ANALYSIS OF THE DUTIES OF OPERATORS IN BIOMEDICAL WASTE MANAGEMENT RULES AND REVISED GUIDELINES FOR COMMON BIO-MEDICAL WASTE TREATMENT AND DISPOSAL FACILITIES

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ABSTRACT

In accordance with the Biomedical Waste Management Rules and revised guidelines 2025, this study examines the responsibilities of operators of common biomedical waste treatment and disposal facilities (henceforth CBWTF).

It is the duty of the CPCB, as a national prescribed authority, to formulate rules or recommendations pertaining to biomedical waste management in order to enhance the efficacy of the regulations, as outlined in Schedule III. Both humans and ecosystems are vulnerable to the dangers posed by biomedical waste. Improper collection and poor management of infectious biomedical waste not only affect individuals on hospital premises but also the world outside, including ragpickers and animals, and unethical activities related to the sale of reused injections and expired medicines are also observed. Consequently, there needs to be more open and accountable regulation of this waste's collection, treatment, and disposal. There are two important stakeholders in these rules who bear the primary responsibility for ensuring proper handling and management of the waste. Firstly, an occupier, and secondly, an operator, which is basically referred to as CBWTF, whose main role is to collect the waste in a vehicle and take it to their treatment plant for the removal of the infectious and hazardous materials from the waste and disposed of according to Schedule I of BMW rules 2016.

This research study is structured into three sections, the first two of which will examine the restrictions and subsequent development of operator obligations as outlined in the Biomedical Waste Regulations in 1998 and 2016. In addition, the updated guideline from 2025 details the operator's responsibilities under BMW guidelines 2016, which are more detailed when it comes to collecting, transporting, treating, and disposing of hospital waste. Additionally, the article emphasises the benefits of CBTWFs, which include significant changes in biomedical waste management towards greater responsibility, better monitoring systems, and standardised operating methods that adhere to regulations that guarantee environmentally friendly

waste management. The article also discusses the future of sustainable waste management via the use of AI and the Internet of Things in the day-to-day life of occupiers and CBWTF.

Keywords: Global Positioning System, infectious medical waste, handling, sustainable waste management.

Introduction

Waste is considered in the general environmental sense to be any substance or material that is discarded, planned to be thrown, or is required to be disposed of by an individual because it has no more use to the holder. It includes solid, liquid, or gaseous substances that are unwanted or unusable in their current form.[1]

Human and animal medical diagnostics, treatments, and immunisations, together with associated research, the manufacturing, and testing of biological products, all contribute to what is known as biomedical waste.[2] Hospital care facilities generate two types of waste: general waste and hazardous/ infectious medical waste, which accounts for approximately 10% to 25% of total healthcare waste, with the remainder being general non-hazardous waste.[3]

History of the development of legislation related to biomedical waste

In the early stages, healthcare waste was largely managed as general municipal waste, without specific regulatory oversight. Healthcare facilities do not segregate the infectious medical waste from their general waste and dispose of this waste either in the open field or at municipal dumping sites, which poses the risk of contamination of municipal waste, which affects public health and causes environmental pollution, such as soil pollution, air pollution and even water pollution. The escalation of human immunodeficiency virus/AIDS cases and other acute health concerns like infection in the skin and eyes, asthma, and poisoning, etc., has brought the issue of improper management and disposal of medical waste into the main focus at international conferences.[4]

[1] Org. for Econ. Co-operation & Dev. (OECD), *Core Set of Environmental Indicators* (1994); U.N. Env't Programme (UNEP), *Global Waste Management Outlook* (2015).
[2] Bio-Medical Waste Management Rules, 2016, r. 3(1)(d), Gazette of India, Extraordinary, Part II, § 3(ii), Notification No. S.O. 3436(E) (Mar. 28, 2016) (India).
[3] World Health Organisation, *Safe Management of Wastes from Health-Care Activities* (2d ed. 2014).
[4] Sanjay Joshi, Biomedical Waste: From Neglect to Regulation, *The Perfect Voice* (June 6, 2025), https://www.theperfectvoice.in/post/biomedical-waste-from-neglect-to-regulation.

Biomedical waste management was first discussed in 1983 at a conference in Berlin presided over by the WHO's regional office for Europe. Later, syringe-related cases were reported due to the reuse and improper disposal of contaminated syringes, which played a major role in shaping biomedical waste management regulations by highlighting the risks of infection transmission and the requirement for a proper treatment and disposal systems.

In India, there were no environmental laws or regulations related to biomedical waste management until 1998. Due to a lack of awareness of the detrimental effects of biomedical waste on the environment and public health, it was disposed of alongside municipal waste, leading to many health-related issues among citizens, especially those who came into direct contact with it. An NGO brought a case on Unregulated Medical Waste Management in Delhi, which drew the attention of the Hon. Supreme Court. The Court directed the Government of India to appoint a committee of experts and develop a clear legislative outline for the classification and proper management of medical waste.[5] This ruling allowed lawmakers to begin filling up the loopholes in biomedical waste management regulations that had previously gone unchecked.

The first major central legislation addressing environmental concerns was the Environment (Protection) Act, 1986, [6] passed after the industrial disaster in Bhopal, Madhya Pradesh and in response to international commitments ratified by India under Article 253[7]. Under this Act[8], the central government was conferred wide-ranging powers to frame rules, issue notifications, and implement measures for environmental protection. Thus, on July 20, 1998, the Bio-Medical Waste (Management and Handling) Rules, 1998, were notified in the official gazette and subsequently became law. Rather than being ordinary executive orders, these regulations are delegated legislation that has the power of law. Those who are subject to these regulations are those who produce, acquire, store, transport, treat, dispose of, or otherwise deal with biological waste.

This rule comprises 14 rules, Schedule VI, and Form V. Later, certain modifications were made in 2000, 2003, and 2011 to address problems such as rising biomedical externalities,

[5] Dr. B.L. Wadhera v. Union of India, (1996) 2 S.C.C. 594 (India).
[6] *The Environment (Protection) Act, 1986*, No. 29, Acts of Parliament (India).
[7] INDIA CONST. art. 253.
[8] *Environment (Protection) Act, 1986*, No. 29 of 1986, §§ 6, 8, 25 (India).

enforcement failures, and technological evolution in waste management.[9]

Five main processes are involved in managing biomedical waste effectively: sorting trash as it is generated, collecting it into various categories, transporting it to treatment facilities, treating it according to the procedures specified in Schedule 1, and finally disposing of it properly. The success of effective management primarily depends on two stakeholders: the occupier, who generates and initially manages the waste and is responsible for their premises and operations. Any facility that provides medical care, such as a hospital, clinic, veterinary clinic, pathology lab, blood bank, or similar service, falls under this category.[10] and next, the treatment facility operator, who is responsible for the safe treatment of waste using the best available treatment methods and its eventual disposal in line with established regulations and guidelines.

In the earlier BMW rules of 1998, the duties of operators were defined in general, vague terms. The main role of the operator was to properly treat and dispose of waste consistent with Schedule I, such as incineration, autoclaving, and microwave treatment, and to follow the prescribed methods in Schedule V.

However, this obligation has been short on procedural clarity, specified monitoring mechanisms, and enforceable accountability, which have been the main reasons for the ineffective implementation of these rules.

Challenges encountered in implementing the 1998 rules.[11]

- The lack of knowledge and training regarding rules among healthcare workers, particularly staff in smaller clinics and rural hospitals, as well as CBTWF staff, was evident in their improper waste segregation and handling protocols.
- **Poor segregation practices:** Due to over-categorisation of wastes and improper segregation by occupiers, the efficiency of this system is reduced.
- Some operators avoid proper disposal methods and do not follow the prescribed standards of

[9] P.P. Gupta et al., The Efficient Disposal of Biomedical Waste Is Critical to Public Health: Insights from the Central Pollution Control Board Guidelines in India, 15(10) *Cureus* e47303 (2023), https://doi.org/10.7759/cureus.47303
[10] Bio-Medical Waste (Management and Handling) Rules, 1998, r. 3(8), G.S.R. 343(E) (India).
[11] Int'l Clinical Epidemiology Network (INCLEN), *Healthcare Waste Management in India: A Situational Analysis (2002–2004)* (INCLEN Rep., 2004).

treatment plants to save money, leading to unsafe dumping or reuse.

- Some operators and occupiers have inadequate record-keeping, in which they either falsify the data of waste, and some operators and occupiers have no authorisation from the prescribed authority for this purpose.

- The occupier cannot adequately monitor the operator's handling of the waste collected from the occupier for proper treatment and disposal. Improper garbage disposal methods and even unlawful dumping might result from this.

- Relatively few facilities were available to treat biomedical waste. Not all areas have access to CBWTFs, which are needed for effective management.

- Treatment technologies used by operators, such as autoclaving and incinerators, are either outdated or not functioning as per the standard prescribed in these rules.

- The healthcare facilities, particularly smaller clinics and non-bedded facilities, are not compliant with these rules and often operate outside effective regulatory monitoring. Many facilities go long periods without audits or compliance checks, which leads to weaker enforcement.

- There are some structural problems in these rules, like the absence of effective tracking mechanisms, and inadequate coverage of emerging healthcare practices such as vaccination camps, home-based care, and diagnostic laboratories.

- Waste generation has increased with population growth and the escalation of the health industry, straining management capacity.

These limitations necessitated replacing the 1998 BMW Rules with the 2016 BMW Rules to address the aforementioned gaps through stricter guidelines, enhanced monitoring, real-time tracking of waste, and expanded coverage.[12] The new BMW Rules of 2016 show the transformative changes from a procedural to a performance-based regulatory framework. While the 1998 Rules focused primarily on establishing baseline procedures, the 2016 framework integrates technology, accountability, and sustainability principles into biomedical waste governance. Any and all entities engaged in the production, acquisition, storage,

[12] Bio-Medical Waste Management Rules, 2016, G.S.R. 343(E) (India), superseding the Bio-Medical Waste (Management and Handling) Rules, 1998.

transportation, processing, or disposal of biological waste are subject to its scope and application. This includes[13]

- Hospitals (public and private)
- Ayurvedic Hospitals
- Homoeopathic Hospitals
- Unani/Siddha Hospitals
- Clinics, dispensaries, and nursing homes
- Research laboratory and institutions
- Blood banks and vaccination camps
- Veterinary hospitals and animal research centres
- Medical colleges and training institutions
- Home healthcare activities (e.g., dialysis, insulin injections)
- Health camps, surgical camps, and immunisation drives.

Obligation of the common biomedical waste treatment and disposal facility

The BMW rules 2016 represent a paradigm shift by institutionalising the operator as a **core compliance agent**. The role of operators is more proactive, accountable, and technology-driven.

All operators are now responsible for:

- **Collection → transportation → treatment → final disposal**
- Ensuring **continuity and integrity** across the waste lifecycle

[13] Bio-Medical Waste Management Rules, 2016, r. 2, G.S.R. 343(E) (India).

This reflects the adoption of a **"cradle-to-grave" regulatory model** that aligns with global environmental governance norms of WHO guidelines.

Rule 6 outlines the multiple responsibilities for every operator to-

a) must comply with all procedures and standards prescribed under the regulation for the safe handling of untreated waste collected from HCFs and dispose of treated waste in an environmentally sound manner.

b) Collection of segregated medical waste of HCFs must be collected in a timely and regular manner,

c) Establishing barcoding systems and implementing Global Positioning System (GPS) tracking in authorised vehicles for safe waste handling. This enables monitoring of waste movement from source to disposal.

d) Immediately provide the information to SCPB/ PPC regarding the violation of segregation of wastes according to Schedule I by HCFs.

e) Workers and staff should be trained annually and during induction on waste management practices,

f) Assisting the HCFs in conducting training for their staff and workers regarding biomedical waste management

g) Mandatory medical screenings for all employees and contractors are conducted during induction and annually. Workers must be vaccinated against tetanus and hepatitis B, as these two diseases can be transmitted in this field. Maintained the records of these vaccinations on file.

h) Supplying enough and suitable PPE to ensure the occupational safety of all personnel working in CBWTFs.

i) Notify the appropriate authorities of any significant accidents, including those involving fires or explosions that occurred while managing waste, as well as any corrective measures taken and any relevant documents (including nil reports), using Form I. Additionally, be sure to include this information in the annual report.

j) Always keep a record of all the treatment equipment used for waste treatment methods in your possession. This record should include the following information: batch weight, waste types treated, treatment date and time, cycle length, and total operating hours.

k) Occupier can verify from the CBWTFs operator regarding the treatment of their waste according to the standard prescribed.

l) upload the authorisation details, treatment records, and annual reports, etc., on its website.

m) Only authorised recyclers should be given the recyclable materials, including plastics and glass, from biomedical waste after the waste has been treated by autoclaving, microwaving, mutilation, or shredding, as applicable.

n) To provide support services to the occupier by supplying non-chlorinated, coloured plastic bags.

o) To ensure uninterrupted collection services, the CBWTF must collect the waste on holidays in order to prevent hazardous waste from accumulating.

p) Maintain all records pertaining to the functioning of their various treatment facilities for a duration of five years.

q) Within two years of this notice, update current incinerators to meet the secondary chamber's retention time requirements, as well as for Dioxin and Furans.

In the post-COVID era, with further development of healthcare infrastructure, population growth, and increased healthcare activities, higher volumes of biomedical waste have resulted. Given the adverse effects on human and environmental health, biomedical waste management must be improved and controlled. The Revised Guidelines for CBWTFs, 2025, published by CPCB on April 12, 2025, aim to strengthen the regulatory framework in response to new environmental concerns and operational challenges. These guidelines promote sustainable waste management practices, raise operational standards, and strengthen compliance. Currently, 234 CBWTFs are operational across India, and 30 are under construction.[14]

[14] Legality Simplified, CPCB Issues New Guidelines for Biomedical Waste Plants, *Legality Simplified.*

Advantages of Common Biomedical Waste Treatment and Disposal Facilities[15]

1. Common Biomedical Waste Treatment Facilities (CBWTFs) perform a central role in strengthening management by providing technologically sound treatment technologies and disposal methods.

2. It takes away the waste handling and disposal process from individual healthcare establishments, which significantly reduces the burden on occupiers to make their own biomedical treatment facility, which is cost-effective and also protects them from improper on-site disposal of waste.

3. CBWTFs protect the environment from improper disposal activity, illegal dumping, and open burning of medical waste by treating this waste in an approved standard. It reduces the burden of landfill by minimising waste and recycling.

4. The market of CBWTF is growing with the expansion of healthcare facilities and the growth of the population in India. The need for more CBWTF increases demand in the environmental services market. In 2024, this market was valued at **USD 286.98 Million**[16] showing growth in the economic field.

5. CBWTF also provide job opportunities to skilled and non-skilled persons, as this system performs a number of tasks, from the collection of waste, transportation, and administrative work. A large no. of staff is needed for effective management.

Key feature of the Revised Guidelines for CBWTFs, 2025

The revised CBWTF guideline 2025 strengthens earlier provisions by refining locational, infrastructural, operational, and technological standards. The main features are-

1. Operation and establishment of a Common Biomedical Waste Treatment facility

CBWTF cannot be established without prior authorisation from the competent regulatory

https://www.legalitysimplified.com/cpcb-issues-new-guidelines-for-biomedical-waste-plants/ (last visited Apr. 29, 2026).

[15] Corpseed ITES Pvt. Ltd., Common Biomedical Waste Treatment and Disposal Facility Setup, *Corpseed* (n.d.), https://www.corpseed.com/service/common-biomedical-waste-treatment-and-disposal-facility-setup (last visited Apr. 29, 2026).

[16] IMARC Group, India Biomedical Waste Management Market, *IMARC Group* (n.d.), https://www.imarcgroup.com/india-biomedical-waste-management-market (last visited Apr. 29, 2026).

authority after scrutiny of project proposals and environmental safeguards. In addition, the operator must obtain valid consents under the Water Act[17] and the Air Act[18], ensuring that effluents and emissions remain within permissible limits. Depending on project scale and categorisation, environmental clearance under the applicable EIA framework is also required.[19] Furthermore, approvals from local governing bodies such as municipal corporations, gram panchayats, or land-use authorities are mandatory to ensure compliance with zoning and spatial planning regulations. Together, these legal instruments create a comprehensive environmental governance structure for the safe and lawful operation of CBWTFs.

2. Location Criteria (Spatial Planning and Environmental Safety)

The guidelines emphasise **environmental buffering and risk minimisation** in siting CBWTFs. Facilities must preferably be established in **designated industrial areas**. A **minimum buffer distance of 500 meters** from residential and ecologically sensitive zones is required. In exceptional cases, this buffer may be relaxed, provided it remains above 250 meters, to reduce human exposure risk. This is based on the precautionary principle for public health protection and environmental justice.

3. Land Requirement Norms

To ensure operational efficiency and compliance, a minimum land requirement for establishing CBWTFs is typically 1 acre. Facilities may be developed on **multiple plots**, but must remain within a unified operational system. In special cases, the land requirement may be relaxed to 0.5 acres, particularly for compact or urban facilities.

4. Coverage Area and Service Radius Regulation

CBWTFs operate under a **regional service model** that provides service **up to 75 km** from the facility. In exceptional cases, extension up to 150 km is permitted if the healthcare bed density is low (<10,000 beds). If bed capacity exceeds **10,000 within a 75 km radius**, additional CBWTFs must be established. This feature prevents overburdening of single facilities and ensures equitable service distribution.

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[17] *Water (Prevention and Control of Pollution) Act,1974,* No.6 of 1974 §§ 25–26 (India).
[18] *Air (Prevention and Control of Pollution) Act, 1981*, No. 14 of 1981, § 21 (India)
[19] Environmental Impact Assessment Notification, 2006, S.O. 1533(E) (India), issued under Environment (Protection) Act, 1986.

5. Treatment technologies-

Facilities must use approved treatment technologies, such as-

- Incineration is a high-temperature controlled combustion process in which solid organic biomedical waste is thermally oxidised at approximately 800–1200°C, converting it into gaseous emissions and a stable inorganic ash residue**.** This process achieves an 85–95% volume reduction, significantly reducing landfill burden.[20] The installation of flue gas treatment units and Continuous Emission Monitoring Systems (CEMS) is compulsory to minimise Air pollution.

- Plasma Pyrolysis- it is a modern thermal treatment technology used in place of an incinerator. It employs a **plasma arc system** to decompose biomedical waste at extremely high temperatures, typically **greater than 1200°C**, in an **oxygen-starved environment**. Waste is broken down to produce syngas (primarily hydrogen, carbon monoxide, and methane) and a stable solid slag.

- Autoclaving - Autoclaving is a **moist heat sterilisation technique** that operates on the principle of saturated steam under pressure, typically at 121°C for 60 minutes or 134°C for 45 minutes.[21]

- Microwaving- Microwave treatment utilises **electromagnetic waves of approximately 2450 MHz** to generate internal heat within waste materials, leading to microbial destruction.[22]

- For wastewater treatment, an efficient effluent treatment plant is required to be set up, and after treatment, the treated water can be reused.

- Vehicle cleaning facilities should be provided to clean the authorized vehicle after collecting the waste.

[20] V. Gautam, R. Thapar & M. Sharma, Biomedical Waste Management: Incineration vs. Environmental Safety, 28 *Indian J. Med. Microbiol.* 191–92 (2010), https://doi.org/10.4103/0255-0857.66465
[21] Y. Thakur & S.S. Katocha, Emerging Technologies in Biomedical Waste Treatment and Disposal, 29 *Chem. Eng. Trans.* 787–92 (2012).
[22] M.R. Capoor & K.T. Bhowmik, Current Perspectives on Biomedical Waste Management: Rules, Conventions, and Treatment Technologies, 35(2) *Indian J. Med. Microbiol.* 157–64 (2017).

6. Collection, Transport, and Digital Traceability Systems

CBWTF's operator used an authorised vehicle to collect segregated waste from HCF in accordance with the prescribed colour-coding system. Any failure of the HCF part related to waste segregation must be reported to the appropriate authority.[23]

Authorised CBWTF vehicles must be equipped with GPS to track them in real time, ensuring accountability and preventing illegal dumping. These vehicles are required to have a separate cabin for the staff and driver who collect waste from HCF, and a separate compartment for storage of waste according to its colour-coded bag to prevent cross-contamination. Vehicle must contain a biohazard symbol. The vehicle waste storage area is designed to facilitate easy washing and disinfection for safety purposes. Barcoding of waste containers is necessary for auditing waste collection and tracking waste movement from HCF to CBWTF premises, thereby reducing the risk of informal leakage or mismanagement of hazardous biomedical waste.[24]

7. Occupational Safety and Workforce Protocols

CBWTF must ensure occupational safety for employees who are engaged in hazardous biowaste handling. The guidelines mandate that every worker in direct contact with waste must be provided with personal protective equipment. They should also provide regular training programmes to enhance operational preparedness. for the workers related to safe handling practices, waste segregation procedures and emergency response mechanisms.

8. Infrastructure set up

CBWTFs must set up the infrastructure in a big area, it has-

a) Separate dedicated rooms for the installation of all treatment plant equipment.

b) A distinct main waste storage area for unloading and temporarily storing waste received from HCF coming through an authorised vehicle of CBWTFs.

[23] Bio-Medical Waste Management Rules, 2016, r.9 G.S.R. 343(E) (Mar. 28, 2016) (India).
[24] QHSE Alert-Legal Update, Common Bio-medical Waste Treatment Guidelines 2025, QHSE Alert, https://legalupdate.qhsealert.com/common-bio-medical-waste-treatment-guidelines-2025/ (last visited Apr.29, 2026).

c) A separate storage area for treated waste, which is acquired after the treatment process and segregated according to its disposal method.

d) An administrative room is required where the functions of administration, like record keeping, billing, and compliance documentation, are carried out.

e) Set up the generator as the backup for the electricity in order to maintain power supply for uninterrupted operation of the treatment technology even in outages.

f) There should be a big vehicle parking area for the loading and unloading of waste.

g) First aid box should be placed in many places of facilities so it can be used in the event of an accident.

h) Facilities are required to have a CCTV camera installed in the critical zones and link their system to the national pollution control board online monitoring portal.

9. Penalties provision

CBWTFs must adhere to the prescribed standards for technologies used for treatment and emission control, waste handling, and data reporting methods as provided by the Central Pollution Control Board. Non-compliance by CBWTF operations may attract penalties, environmental Compensation, suspension of CBWTF operations, and legal proceedings initiated by the prescribed authority.[25] Compensation fees may increase several times for repeated infractions, and in extreme circumstances, these facilities may be asked to close completely, thereby restricting future eligibility.[26]

Future Advancement under the BMW Rules-

In the era of the internet and advanced technologies, we need to integrate Artificial Intelligence into our waste management activities to make the implementation of the BMW Rules 2016 more efficient, transparent and sustainable. This addresses the issues of data-driven management, automated waste sorting, and real-time monitoring identified in the BMW Rules 2016. Smart sensors and RFID tagging in container bins can trigger an automatic response

[25] Environment (Protection) Rules, 1986, r. 15, G.S.R. 712(E) (India).
[26] Cent. Pollution Control Bd., *Guidelines for Imposition of Environmental Compensation against Healthcare Facilities (HCFs) and Common Biomedical Waste Treatment Facilities (CBWTFs)* (2019) (India).

when 2/3 of the bins are filled, preventing waste from overflowing. AI analytics allows for automated sorting verification at the source.[27] Geospatial technology and remote sensing can be used in CBTWF vehicles for visual route planning, generating heatmaps to show high-waste zones, and even including citizen-facing portals to report issues or schedule pickups.

Blockchain technology can be used to track waste from generation to disposal, recording it in real time, enabling tamper-proof audit trails, and helping prevent illegal dumping and mishandling. This will help promote transparency and accountability among the persons involved in this process.[28]

Additionally, IoT-derived predictive analytics can enable CBWTF operators to forecast waste flow, optimise incineration or autoclaving capacities, and reduce environmental emissions through better load management.[29] Overall, these technologies improve safety and efficiency and promote a shift toward sustainable, data-driven environmental management in biomedical waste systems.

CONCLUSION

The governance of biomedical waste has evolved from 1998 to the present into a more structured and environmentally responsive regulatory regime. These new Guidelines of 2025 have strengthened the legal responsibilities for CBWTFs and operationalised technical and infrastructural standards to ensure that the regulatory objectives of BMW 2016 can be translated into measurable field-level compliance. The precautionary principle and strict liability are imposed on CBWTFs to make them more careful and responsible in handling and disposing of waste, and to hold them more accountable through regular monitoring and strict penalties for violations of these rules. However, there are still many challenges in real-life implementation, especially in rural areas, uneven availability of CBWTFs, and inadequate technological integration in CBWTFs.

In conclusion, the existing rules of 2016 and guidelines are robust and efficient, but their success heavily depends on the proper enforcement, better institutional capabilities and

[27] M. Verma & S. Agrawal, IoT-Based Intelligent Segregation of Biomedical Waste, 14(2) *J. Hazard. Waste Mgmt.* 122–28 (2021).
[28] Hardik A. Gangadwala, Hiteshkumar J. Lad & Shaileshkumar M. Gheewala, The Role of IoT in Enhancing Biomedical Waste Management: A Review, 4(2) *VNSGU J. Res. & Innovation* (2025).
[29] P. Kumar & A. Raj, GPS-Based Tracking and Monitoring of Biomedical Waste Transportation, 11(1) *Int'l J. Healthc. Info. Sys.* 33–40 (2020).

adoption of new best available technologies, including IoT and Artificial Intelligence technology and sustainable waste minimisation, waste reuse and recycling principles to ensure safe waste management practices in India.