INTERNATIONAL JOURNAL FOR LEGAL RESEARCH AND ANALYSIS

Open Access, Refereed Journal Multi Disciplinary
Peer Reviewed

www.ijlra.com

ISSN: 2582-6433

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ISSN: 2582-6433

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ISSN: 2582-6433

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ISSN: 2582-6433

CRITICAL ANALYSIS OF LEGAL FRAMEWORKS AND CHALLENGES IN HAZARDOUS SUBSTANCE MANAGEMENT

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Abstract

The management of hazardous substances has emerged as one of India's most pressing regulatory challenges, given the rapid upward trajectory of industrialisation, urbanisation, and including high-risk sectors such as electronics, energy storage, and chemicals. This paper critically examines the legal and institutional frameworks for hazardous substance management in India, with focus on their effectiveness, limitations, and future directions. It reviews the principal statutes and rules, including the Environment (Protection) Act, the Manufacture, Storage and Import of Hazardous Chemical Rules, the Hazardous and Other Wastes Rules, and the Public Liability Insurance Act, highlighting their role in establishing liability, precautionary mechanisms, and insurance-based relief. The analysis finds that while India's framework is relatively comprehensive and aligned with international obligations, it suffers from fragmented regulation, weaker enforcement, lack of fund management such as the Environment Relief Fund, coordination problems and weak compliance with Extended Producer Responsibility mandates. The emergence of novel waste streams such as lithium-ion batteries and the persistence of informal recycling practices further compound these regulatory gaps. Judicial interventions and recent policy reforms has mitigated certain grey areas and fixed lacunae, the paper advocates for the consolidation of laws into a unified Hazardous Substances Management Act, the adoption of digital tracking systems for waste, stricter enforcement of producer responsibility backed by penalties, and the integration of informal workers into the formal recycling economy. By advancing these recommendations, the study contributes to the discourse on strengthening India's environmental governance to ensure sustainable and equitable management of hazardous substances.

Key Words: Hazardous Substance Management, Hazardous Waste, Environment Protection, Industrialisation, Bhopal Gas Tragedy, Environmental Protection Act, 1986,

ISSN: 2582-6433

1. Introduction:

Hazardous Substances are those substances which when left untreated or improperly disposed has tendencies to seriously contaminate the natural environment around us and ultimately make it inhabitable and unfit for living. Section 2(e) of Environment (Protection) Act, 1986 defines hazardous substance as any substance or preparation which, by reason of its chemical or physio-chemical properties or handling, is liable to cause harm to human beings, other living creatures, plants, micro-organism, property or the environment[1].Hazardous Substance Management is a necessity, and it includes a series of positive acts such as collecting, treating, and disposing of substances which are hazardous in nature. Failing to do so will lead to serious repercussions to the environment and ultimately affect the health and lives of not only humans but also animals and other living organisms. Hazardous waste generation is one of the primary by-products of Industries involved with the use of hazardous substances. The Hazardous waste generated by these industries could be of any form. It may be in traditional forms like solidified, liquefied, gaseous form or may even be in the form of sludges. Industries involved with handling of such substances may cause environmental harm as a result of improper management, disposal, storage, transportation, and release in air or water causing widespread and directly impacting human lives and livelihood and causing detrimental and long term damage to the environment.[2] To control and regulate the affairs of industries directly or indirectly involved in dealing with hazardous substances, the Government of India has formulated laws, mechanisms and policies with the aim of preservation and protection of the environment and establishing corporate responsibility and oversight mechanisms to achieve sustainable development goals.

The aim of this paper is to critically examine legal frameworks and challenges in hazardous substance management in India. The issue of hazardous substances management becomes more vital as sources of hazardous waste generation are rapidly expanding with the continuous upward growth in urbanization and industrialisation. It not only includes traditional sources such as industrial manufacturing processes but also newer sources such as battery related wastes and other e-wastes. Increased chemical

[1] The Environment (Protection) Act, 1986, S.2(e).
[2] BRITANNICA, *Hazardous waste management* available at-https://www.britannica.com/technology/hazardous-waste-management (Last visited on Sep. 10, 2025).

ISSN: 2582-6433

usages solidified the possibility of chemical accidents endangering everything in vicinity and beyond.[3]

2. Evolution of Hazardous Substance Regulation in India:

Bhopal Gas Tragedy was one of the most tragic and far reaching industrial chemical disasters in the history of India. It claimed countless lives and its damage was widespread. One of the reasons for the tragedy was lack of proper regulation and supervision of appropriate authorities on businesses dealing with Hazardous Substances. The development of laws dealing with Hazardous Substance and other environment laws are a direct consequence of the Bhopal incident. Evolution of Environmental laws can be done in two phases: pre and post bhopal gas incident.

1. Pre-bhopal regulatory landscape:

The regulatory framework before the Bhopal Gas tragedy was fragmented and had several regulatory gaps. Industrial accidents were largely governed by the Factories Act, Explosive Substance Act, 1908; IPC 1860, CrPC 1973; Water Act, 1974; Air Act, 1981 and others.

2. Post-Bhopal Gas Regulatory Landscape:

This Environment (Protection) Act, 1986 was enacted as a direct consequence of Bhopal Gas Tragedy. The EPA, 1986 is an umbrella legislation which resulted in enactments of other laws for environment and public welfare and protection. The act created the Ministry of Environment and Forest (MoEF). The MoEF overtook the responsibility and functions of Supervision, administration, formulation, and implementation of environment policies and laws. Under the EPA act a number of rules were made such as Hazardous Waste (Management and Handling) Rules, 1989. The government further amended Factories Act, and also enacted other legislations such as Public Liability Insurance Act, 1991 and The Manufacture, Storage, and Import of Hazardous Chemicals (MSIHC) Rules, 1989.

These enactments, amendments of laws and rules were made to establish corporate accountability and social responsibility over business owners and also

[3] EPA, *Learn the basics of hazardous waste* available at- https://www.epa.gov/hw/learn-basics-hazardous-waste (last visited on Sep.10, 2025).

ISSN: 2582-6433

over appropriate government authorities with a view to avoiding any future similar accidents.[45]

3. Core Legal and Institutional Frameworks:

1. Constitutional Provisions:

The Indian Constitution under Article 21 which talks about the right to life. The scope of right to life has been broadened by the Indian Judiciary to also include rights related to the environment such as the right to live in a pollution free environment. The right to live in a pollution free environment U/A 21 is also supplemented by other Constitutional Provisions such as Art. 47, Art. 48A, Art. 51A (g) and others. In **Vellore Citizen's Welfare Forum v. Union of India[6],** the Supreme Court applied the concept of precautionary and polluter pay principles and held the concerned industries liable and to pay damages for environmental harm. The court further observed that certain industries, although necessary for the country's growth and development, cannot be allowed to harm the ecology and environment. The court stressed on sustainable development and the use of pollution control devices by the industries causing pollution.

2. Key Legislations:

The Environment (Protection) Act, 1986

This act as discussed above, was enacted as a result of the Bhopal Gas Tragedy and its objectives are to provide protection and protection to the environment. The act created the Ministry of Environment and Forest (MoEF) which was later called the Ministry of Environment, Forest and Climate Change (MoEFCC). This Act U/s 25 empowers the central government to make rules for the purposes of the act itself. [7]

[4] TAXTMI, *Legacy of bhopal gas tragedy and Indian chemical industrial sector-learnings and path forward* available at- **https://www.taxtmi.com/article/detailed?id=13630** (last visited on Sep. 10, 2025).
[5] PMC, *The Bhopal disaster and its aftermath: a review* available at **https://pmc.ncbi.nlm.nih.gov/articles/PMC1142333/**(last visited on Sep. 12, 2025).
[6] Vellore Citizen's Welfare Forum v. Union of India, (1996) 5 SCC 647.
[7] CENTRAL POLLUTION CONTROL BOARDavailable at https://cpcb.nic.in/env-protection-act/ (last visited on Sep. 12, 2025).

ISSN: 2582-6433

The Manufacture, Storage, and Import of Hazardous Chemicals (MSIHC) Rules, 1989

It deals with industries involved with handling chemicals. The object of these rules is to minimize and prevent potential environmental harm due to businesses dealing with hazardous substances or chemicals. The act provides for oversight and safety mechanisms to implement safety measures and formulate emergency plans.[8]

The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

It has amended the Hazardous Waste (Management and Handling) Rules, 2008 and is Basel Convention compliant. The 2016 amendment has widened the scope of these rules by including **other wastes.** These other wastes include waste produced from tyres, metal scraps, and used electronics. These rules deal with import, export, classification of wastes into categories given in its schedules and other aspects.[9]

Chemical Accidents Rules, 1996

These rules were enacted under EPA, 1986 by the Ministry of Environment with the aim of ensuring preparedness of emergency response during the unfortunate events of chemical accidents or disasters. These rules empower the appropriate authorities to constitute crisis groups at different levels: State level; District level; Local Level. These crisis groups maintain oversight and review preparedness and planning emergency response.[10]

Public Liability Insurance Act, 1991

It was enacted to provide immediate relief to the victims of accidents caused by hazardous substances. The act streamlined the litigation process for

[8] DEFACTOIAS, *Hazardous Substance regulation in India* (May 12, 2024) available at https://www.npcindia.gov.in/NPC/Files/delhiOFC/EM/Hazardous-waste-management-rules-2016.pdf (last visited on Sep. 12, 2025).

[9] NPCINDIA, *Hazardous Waste management rules* available at- https://www.npcindia.gov.in/NPC/Files/delhiOFC/EM/Hazardous-waste-management-rules-2016.pdf(last visited on Sep.12, 2025).

[10] LABOUR COMMISSIONER,*The Chemical Accident Rules,1996* available at- https://labour.delhi.gov.in/labour/chemical-accident-rules-1996(last visited on Sep.12,2025).

ISSN: 2582-6433

compensation. The act also makes it compulsory for businesses involved with hazardous substances to take public insurance policy which shall cover accidents caused due to hazardous substances and resulting in death, injury, and others. The act mandates establishing environmental relief funds which are to be paid by the owners annually, it is a centralised fund and is supplementary to compensation under insurance policies.[11]

3. **Sector Specific Rules:**

E-waste Rules 2022 amendments

It aims at management of e-wastes to avoid adverse effects on health and environment. The regulation focuses on placing the duty of Extended Producer Responsibility to meet recycling processes through registered recyclers failing to do so will invite penalty and payment of compensation for environmental damages.[12]The rules also focus on recycling sectors and mandates the need for Authorization from SPCBs and Pollution Control Committees (PCC) to dismantling and recycling units. CPCB issues guidelines and Standard Operating Procedures (SOPs) for processing and recycling of e-wastes.[13]

Bio-Medical Waste Management Rules, 2016

It deals with the treatment, handling and proper disposal of Bio-Medical wastes generated from Hospitals and other Healthcare Facilities including camps and clinics. It places a responsibility on the stakeholders and mandates classification of types of medical wastes as given in its schedules.

Under Section 8 of the rule, methods of proper segregation, packaging, transportation and storage have been provided. The rules also focus on training and immunization of workers to ensure proper medical waste disposal[14].

[11] ICICI LOMBARD, *Why public liability act, 1991 matters for Indian businesses* (Apr. 15, 2025) available at- https://www.icicilombard.com/blogs/online-insurance/article/why-public-liability-insurance-act-1991-matters-for-indian-businesses#:~:text=Environmental%20Relief%20Fund%20management:%20The,to%20disburse%20the%20required%20compensation (last visited on Sep. 12, 2025).

[12] PIB, *Re-cycling of e-waste(Dec.09,2022)* available at- https://www.pib.gov.in/PressReleasePage.aspx?PRID=1881761 (last visited on Sep.14 ,2025)

[13] CPCBavailable at https://cpcb.nic.in/uploads/Projects/E-Waste/FAQ_ewaste_23012024.pdf (last visited on Sep. ,2025).

[14] DEPARTMENT OF HEALTH RESEARCHavailable athttps://dhr.gov.in/sites/default/files/Bio-medical_Waste_Management_Rules_2016.pdf (last visited on Sep.14, 2025).

ISSN: 2582-6433

Battery Waste Management Rules, 2022

MoEFCC has enacted these rules by replacing the Batteries (Management and Handling) Rules, 2001. The regulation is based on Extended Producer Responsibility, a duty placed on the producers to collect, recycle and reuse battery wastes. [15]It becomes more vital with the increased push by Central and State governments on e-vehicles in a move to reduce dependence on fossil fuels. The regulation is aimed at creating a circular economy for battery materials, ensuring recycle and reuse of such battery wastes.[16]

Plastic Waste Management Rules, 2016

The regulation places a responsibility on producers and generators of plastic wastes to reduce, reuse and recycle. It aims at segregation of plastic based on their characteristics to ensure proper handling. It also provides SOPs for identifying single use plastics and to reduce its production. The regulation also places this responsibility on local bodies including gram panchayats.[17]

4. Institutional Framework:

To tackle the issues of Hazardous Substance Management the union government has established the Ministry of Environment, Forest, and Climate Change which is a central regulatory body and it is tasked with oversight, implementing of environmental policies. It does such tasks through organisations such as the Central Pollution Control Board (CPCB) at Central level and State pollution control boards (SPCBs) at State level. These pollution control boards are further assisted by the Local Authorities at local levels.[18]

National Green Tribunal is an adjudicatory body which exclusively deals with environment related cases. In other words it is the court of first instance having original jurisdiction over the environment related matters. Although an appeal

[15] PIB, *Government notifies battery waste rules, 2022 (Aug*. 25, 2022*)* available at- https://www.pib.gov.in/PressReleasePage.aspx?PRID=1854433 (last visited on Sep. 16, 2025).
[16] IEA, *Battery Waste Management Rules, 2022*(Apr.29, 2025) available at-**https://www.iea.org/policies/25166-battery-waste-management-rules-2022** (last visited on Sep.15, 2025).
[17] IPCA, *Plastic Waste Management (Amendment) Rules, 2022* available at- https://environment.delhi.gov.in/sites/default/files/inline-files/pwm_epr_1.pdf (last visited on Sep. ,2025).
[18] TAXTMI, *Flue gas: MOEFCC, CPCB, and SPCB-Roles and Responsibilities in mitigating Emissions(Mar. 15,2025)* available at- https://www.taxtmi.com/article/detailed?id=13800#:~:text=The%20MOEFCC%2C%20CPCB%2C%20and%20SPCBs%20play%20a%20critical%20role%20in,sustainable%20industrial%20practices%20in%20India (last visited on Sep. 16,2025).

ISSN: 2582-6433

from NGT can be made in the Supreme Court of India. The primary aim of the tribunal is to provide conservation and protection of the natural environment and its resources. The NGT was established by the National Green Tribunal Act, 2010 and is tasked with enforcement of environmental laws. The decisions made by the tribunal are binding in nature and are also empowered to grant compensation and other necessary reliefs.[19]

4. International Commitments and Influences:

There are three primary conventions which deal with Hazardous Substance Management. Below is the overview of these conventions:

1. Basel Convention

As the name itself suggests, it is aimed to limit and control the transboundary movements of hazardous waste substances and their disposal. It was adopted on 22nd March, 1989 in the Conference of Plenipotentiaries, dumping in developing and under-developed Nations. The objects of this convention are primarily aimed at protection of environment and human health from the detrimental effects of hazardous wastes including certain other wastes. The convention also aims to reduce generation of such hazardous wastes and also improve its management while restricting unfavorable or adverse transboundary movement of such wastes[20].

2. Rotterdam Convention

It was adopted on 10th September, 1998 in the Conference of Plenipotentiaries in Rotterdam, the Netherlands. Its aims are to promote collective responsibility and co-operation in regards with International trade of certain kinds of hazardous chemicals. The convention focuses on information exchanges and control and oversight of import and export of it, within the country. The convention is legally binding on its parties with respect to implementation of

[19] NGT available athttps://www.greentribunal.gov.in/faqs#:~:text=The%20Tribunal%20is%20tasked%20with,legal%20right%20relating%20to%20environment (last visited on Sep.17, 2025).
[20] BASEL CONVENTIONAVAILABLE athttps://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx (last visited on Sep.17, 2025).

ISSN: 2582-6433

the Prior Informed Consent[21].

3. **Stockholm Convention on Persistent Organic Pollutants**

   This convention focuses on POP, it was adopted by the Conference of Plenipotentiaries on 22nd May, 2001 in Stockholm, Sweden. It is aimed at ensuring human health and that of the environment from POPs as laid down in Article 1. It is a global treaty to safeguard human and environment health from the chemicals which have persistently longer endurance when compared with others and has affect on tissue level, endangering food cycle and health. POPs are carcinogenic in nature and can even adversely affect the immune and reproductive system leading to abnormal births and sometimes even damaging central and peripheral nervous systems.[22]

4. **Implementation in India**

   India has enacted laws which are compliant to international standards in dealing with hazardous substances. India has ratified the previously mentioned conventions aimed at controlling the transboundary movement of hazardous waste, regulating persistent organic pollutants (POPs), and managing the trade of certain hazardous chemicals and pesticides. India has enacted laws such as EPA, 1986, Hazardous Waste Rules, and is also involved in establishing vital oversight and regulatory bodies such as CPCB and SPCBs under the MoEFCC. These bodies are responsible for ensuring compliance through authorization, accident related information, and waste management mechanisms, including a waste management hierarchy.

5. Judicial Trends and Landmark Cases:

The Indian Judiciary up an active approach in dealing with environmental cases, it has widened the scope of Article 21 to also include rights to live in a healthy and pollution free environment making it a fundamental right. The disastrous tragedy that happened in Bhopal gave rise to increased instances of judicial activism and environmental

[21] ROTTERDAM CONVENTIONavailable athttps://www.pic.int/TheConvention/Overview/tabid/1044/language/en-US/Default.aspx(last visited on Sep.18, 2025).
[22] STOCKHOLM CONVENTIONavailable at-https://chm.pops.int/TheConvention/Overview/tabid/3351/Default.aspx (last visited on Sep. 19, 2025).

ISSN: 2582-6433

protection Public Interest Litigations. The Indian judiciary played a vital role in adopting principles such as that of Absolute Liability, Precautionary Principles, and Polluter Pay Principles. The Indian judiciary also played a vital role by granting compensation to the victims and environment conservation and protection when harmed or severely damaged. The laws regarding compensation were inadequate so the judiciary filled in the gap for it. NGT or National Green Tribunal is the court of first instance dealing with environment related cases. An appeal from NGT could be made in SC within a period of 90 days. NGT as the first court of first instance was established with the view to streamline litigation related to the environment and it is also suitable to deal with wide array of subjects with respect to the Environmental Protection.

In the landmark case of **M.C. Mehta v. UOI (Oleum Gas Leak case),** [23]the SC applied the principle of absolute liability and held that if any damages are caused as a result of hazardous activities then the victims have right to be compensated and further observed that even if due reasonable care was taken by the polluters yet they would be held liable for it. In the case of **Indian Council for Enviro-legal action v. UOI [24](Bicchiri village case)** the court applied for the first time the principle of Polluters Pays and the respondents were held responsible for damaging ecology as it violates the fundamental right of the citizens under article 21of the Constitution. The respondents industries were held liable to pay damages to the victims of the pollution. In the case of **Vellore Citizens welfare Forum v. UOI[25],** the SC held that although certain industries are vital for national growth and employment of people, it cannot be allowed to harm the ecological balance and they must follow the principles of Sustainable Development while operating their businesses. The court applied the Precautionary and Polluter Pays Principle and ordered compensation to the victims and to contribute funds for reversing the effect of damage to ecology.

6. Critical Analysis of the Existing Frameworks in the domain of hazardous substance management:

The legal framework in India is primarily based on the Environmental (Protection) Act, 1986 which is often referred to as the umbrella legislation which enables the

[23] M.C. Mehta v. Union of India, (1987) 1 SCC 395.
[24] Indian Council for Enviro-Legal action v. Union of India, (1996) 3 SCC 212.
[25] Vellore Citizen's Welfare Forum v. Union of India,(1996) 5 SCC 647.

ISSN: 2582-6433

formulation of rules and laws for the purpose of preservation and protection of the natural environment. Some of the examples of the act include the Hazardous waste (Management, Handling & Transboundary Movements) Rules, MSIHC rules, Chemical Accidents Rules and others. The laws in India dealing with hazardous substances are comprehensive in nature[26]. Its existing frameworks are also supplemented by Indian judiciary which applied the principles such as Precautionary and Polluter Pays. In the **M.C. Mehta v. U.O.I** Case the rule of absolute liability was adopted.[27] It led to the formation of legislation such as the Public Liability Insurance Act, 1991 to ensure compensation to the victims of the accidents in Chemical industries. There exists mechanisms both for enforcement through institutions such as the Pollution Control Board at central and state levels and also Indian Courts and redressal mechanisms. Furthermore Indian laws are compliant to international Commitments such as Basel Convention, Rotterdam Convention, Stockholm Convention, Minamata convention on mercury and others[28]. Together all these institutions and mechanisms cover a wide array of subjects ranging from manufacture to disposal of hazardous substances, from handling to trade, preparing and formulating emergency plans and policies and compensating the victims of accidents and pollution.However, implementing these frameworks has revealed a number of grey areas which weakens the effectiveness of existing regulatory frameworks for hazardous substances management. Some of those are as follows:

- Fragmented regulatory systems and also overlapping statutes [29]and agencies administer different waste streams (air, water, municipal, industrial, e-waste, bio-medical, plastics, etc.) . The enforcement mechanisms are split between central and state pollution control boards.

[26] Environmental Law Institute and National Law School of Indian University, Enforcing Haazardous Waste Rules in India (2014) available at- https://www.eli.org/sites/default/files/files-pdf/eli-nlsiu-enforcing-hazardous-wastes-rules-india-handbook.pdf#:~:text=ensuring%20compliance%20and%20effectively%20enforcing,various%20human%20health%20and%20environmental (last visited on Sep. 28,2025).

[27] Ishani Samajpati, *MC Mehta vs. Union of India (1986): case analysis*, IBLOGPLEADERS (Oct. 3, 2022) available at-https://blog.ipleaders.in/mc-mehta-vs-union-of-india-1986-case-analysis/#:~:text=strict%20liability%20and%20evolved%20a,activity%20should%20be%20absolutely%20liable (last visited on Sep.28,2025).

[28] Sandeepa Bhat & Dulung Sengupta, *Chemicals and Hazardous Waste Management: International Norms and their Implmentation in India*, 2 *RG 346(2025).*

[29] EARTH5R, *Waste Management in India: Challenges, Innovations, and Earth5R case studies* available at-https://earth5r.org/waste-management-india-solutions/#:~:text=Waste%20Management%20in%20India%3A%20Regulatory,Gaps%20and%20Policy%20Challenges (last visited on Sep.28, 2025).

ISSN: 2582-6433

- Weaker enforcement mechanisms owing to limited access to funds, understaffed and lack of technical expertise to monitor and inspect these Industries dealing with hazardous substances. [30]
- Legislation did not properly address legacy pollution. Such as 1984 Bhopal disaster pollution which has not been properly addressed. [31]In **Bhopal Gas Peedith Mahila Udyog Sangathan v. Union of India,** the Supreme Court directed Union of India and State of Madhya Pradesh that the huge toxic materials/waste lying in and around the factory of Union Carbide Corporation Ltd. in Bhopal, the existence of which was hazardous to health, needing to be disposed of at the earliest, to be disposed of within six months which should be strictly in a scientific manner which may cause no further damage to human health and environment.[32]
- The recycling capacity in India is lagging behind the amount of e-wastes it generates annually. According to estimates India generated 1.6 million tonnes of e-waste out of which only one-thirds of it was formally recycled. In India over 90% of e-wastes is processed by the informal sector by burning and acid bathing methods which release long lasting and harmful toxins in the environment.[33] Similar patterns hold for toxic battery dumps and scrap metal smelting.

Although these scenarios are covered by official rules and regulations but due to lack of effective enforcements they often go unnoticed and untraced.

These weaknesses have led to real world compliance gaps, although the Indian judiciary has time and again stepped up to supplement these regulatory gaps. A notable example is the 2020 Visakhapatnam gas leak (LG Polymers) case in which the National Green Tribunal stepped in suo-moto and ordered the company to deposit of Rs. Fifty crores

[30] Supra, note 22, Environmental Law Institute and National Law School of Indian University, at 9.
[31] CHEMSCOREavailable athttps://chemscore.chemsec.org/app/uploads/2023/10/Dow-2023-Controversies-.pdf#:~:text=%E2%80%A2%20In%20December%202021%2C%20survivors,Dow%20Chemical%20had%20failed%20to (last visited on Sep.28, 2025).
[32] Bhopal Gas Peedith Mahila Udyog Sangathan v. Union of India, AIR 2012 SC 3081.
[33] COUNCIL ON ENERGY, ENVIRONMENT AND WATERavailable at https://www.ceew.in/electrical-and-electronic-waste-recycling#:~:text=There%20has%20been%20rapid%20technological,this%20regard%2C%20urban%20mining%20of(last visited on Sep. 28, 2025).

ISSN: 2582-6433

with the government, explicitly to fund site cleanup and victim relief.[34] This ruling highlighted the fact that the businesses must provide relief for damages done and the fact that without judicial interventions some of these liabilities would be left unaddressed.

In conclusion, India's hazardous substance regulation covers broad legal aspects while incorporating principles and policies for environmental protection but it lacks structural and enforcement weakness. Multiplicity of regulations leads to fragmentation and weakens enforcement mechanisms. Also Lack of coordination between agencies leads to inefficiency and improper oversight mechanisms. Fragmented regulations and lack of coordination between agencies and authorities is also responsible for division of resources and ultimately leading to lack of it. Addressing these challenges will require not only updating the regulatory framework but also strengthening institutional capacity, clarifying overlapping mandates, and extending and integrating oversight into informal sectors.

While regulation is necessary it is also to be noted that balancing the need for industrial development with environmental protection and public health concerns is necessary. It will require a balanced approach while taking into account the economic benefits of industrial activities and ensuring that they do not harm environmental integrity and human health.

7. Emerging Challenges:

With the rise of Industrialisation specifically in certain Sectors such as electronic, automotive, and chemical, has paved the way for novel sources of pollution. The imminent threat of hazardous substances pollution has become a reality. Industrialisation is not the only source of emergence of newer pollution sources but there are other contributory factors as well such as climatic variations, EV related wastes, role of informal sector, waste imports, need for community involvement. Below is a detailed assessment of all these factors:

[34] Visakhapatnam gas leak (LG Polymers), 2020 S.C.C. Online.

ISSN: 2582-6433

1. **Industrialisation and Urbanisation:**

India is facing rapid change in its industrial landscape, which is ultimately leading to generation of over 4 million tonnes of hazardous waste annually[35].The rapid industrialization has led to contamination of urban environments by hazardous industries, with metropolitan regions becoming nodes for concentration of economic activities at significant environmental cost. With the dynamic growth of industries which led to hazardous urban contamination by hazardous Industries. As metropolitan cities are the hub for concentration of such economic activities, it comes with heavy environmental costs[36].Solid waste generated in urban areas has reached over 62 million tonnes annually, out of which the collection of these wastes is limited to only 43 million tonnes whereas the remaining is left untreated or end up in improper disposal sites. The number of waste production is increasing annually and rapidly, but India lacks proper waste collection infrastructure. Even the present capacity of waste collection is strained but with emergence of newer sources of hazardous contaminants it would be strained further leading to environmental challenges.[37]

2. **Rise of Lithium ion battery and EV related wastes:**

The Electric vehicle or EV revolution is here, but as we celebrate its arrival the issue of environmental effects and battery waste or e-wastes challenges becomes imminent. According to NITI ayog estimates suggest the need for recycling capacity of e-wastes to be increased from current 2 Gigawatt hours (as of 2024) to approx 128 Gigawatt hours by 2030[38].A typical EV battery (Lithium-ion type) has a life expectancy ranging from 6-10 years creating the need for disposal of it. Unlike as in the case of lead-acid batteries the recycling efficiency of Lithium-ion batteries is still in initial stages creating disposal of it harder.[39]The disposal and recycling of e-wastes is primarily led by the informal

[35] CEM ENGINEERSavailable athttps://cemengineers.com/blogs/managing-hazardous-industrial-waste-in-indian-cities/ (last visited on Sep.28, 2025).
[36] GEOSPATIAL WORLD, *Contamination of Urban Indian Environment by Hazardous Industries(Jan. 9,2009)* available at-https://geospatialworld.net/article/contamination-of-urban-indian-environment-by-hazardous-industries/(last visited on Sep. 28,2025).
[37] NEXTIAS, *Waste Management: Facts, challenges & Solutions* (Sep. 12, 2024) available at-https://www.nextias.com/blog/waste-management-in-india/ (last visited on Sep.28 ,2025).
[38] THE ECONOMIC TIMES, *Is India ready to recycle millions of end-of-life EV batteries*,THE ECONOMIC TIMES,*(Aug. 02,2024)* available at-https://economictimes.com/industry/renewables/is-india-ready-to-recycle-millions-of-end-of-life-ev-batteries/articleshow/112217778.cms (last visited on Sep.29,2025).
[39] IBEF, *Leading the charge:EV Battery Recycling in India(Jun. , 2025)* available at-https://ibef.org/research/case-

ISSN: 2582-6433

sector. The informal sector provides a competitive edge when compared to formal channels ultimately creating supply chain issues for authorised recycling plants. However, processing methods used by them often lack efficiency and safety standards disregarding proper care and concerns for environmental protection.[40]

3. **Hazardous waste imports:**

Transboundary movement of hazardous waste creates complex enforcement challenges despite comprehensive legal frameworks in the form of The Hazardous and Other Wastes (Management and Transboundary Movement) Rules 2016 which also governs export and import of hazardous wastes, but illegal imports which are untraced can be hazardous and if uncontrolled would lead to disastrous environmental impact. The perpetrators of it use multiple methods towards this end such as misclassification and disguised under different categories such as "scrap metals," "mixed scrap metals," or "used goods" makes it harder for customs officers to detect. The visual similarity between functional and non-functional electronic components further complicates detection efforts. Lack of proper identification methods leads to improper enforcement challenges. The informal sector facilitates illegal imports through unregulated channels and offers low cost processing of illegal wastes. Lack of coordination between different agencies and authorities such as Customs department, Ministry of Environment, Forest and Climate Change, CPCB result in delays in sampling, testing, and regulatory clearance.[41]

4. **Climate Change and disaster risk management overlap:**

Climate Change is no longer just a theory but a reality. Climate change, often responsible for natural disasters, can exacerbate hazards including floods, droughts, cyclones, and sudden onset events like flash floods and landslides. These natural calamities or hazards can adversely affect the handling of hazardous substances stored, being transported, or being processed and lead to

study/leading-the-charge-ev-battery-recycling-in-india (last visited on Sep. 29,2025).

[40] CEEW,*Lithium-ion Battery Waste Recycling*, available at-https://www.ceew.in/lithium-ion-battery-waste-recycling (last visited on Sep. 29,2025).

[41] Lalit Bhatt, Prof. J.S. Bisht, *Transboundary, Movement of E-waste: A comparative Regulatory Stud*,6 IJRPR,6140-6147(2025).

ISSN: 2582-6433

secondary disasters and hence intensifying the environmental damage.To ensure the preparedness for such potential disasters, Disaster Management Act, 2005 was enacted[42] but it must be integrated with The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules 1996 which is aimed at dealing with such unforeseen circumstances of industrial accidents. For better preparedness the Chemicals Accident Act must be integrated with Disaster Management Act to deal with secondary disaster scenario.

5. **Community awareness and participate gaps:**

Public awareness is necessary for proper waste management. It becomes critical for public participation to implement hazardous substance management. Educating the masses about the need for segregation, recycling-reducing-reusing benefits, and environmental impact. Socioeconomic and education are primary factors which play a huge role in public participation in this regard while other factors like language barriers and cultural norms also affect how waste management is viewed and considered. Marginalized communities face particular challenges due to poverty and infrastructure limitations. The absence of proper education and awareness campaigns has led the masses to have passive attitudes towards waste disposal and their role in it[43].

8. Recommendations and way forward:

Indian regulation post Bhopal gas tragedy is one of the comprehensive ones in which established legal and institutional frameworks have further strengthened oversight mechanisms, persistent implementation gaps, enforcement deficiencies, and emerging challenges necessitate comprehensive reforms. Although the path forward requires a multi-facet approach with the emergence of newer challenges such as battery related e-wastes, the need for reform in the legal landscape has been felt. There are several grey areas like the informal sector, overlapping regulations, lack of stringent enforcement mechanisms needs to be urgently addressed. Below are certain grey areas which need to be addressed:

[42] PIB, *Disaster Preparedness and Climate Resilience* (Dec. 10, 2024) available at- https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2082745&utm_(last visited on Sep.26,2025).
[43] Ajay Chhetri,*Impact of Public Awareness and Participation on sustainable Waste Management for Tadong Ward under Gangtok Municipal Corporation*, 44 LPI, 22698-22708(2024).

ISSN: 2582-6433

1. **Fragmented regulations:**

   The current regulatory frameworks are fragmented creating compliance and regulatory ambiguities. There are a number of overlapping regulations which furthers these ambiguities and it needs to be consolidated into a single hazardous substance management act which will not only reduce the ambiguities and vagueness but also place responsibilities on the necessary parties including the public authorities, reducing administrative and enforcement complexities.[44]This consolidated framework should include Environment Protection Act, Hazardous Waste Rules, Chemical Accidents Rules, and Public Liability Insurance Act.

   Although the 2024 amendment in Hazardous Waste management rules, single window clearances for disposal facilities has been opted[45], but this deals with only one aspect, a similar approach needs to be followed to cover all the aspects of the hazardous substances management.

2. **Institutional Strengthening:**

   State Pollution Control Boards (SPCBs) which are often termed as the backbone of hazardous waste regulation, yet it often faces hurdles such as being understaffed and under-funded. [46]The central government needs to establish a regulatory framework for all SPCBs providing them with a mechanism in which the funds are allotted to support SPCB operations. It could be achieved by establishing a dedicated Environmental Regulatory Fund which would be constituted by the funds from environmental compensation collections and industrial levies. This fund could be used by the SPCBs to hire expert staff and utilise modern technologies including Artificial intelligence to monitor and establish regional testing facilities.

[44] LEGAL SIMPLIFIED,*Government Introduces Amendments to Hazardous and other wastes Management Rules(Mar. 19,2024)* available at-https://www.legalitysimplified.com/government-introduces-amendments-to-hazardous-and-other-wastes-management-rules/ (last visited on Sep.26,2025).

[45] PIB, *Environment Ministry Notifies Hazardous Waste Management Rules, 2016* available at-https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=138521& (last visited on Sep. 26, 2025).

[46] CEEW,*How are India's State Pollution Control Boards Adapting to Evolving Workloads and Roles* available at-https://www.ceew.in/publications/how-are-state-pollution-control-boards-addressing-workload-resources-and-financial-challenges-by-innovative-functional-practices (last visited on Sep. 27,2025).

ISSN: 2582-6433

3. **Environmental Relief Funds (ERF)**

   The Environment Relief Fund (ERF) needs urgent overhaul to ensure effective utilisation of funds and resources currently the ERF suffers from poor disbursement mechanisms and lack transparency.

4. **Integration Informal Sector:**

   Integrating informal sectors is a necessity it could be done by giving out licences and recognitions to waste pickers, extending them social security and providing them with training and other necessary incentives.[47]

5. **Technology Integration:**

   Technology must be integrated in the monitoring process for better oversight and ensuring compliance. Using live digital tracking systems to manage wastes. The state of Gujarat has adopted this method in the form of Vehicle Location Tracking System (VLTS) demonstrating the untapped potential of GPS-enabled monitoring. The system tracks 700+ trucks in real-time, preventing illegal dumping and ensuring waste reaches designated facilities. This model should be replicated nationwide through the NHWTS platform[48].Also the need for real-time Hazardous waste generation, transportation and disposal monitoring has been realised. For this purpose a monitoring dashboard at national level should be implemented. This could be accomplished through the Central Pollution Control Board's National Hazardous Waste Tracking System (NHWTS).[49]

6. **Extended Producer Responsibility(EPR) Framework:**

   The Extended Producer Responsibility Framework should be further strengthened to include informal sectors, stricter EPR targets and penalties for non compliance, enhanced monitoring and to also provide incentives for circular economy.

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[47] PIB,*Recycling of E-waste* (Aug. 01,2024), available at https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=2040028#:~:text=Ministry%20has%20comprehensively%20revised%20the,These%20rules%20also%20promote (last visited on Sep. 27,2025).

[48] Himanshu Kaushik, *Gujarat introduces real-time VLTS for disposal of Hazardous industrial waste*, THE TIMES OF INDIA,(Aug. 12, 2022) available at-https://timesofindia.indiatimes.com/city/ahmedabad/gujarat-introduces-real-time-vlts-for-disposal-of-hazardous-industrial-waste/articleshow/93517009.cms (last visited on Sep.27,2025).

[49] CENTRAL POLLUTION CONTROL BOARDavailable at- https://nhwts.nic.in/nhwtsweb (last visited on Sep.27, 2025).

ISSN: 2582-6433

7. **Financial Mechanisms: Sustainable Funding Models:**

   A Hazardous Substance Cess levied on imports and domestic production would generate dedicated funding for regulatory activities, research, and victim compensation. This cess should be differentiated based on substance toxicity and environmental persistence, creating market incentives for safer alternatives. Green bonds for environmental remediation would mobilize private capital for cleanup of contaminated sites. The government should provide credit enhancement mechanisms to make such bonds attractive to institutional investors.

   The recent proposal for Remediation of Contaminated Sites Rules, 2024 provides a regulatory framework for such initiatives[50].

8. **Local Emergency planning Committee:**

   LEPC should be established in all industrial districts following the example of USA. This committee will be constituted comprising of first responders, industry representatives, and community members. These committees would develop site-specific emergency response plans and ensure regular training of local personnel.[51]

9. **Compensation and liability reforms are needed:**

   Victim compensation proceedings should be speedy through a no-fault compensation system similar to motor accident claims tribunals. The enhanced ERF should provide immediate relief to victims while pursuing recovery from responsible parties through separate legal processes.

9. Conclusion

The Hazardous Substance management and regulations have matured since the trigger event of Bhopal Gas Tragedy, the regulations are comprehensive and encompasses the full lifecycle of hazardous substances. The basis of these regulations can be traced back to Constitutional provisions under Articles 21, 48A, and 51A (g). A number of statutes

[50] Nitin Kumar, *Govt. proposes to introduce new rules to clean up contaminated sites* (Aug. 26, 2024) available at-https://www.business-standard.com/india-news/govt-proposes-to-introduce-new-rules-to-clean-up-contaminated-sites-124082600929_1.html (last visited on Sep.27, 2025).

[51] EPAavailable at**https://www.epa.gov/epcra/local-emergency-planning-committees** (last visited on Sep.27, 2025).

ISSN: 2582-6433

like the Environment Protection Act, 1986 to the Hazardous and Other Wastes Rules, 2016 have become grundnorm for further regulations. Establishment of Institutional bodies such as the MoEFCC, CPCB, SPCBs, and the National Green Tribunal have progressively strengthened oversight and enforcement. However, these regulations are not sufficient for all the issues and leave some grey areas which is needed to be addressed, overlapping regulations and weak single-window systems weakening compliance, while under-resourced SPCBs struggle to monitor complex industrial landscapes. Novel waste streams ranging from lithium-ion batteries to pharmaceutical effluents and microplastics expose critical gaps in existing rules. Illegal transboundary trade and legacy contamination at sites such as Bhopal continue to threaten public health and ecosystems. Climate Change disasters further intensifying the risks by mobilizing stored hazardous substances, while community awareness and participation remain insufficient.

The way forward demands proactive, adaptive governance. Consolidation legislation into a unified Hazardous Substances Management Act, along with digital single-window clearance mechanisms, will streamline regulation. Institutional strengthening through dedicated funding, real-time monitoring dashboards, and empowered local committees will enhance capacity. Technological tools such as GPS-based tracking can ensure transparency, accountability, and better coordination, while formal inclusion of the informal sector and robust community right-to-know measures will foster broader engagement.

While Regulation is necessary, a balanced approach is to be adopted for sustainable development, ensuring protection of both the environment and industries. The legislative framework integrates prevention, preparedness, and resilience for better governance ecosystem of Hazardous Substance Management.