariably led to a surge in hazardous waste generation, underscoring the critical need to minimize its production. Source reduction, alongside recycling, reuse, and recovery initiatives, becomes indispensable to systematically reduce the net volume of hazardous waste.

While the industrial sector is a significant contributor to hazardous waste, it is crucial to recognize that hazardous waste is not confined solely to industrial settings. Laboratories, households, and healthcare facilities also generate hazardous waste, necessitating meticulous handling and disposal procedures [4-6]. Special attention must be directed towards heavy metals like lead and mercury, prevalent in industrial processes and household items. While stringent legal regulations govern the industrial handling of these substances, the disposal of household items containing hazardous materials, such as thermometers and batteries, often occurs recklessly. Hence, establishing proper methods for household hazardous waste disposal and elevating public awareness about safe disposal practices become imperative [7, 8].

Ensuring the safe management of hazardous waste involves equipping workers engaged in its processing with adequate training, tools, and knowledge [9]. While the enforcement of regulations is undoubtedly a critical facet of hazardous waste management, its sustainability in the long run remains uncertain [10].

Recognizing the theoretical underpinnings of prior studies, this research seeks to bridge the gap between theory and practice. Conducting a field survey and engaging in interviews with individuals actively involved in hazardous waste management is deemed necessary to extract real-world insights. The overarching aim of this study is to amalgamate a comprehensive literature review on hazardous waste management with on-the-ground observations, providing a nuanced understanding of the challenges faced. Through these insights, the research endeavors to propose practical and effective solutions that will benefit all stakeholders involved in hazardous waste management, steering toward the collective goal of achieving environmental sustainability.

2. Materials and Method

The study is done based on field observations, interviews with the stakeholders engaged in hazardous waste management in different states of India, and also a study on different literature on hazardous waste management.

2.1. Current Scenario on Management and Handling of Hazardous Waste

The challenges in the management and handling of hazardous waste extend beyond regulatory complexities and resource constraints. In many instances, the existing legal framework lacks the flexibility required to adapt to dynamic industrial landscapes and evolving technologies. As industries progress and introduce new processes, the regulations governing hazardous waste management may struggle to keep pace.

In light of the evolving nature of industries, there is a growing need for periodic reviews and updates of existing regulations to ensure their relevance and effectiveness. A lack of periodic reassessment can result in outdated regulations that are ill-equipped to address emerging environmental concerns associated with novel industrial practices. To foster a more adaptive regulatory environment, regular consultations with industry experts, environmental scientists, and technological innovators are essential to incorporate their insights into the legal framework.

Another critical aspect is the need for heightened awareness and education among industries regarding the environmental impact of hazardous waste. Many generators may not fully grasp the intricacies of the regulations, leading to unintentional violations or non-compliance. Efforts should be directed toward educating businesses about the importance of proper waste management, the potential consequences of non-compliance, and the available resources for assistance.

Moreover, incentivizing environmentally friendly practices and investments in waste reduction technologies can be a catalyst for positive change. Governments can consider offering tax incentives, subsidies, or grants to industries adopting sustainable waste management practices. This approach not only encourages compliance but also promotes a culture of corporate responsibility, where businesses actively seek ways to minimize their environmental footprint.

The establishment of more accessible and strategically located authorized disposal facilities is crucial to overcoming logistical challenges. Governments should collaborate with private entities to create a network of disposal facilities that are easily accessible to industries across different regions [11, 12]. Additionally, investing in research and development to identify alternative methods of hazardous waste disposal that are cost-effective and environmentally sustainable can provide long-term solutions to the accessibility issue.

Furthermore, the integration of technology in monitoring and tracking hazardous waste movements can enhance transparency and accountability. Implementing a centralized digital system for tracking the entire lifecycle of hazardous waste, from generation to disposal, can streamline regulatory oversight. This would not only facilitate compliance monitoring but also serve as a valuable tool for authorities to identify and address potential issues proactively.

Addressing the challenges in the management and handling of hazardous waste requires a multifaceted approach that encompasses legal reforms, industry education, incentives for sustainable practices, strategic infrastructure development, and technological integration. By fostering collaboration among governments, industries, and environmental experts, a more resilient and adaptive framework can be established to ensure the safe and environmentally sound management of hazardous waste in the ever-evolving industrial landscape.

3. Observation and Discussion

Industries and waste generators must proactively embrace innovative and sustainable processes and materials to curtail the generation of hazardous waste and other polluting substances at their source. Many industries are already taking steps to implement effective methods for sustainable manufacturing [13] and the management and handling of hazardous waste, particularly those with substantial resources and robust management structures. Certain states, such as Gujarat in India, have successfully implemented these practices through collaboration between the state government and industries [14].

The government has a pivotal role to play in this endeavor. It should facilitate the development of necessary infrastructure and incentivize industries to utilize these facilities at reasonable costs. Simplified procedures for

authorizations and registrations should be put in place to encourage stakeholders to come forward, register, and accurately declare the quantity of hazardous waste they generate. Wherever possible, the regulatory process should be streamlined.

Furthermore, state governments should actively cooperate with other states to facilitate the transportation and disposal of hazardous waste, fostering a collective effort toward effective waste management. There should be a mutual agreement between the state governments to accept and help each other in the process of hazardous waste management and handling. Authorities should attentively listen to the concerns voiced by industries and work towards cost-effectively resolving them. Implementing the observations and recommendations of various committees can help remove bottlenecks and ensure the smooth and proper implementation of hazardous waste management rules [15].

4. Conclusion

With the continuous growth in industrial production, it is inevitable that the generation of various types of waste, including hazardous waste, will also escalate. Therefore, it is imperative to adopt innovative and sustainable processes and materials to curtail waste generation at its source. While penalties can serve as a deterrent, they must be reasonable and complemented by a meticulous analysis of root causes, which should be addressed through well-crafted policies.

Recycling and reuse should be strongly encouraged, with government bodies offering a variety of rewards and recognition incentives like there are such incentives given in the installation of solar power plants and use of solar energy, Installation of biodiesel plants, etc. For example, the industry that recycles and reuses hazardous waste will be given some reward and recognition. Existing policies should be revisited and revised to prioritize waste reduction and minimization, particularly at the source. This strategic emphasis on waste reduction and minimization is crucial for achieving more effective waste management practices.

Conflict of Interest

The authors declare that they have no conflict of interest.

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References

- [1] Jena MC, Mishra SK, Moharana HS. Experimental investigation on power consumption of an industrial fan with different flow control methods. *Environ Prog Sustain Energy*. 2019; 39: e13237. <https://doi.org/10.1002/ep.13237>
- [2] Bhawan P, Arjun Nagar E. National policy of hazardous waste. Delhi: Central Pollution Control Board; 2003. Available from <https://mpcb.gov.in/sites/default/files/focus-area-reports-documents/NationalPolicy.pdf> (Accessed on November 2023).
- [3] Karthikeyan L, Suresh V, Krishnan V, Tudor T, Varshini V. The management of hazardous solid waste in India: An overview. *Environments*. 2018; 5: 103. <https://doi.org/10.3390/environments5090103>
- [4] Al-Jabari M. Establishing hazardous waste list for a developing country: Palestinian Case Study. *J Eng Archit*. 2014; 2: 187-96. <https://doi.org/10.15640/jea.v2n2a13>
- [5] Al-Tamimi WMW, Al-Khatib IA, Kontogianni S. Household hazardous waste quantification, characterization, and management in developing countries' cities: A case study. In: Hussain CM, Ed. *Handbook of Environmental Materials Management*, Cham: Springer; 2018, p. 1-23. https://doi.org/10.1007/978-3-319-58538-3_15-1
- [6] Siril AJ, Abu Bakar SN, Fatehah MO. Hazardous waste management, challenges, and risks in handling laboratory waste in universities. In: Baskar C, Ramakrishna S, Baskar S, Sharma R, Chinnapan A, Sehwat R, Eds. *Handbook of Solid Waste Management*. Singapore: Springer; 2022, p. 1655-714. https://doi.org/10.1007/978-981-16-4230-2_79
- [7] Broussard LA, Hammett-Stabler CA, Winecker RE, Roper-Miller JD. The toxicology of mercury. *Lab Med*. 2002; 33: 614-25. <https://doi.org/10.1309/5HY1-V3NE-2LFL-P9MT>
- [8] Williams RT, Dean RB, Wise RH. Disposal of mercury wastes from water laboratories. *Environ Sci Technol*. 1971; 5: 1044-5. <https://doi.org/10.1021/es60057a006>

- [9] Safety and health in the use of chemicals at work 2013. International Labour Health Organization; 978-92-2-128316-4.
- [10] [10] Enforcing hazardous waste rules in India: Strategies and techniques for achieving increased compliance, Washington DC: ELI; 2014.
- [11] Babu BV, Ramakrishna V. Extended studies on mathematical modeling of site sensitivity indices in the site selection criteria for hazardous waste treatment, storage and disposal facility. *J Inst Public Health Eng India*. 2003; 2003:11-7.
- [12] Khanna P, Kumar R, Kulkarni V. Case study 3: hazardous waste issues in India. Available from <http://www.eolss.net/sample-chapters/c09/e1-08-06.pdf> (accessed on 29 June 2018).
- [13] Jena MC, Mishra SK, Moharana HS. Application of Industry 4.0 to enhance sustainable manufacturing. *Environ Prog Sustain Energy*. 2019; 39: 13360. <https://doi.org/10.1002/ep.13360>
- [14] Ahuja AS, Abda SA. Industrial hazardous waste management by government of Gujarat. *Res Hub Int Multidiscip Res J*. 2015; 2: 1-11.
- [15] Report of the high powered committee on management of hazardous wastes. Available from: <https://swachcoop.com/pdf/Bajaj%20Committee%20Report%201995.pdf> (accessed on 29 June 2018).