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Informal Waste Sector in Urban India: A Review of Waste Management Policies and Their Impact

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Abstract

Nearly 70% of India's 62 million tonnes of municipal solid garbage are improperly handled, creating serious problems for the country's environment, public health, and socioeconomic standing. The present management systems are under a great deal of strain due to the fast urbanisation and economic expansion that increase waste creation. Notwithstanding the quick economic growth, efficient waste management has proven challenging, suggesting a weakness in development plans. In this article, discuss the effects of waste management regulations in metropolitan India. The analysis shows that there are many serious issues with India's solid waste management system, such as low public awareness, weak policy enforcement, inadequate infrastructure, and a lack of finance. Despite initiatives such as SBM, Smart Cities Mission, and SWM Rules (2016), gaps between policy and practice persist, leading to overflowing landfills, hazardous dumping, and severe public health risks. The informal sector, though under recognized, plays a vital role in recycling and waste reduction. Integrating this sector into formal systems, along with adopting decentralized composting, biogas, and modern waste-to-energy technologies, can enhance efficiency. Ultimately, sustainable MSWM demands inclusive governance, technological innovation, and collective participation.

Keywords; Municipal Solid Waste, Informal Waste Sector, SWM Rules (2016), Swachh Bharat Mission, Smart Cities Mission.

INTRODUCTION

One of the biggest and most pressing problems in the world today is "solid waste management, or SWM". It is possible to evaluate the problem's criticality since solid waste is strongly linked to twelve of "the United Nations' seventeen Sustainable Development Goals (SDGs)". In emerging and transitional economies like India, this issue is made worse by the country's increasing urbanisation and population [1]. Fortunately, informal labourers in developing nations—particularly in metropolitan areas—have an environmental brigade that keeps the nation from drowning in its own filth. This informal sector supports the circular economy's objectives and aids in achieving the SDGs. It is exemplified by cheap labour costs, low standards for procedures, and low costs for technology and processes [2]. For example, encouraging recycling keeps recyclable garbage out of landfills and the ocean, creates jobs for the underprivileged, and lessens the demand for new raw materials [3], [4].

For further explanation, home or municipal garbage resulting from various human activities accounts for a significant amount of the total solid waste. In developing nations like India, households generate the majority of municipal solid waste (MSW), followed by commercial establishments and market areas [5], [6]. The ecology may be ruined and illnesses can flourish in poorly handled municipal trash. Government organisations have mostly been able to focus on the collection of MSW due to capacity constraints and the size of their operations, despite the fact that this is a crucial problem that needs daily attention [7]. Since a significant amount of the garbage that they collect actually ends up in landfills without any substantial processing, waste processing after collection is an issue that desperately needs attention and redesign.

However, the informal sector has become responsible for the whole volume of recyclable solid waste and is far more skilled at this [8], [9]. As a result, the informal sector provides a great deal of assistance for the circular economy (CE), whose cross-cutting character aids in the accomplishment of several objectives including reduced harmful emissions from disposal sites, cleaner waterways, and responsible production and consumption [10].

A large amount of the waste produced in India today isn't disposed of in the recycling stream but rather is mixed with other types of municipal solid waste due to this weakening and the state's predicted concurrent absence to set up segregation-at-source through municipal governance [11], [12]. To use the kabadis and the inherent resilience and strength of the informal ecosystem, it is imperative that informal waste management be improved via a range of policy-making activities. Although the government acknowledges its efforts through certain policies and programs, the functionalities of formal and informal structures are often so dissimilar that a solution for one may not be applicable to the other [13]. This is the exact reason India's cities want a well-considered, all-encompassing regulatory framework that examines the nature of the connections between the official and informal sectors in addition to acknowledging the significance of the informal waste management industry [14]. However, this endeavour is difficult due to the informal sector's heterogeneous value chain. Therefore, the goal of this study is to investigate how the current policies, which are mostly focused on the formal sector, might be effectively implemented (with small modifications) to benefit both "the informal sector in particular and solid waste management in general" [1]. Furthermore, it's critical to comprehend the extent of their operations in order to research “the informal management system”. Without sufficient data, it is difficult to represent this intricate system using any traditional simulation or optimization-based model [15].

The Informal Waste Sector

Small-scale recyclers, scrap dealers, rubbish pickers, and rag pickers who operate outside of official waste management systems comprise India's informal waste industry. Paper, plastic, glass, metal, and other recyclable items are often gathered, separated, and sold to bigger recycling enterprises by these people. The urban environment relies on them for an indispensable service, frequently operating in hazardous conditions without adequate protection or recognition [16].

These workers are in charge of retrieving a significant quantity of recyclable materials, but they do it without the necessary resources, assistance, or safety nets. As a result of inadequate institutional support and infrastructure, the industry frequently operates in the shadows and circumvents the official “waste management system”. In spite of this, the informal trash industry plays a vital role in waste management in India, processing between 60 and 90 percent of recyclables in certain cities [17].

Waste Management

Waste management is the term used to describe the procedures utilised to handle garbage from creation to death. Collection, transportation, disposal, or recycling of waste products resulting from human activity is done under observation [18]. All types of garbage are covered in waste management, including household, industrial, and hazardous waste. Each kind of waste—solid, liquid, or gas—has a unique method for handling and disposal. In waste management, the primary objective is to decrease the amount of trash that is dumped in landfills. In contrast, it's critical to see waste as a useful resource [19].

Hierarchy of Waste Management

- **Prevention:** Preventing or minimising the initial production of refuse.
- **Reuse:** recycling materials or products for a new or different use without altering their shape or quality.
- **Recycling:** turning garbage into raw resources or new goods.
- **Recovery:** removing elements or energy from garbage that cannot be recycled or utilised again.
- **Disposal:** disposing of garbage by landfilling or dumping that cannot be avoided, reused, repurposed, or retrieved. The option that is least preferred has the greatest detrimental effect on human health and the environment.

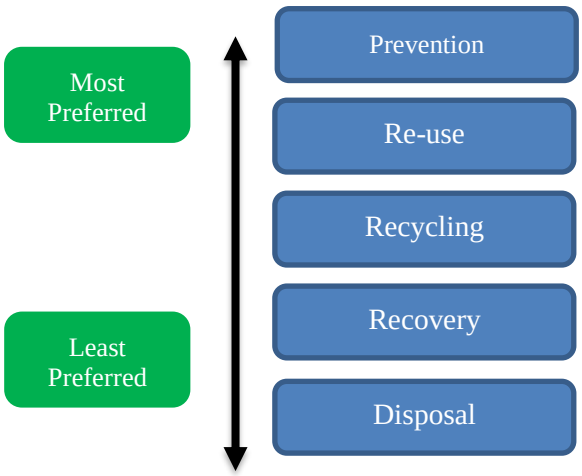

Figure 1 Hierarchy of waste management

Waste Management Rules

1. **Solid Waste Management Rules, 2016**
   - Announced on April 8, 2016
   - The scope of application went beyond localities to include recognised industrial townships, census towns, urban agglomerations, etc.
   - It is required to separate garbage at the source and collect it from door to door in order to divert it for beneficial uses including recycling, reuse, and recovery.
2. **E-Waste (Management) Rules, 2022**
   - It includes "106 Electrical and Electronic Equipment (EEE)", including waste from solar photovoltaics, and was notified on November 2, 2022.
   - An important step in putting the Hon. Prime Minister's announcement to support the circular economy into action.
   - A regime of "Extended Producer Responsibility (EPR) for e-waste recycling" that is appropriate for the current situation should be implemented.
3. **Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016:**
   - On April 4, 2016, the priority sequence was expanded to incorporate the waste management hierarchy, which includes "prevention, minimisation, reuse, recycling, recovery, co-processing, and safe disposal".
   - Those that "handle, create, collect, store, package, transport, utilise, treat, process, recycle, recover, pre-process, use, offer for sale, transfer, or dispose of hazardous and other wastes" are subject to these standards.
4. **Bio-Medical Waste Management Rules, 2016**
   - Notified with the intention of enhancing the safe and ecologically responsible “collection, processing, treatment, and disposal of infectious biomedical waste”.
   - "Medical facilities, clinics, dispensaries, veterinary clinics, animal houses, pathological labs, blood banks, AYUSH hospitals, clinical facilities, educational or research institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, school first aid rooms, forensic labs, and research" are all included in this. Additionally, it pertains to any individual who generates, accumulates, receives, stores, transports, processes, disposes of, or manages biomedical waste in any capacity.
5. **Plastic Waste Management Rules, 2016**
   - Notified March 18, 2016.
   - Regulations apply to "carry bags, plastic sheets, multilayered packaging, import stocking, distribution, sale, and use". Both rural and urban regions are now included in the jurisdiction of applicability.
   - The accountability of garbage producers has been mandated for the first time.
   - Individual and large producers, such as workplaces, businesses, and industries, are required by municipal bylaws to separate plastic garbage at the source, transfer the separated waste, and pay a user fee.
6. **Construction & Demolition (C&D) Waste Management Rules, 2016**
   - The regulations are applicable to any individual, organisation, or authority that produces construction and demolition waste, including debris, building materials, and rubble refuse, when constructing, renovating, repairing, or demolishing any civil structure.
   - The regulations require that C&D waste be collected, transported, stored, and reprocessed.
   - Recycling and recovering valuable materials and construction and demolition debris was emphasised as a "RESOURCE."
   - Excavation, road/flyover/underpass/bridge construction, utility conduit installation, and construction and demolition/renovation of buildings are all included in the scope of the rules.
   - In order to recycle C&D waste, a timeline was established for the construction of actual reprocessing facilities everywhere.
7. **Battery Waste Management Rules, 2022**
   - In order to guarantee ecologically responsible disposal of used batteries, it was published on August 24, 2022.
   - "The 2001 Batteries (Management and Handling) Rules" have been replaced by new regulations. All battery types are covered by the regulations, including industrial, automobile, portable, and electric vehicle batteries.
   - The regulations are based on the EPR principle, which states that battery manufacturers, including importers, are in charge of collecting used batteries, recycling or refurbishing them, and using the resources recovered from waste to make new batteries.

8. **Ash utilisation notification, 2021:**
   - On December 31, 2021, MoEF&CC released a new notice with the goal of using all of the ash produced by “coal and lignite-based thermal power plants”.
   - Requires thermal power stations to use all of their current ash output within three to five years and all of their legacy ash within ten years.
   - Environmental restitution for clause noncompliance.
   - Use of ash or ash-based goods within 300 km of thermal power plants is required of user agencies engaged in road construction, the laying of roadways and flyover embankments, dam construction, mining, the production of “ash-based products and building construction”.
9. **Chemical Safety**
   - To ensure chemical safety in the nation, MoEF&CC announced "the Chemical Accidents (Emergency Planning, Preparedness and Response) (CAEPPR) Rules, 1996 and the Manufacture, Storage and Import of Hazardous Chemicals (MSIHC) Rules, 1989”.
   - One of the goals is to reduce the severity of chemical catastrophes and prevent them from occurring as a result of industrial operations.
   - In addition to conducting frequent safety audits and exercises, the owner of hazardous substances is required to notify the public of the primary risks associated with industrial operations, develop an emergency plan and safety reports on the premises, and more.
   - A crisis management plan has been created for chemical emergencies.
   - During chemical catastrophes, the Red Book, also known as the Crisis Alert System, is developed and updated every year to enable prompt information sharing.
10. **Public Liability Insurance**
   - "The Public Liability Insurance Act of 1991" was designed to provide timely assistance to anyone affected by accidents involving the handling of hazardous materials and for problems related to or incidental to these occurrences.
   - The Act covers property damage or death from an accident involving a hazardous material handling mishap, as well as injury or death to anybody other than a worker (general public).
   - The Act applies to 179 flammable and chemical compounds.
   - According to Section 7A of the Amended Act, 1992, the Major Accident Hazard (MAH) units are required to donate the equivalent of the insurance policy premium to "the Environment Relief Fund (ERF), which will be established by the Central Government".

LITERATURE REVIEW

(Hamdan et al., 2025) [20] The present state of MSW's functional components, including its administrative and financial frameworks, is thoroughly examined in this paper. It also shows the waste management practices that are now in place in the demographic areas of 10 smart cities in India. The research gathered materials from reports from important stakeholders, government and local authority databases, and secondary literature. Regarding the possibilities, difficulties, and viability of putting waste-to-energy (WtE) systems into place in India, this paper provides advice and insights. Increased population density and unsegregated waste at the source are positively connected with biomass quality decline and unplanned urban centre expansion, undermining "the potential socio-economic and environmental benefits of decentralised composting initiatives and waste-to-energy pathways". In industrialised nations, waste-to-energy options have produced a considerable amount of energy. However, it is difficult to replicate treatment procedures that could be effective in developed equivalents due to the distinct waste makeup of Indian cities.

(Mrs. Supriya Prasad Patil, 2025) [21] This article looks at India's waste management situation right now, the main issues it is facing, and the negative effects that inappropriate rubbish disposal has on the country's economy, public health, and ecology. It also examines innovative methods that might increase efficiency, such decentralised waste processing, automated trash collection systems, and waste-to-energy initiatives. In order to comprehend how their efforts might improve waste management, the roles of various stakeholders—including governmental organisations, commercial enterprises, non-governmental organisations, and informal trash workers—are also examined. Effective waste management in India requires a team-based, technologically advanced strategy. The future will be cleaner and healthier if rules are strengthened, the efforts of informal trash workers are acknowledged, more money is invested in sustainable solutions, and public engagement is encouraged.

(Ravish, 2025) [11] This review evaluates emerging technologies such as "waste-to-energy systems, biomining, and bioremediation", as well as the complex implications of

landfill operations in India. It also critically examines current regulatory processes. A comprehensive, equity-based paradigm for sustainable landfill management that incorporates social justice, health, and environmental viewpoints is put forward. The report emphasises the importance of climatic resilience, decentralisation, and stakeholder involvement in landfill management. It also advocates for reform measures "that align with India's objectives for sustainable development and the circular economy". More than just infrastructural improvements are needed to address these issues; a paradigm change towards open and "inclusive governance, data-driven decision-making, and the empowerment of informal trash workers is also necessary".

(Ali et al., 2024) [22] In order to help researchers and the appropriate authorities develop more effective programs, this article offers a thorough assessment of the situation of "municipal solid waste management in India at the moment". Solid refuse management in urban areas of India is also the subject of this paper, which investigates the current situation, significant challenges, and potential future developments. Improving waste inclusion requires efficient processing and recycling techniques. At the source, solid waste must be separated. The dry waste is sent to "RDF facilities, energy plants, recycling, and reuse", while the moist waste is sent to composting or biogas generation. Additionally, the investigation of advanced treatment methods such as pyrolysis and gasification is necessary, as they are cost-effective and have a minimal environmental impact, prior to their comprehensive implementation. In an effort to attain true sustainability within the MSWM system, it is feasible to manage solid refuse at numerous sources through the implementation of "both centralised and decentralised methodologies".

(Amit Kapoor & Chakma, 2024) [23] In-depth research and analysis on solid waste management are presented in the article, emphasising how solid waste provides both opportunities and challenges for Indian cities. The imperative necessity for "sustainable waste management solutions" is also underscored in order to resolve environmental issues and realise economic potential. Critically important are constructive methodologies that incorporate public participation and account for geographical disparities. By adopting sustainable methods including reduction, reuse, recovery, communities, and waste disposal may turn trash from a problem into a resource that enhances "the environment, the economy, and public health in urban areas". Despite the introduction of several laws and regulations aimed at improving waste management, such as "the move from centralised (2000) to decentralised (2016) techniques", difficulties still arise when these policies are put into practice. To overcome the obstacles and accomplish efficient waste management, a change to responsible habits is required, as is investment in infrastructure, funding, technology, and awareness.

(Pal & Bhatia, 2022) [24] An important part of India's well-known "Swachh Bharat Abhiyan" initiative is municipal solid waste (MSW). Hazards such as "environmental degradation, water pollution, air pollution, and soil pollution" are associated with the inadequate collection, unscientific treatment, and inadequate utilisation of technology-based solutions for “managing municipal solid waste (MSW)”. In addition to analysing the production, properties, and processing techniques used in India, the review paper details the present situation of MSW in several states and union territories. While implementing an efficient "municipal solid waste management (MSWM) system", it also underscored the influence of government policy and a variety of geographic constraints. Through IoT-enabled technologies, SWM has been fully deployed as part of the smart city objective. In smart cities, a system handles the management information system (MIS), waste collection vehicle route selection, and smart IoT-enabled bin filling level monitoring.

(Benjongkumba & Parhi, 2021) [25] The term "waste" refers to the undesirable material that is disposed of into the dangers environment. Households and the community's liquid and solid waste, including excreta, are a significant health hazard that has contributed to the transmission of infectious diseases. The secondary data used in this investigation was gathered from a number of sources. Along with highlighting the sources and kinds of urban solid waste, the article also discusses how improper waste management can result in health and environmental problems, offers suggestions for "proper waste management in urban areas, and concludes" with a clear call to action: only by increasing public awareness will this issue be prevented or controlled.

(Somani et al., 2021) [26] An increase in solid refuse generation is directly correlated with the blooming of industrialisation and urbanisation. The management of "India's 62 million tonnes of municipal solid trash", such as plastic, medical, and e-waste, is a major challenge every year. This has grown and continues to be a developing threat to environmental and public health. In India, sustainable development is mostly followed in “solid waste management”. States differ in their compliance with the waste management regulations, which are typically

formulated and managed by “the Ministry of Environment and Forests (MoEF)”. This article discusses the current state, difficulties, and practices of waste reduction, “including collection and segregation, recycling, energy recovery (composting, biomethanation, and bioremediation), land filling of industrial and domestic waste, and the environmental effects of these practices”. In order to improve the present Indian systems, this assessment closes with a few straightforward and practical global waste management trends.

RESEARCH OBJECTIVE

- To study about informal waste sector, waste management policies and their various rules.
- To study the various literature works on waste management policies and their impact.

RESEARCH GAP

Even though sustainable waste management is emphasised in a number of policies, such as "the Extended Producer Responsibility (EPR) framework, the Swachh Bharat Mission, and the SWM Rules (2016)", there hasn't been much focus on integrating the informal waste sector into formal systems. The majority of research concentrates on technical solutions, such as waste-to-energy and decentralised processing, while "the economic, social, and governance dimensions of informal labourers" are still not fully investigated. There is insufficient empirical research on their contribution to recycling, livelihood security, and environmental benefits. Furthermore, the policy–practice gap persists, with little assessment of how current regulations affect informal waste pickers. This warrants deeper investigation into inclusive, data-driven models.

RESEARCH METHODOLOGY

To assess the informal refuse sector and the influence of "waste management policies in urban India", this review paper implements a qualitative research methodology that is predicated on secondary data analysis. An extensive literature review was conducted, systematically examining peer-reviewed journals, scholarly articles, government reports, technical papers, and case studies published between 2016 and 2025. The selection of sources followed a thematic approach, focusing on policy frameworks, informal sector contributions, and waste management rules. Data were critically analyzed to identify trends, policy–practice gaps, and the role of informal workers, providing a comprehensive understanding of their impact within urban waste systems.

CONCLUSION

The review highlights that the rate of waste generation in India has risen sharply, driven by rapid population growth, urbanization, changing lifestyles, and low public awareness. Despite the presence of policies such as the Solid Waste Management (SWM) Rules (2016), the Swachh Bharat Mission, Smart Cities Mission, and Extended Producer Responsibility (EPR) framework, India’s waste management system continues to face multiple challenges. Poor waste segregation at source, insufficient infrastructure, financial limitations, and weak policy enforcement hinder effective implementation. Landfills, often located close to residential areas, are overflowing and releasing hazardous pollutants, disproportionately affecting marginalized communities.

One of the key findings is the significant yet under recognized role of the informal waste sector. Informal waste pickers contribute substantially to recycling and resource recovery, yet remain excluded from formal systems and policy considerations. Their integration into formal waste management could enhance efficiency, increase recycling rates, and reduce landfill dependency. Case studies from municipal cities demonstrate positive strides with decentralized composting, biogas facilities, and community-based initiatives, underscoring the potential of innovative localized solutions.

Technological advancements, including IoT-enabled waste monitoring, route optimization for collection vehicles, and waste-to-energy plants, show promise but require broader implementation and policy support. However, achieving sustainable municipal solid waste management (MSWM) demands more than technology; it requires inclusive governance, transparent data-driven decision-making, and strong public-private partnerships. Importantly, public attitudes toward waste disposal remain a critical barrier, necessitating sustained awareness and behavioral change campaigns.

In conclusion, India’s urban waste management challenges are systemic, impacting both environmental and public health. Unmanaged wastes lead to respiratory illnesses, water-borne diseases, and other health risks. Addressing these issues requires an integrated approach that combines technological innovation, decentralized solutions, strict policy enforcement, and recognition of the informal waste sector. By fostering inclusivity and sustainability, India can transform its waste crisis into an opportunity for cleaner, healthier urban development.

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