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LIVING WITH WASTE: KNOWLEDGE, LAW AND ETHICAL DIMENSIONS OF DUMPYARDS IN THE MUMBAI METROPOLITAN REGION

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Abstract
This paper explores the dumpyards of the Mumbai Metropolitan Region (MMR) through the connected themes of knowledge, law, ethics and environment but with a special focus on the people whose lives are shaped by these massive landscapes of waste. Mumbai's only dumpyards; Deonar, Kanjurmarg and the now-closed Mulund site are more than just overflowing mounds of garbage. Mumbai generates over 11,000 tonnes of solid waste daily, much of which continues to be channelled into overburdened dumpyards, making these sites key locations where policy frameworks encounter lived realities. Although laws such as the Solid Waste Management Rules (2016) outline clear responsibilities, the conditions on the ground often tell a different story. Gaps in public awareness, weak segregation practices and fragmented institutional knowledge all contribute to systems that struggle to protect both people and the environment. Using a mixed-method approach that combines analysis of legal and policy documents and secondary data review, the paper highlights the severe environmental consequences of dumpyard dependence, including recurring fires, air and water pollution, and irreversible land degradation. The environmental impacts are well known, fires that blanket neighbourhoods in smoke, polluted water sources, and land that can no longer breathe. Waste-pickers who sort through garbage to earn a living, children who grow up breathing toxic air, and families who continue to hope for safer surroundings bring to light the deep ethical questions that surround Mumbai's waste problem. By combining historical understanding, current field observations and emerging technological possibilities, this paper argues that Mumbai's waste future must integrate ancient wisdom, stronger legal enforcement, humane ethics and intelligent systems such as AI-driven segregation, decentralised processing and circular economy models. A truly sustainable approach demands not just technical upgrades but compassionate governance, better knowledge-sharing and meaningful inclusion of vulnerable communities. Ultimately, this study calls for a shift from viewing dumpyards as neglected spaces to seeing them as critical sites where knowledge, law, ethics and environmental responsibility must come together to shape a more just and a sustainable future.

Keywords: Mumbai Metropolitan Region, Dumpyards, Solid Waste Management Rules (2016), Environmental Ethics, Environmental Justice, Knowledge Systems, Legal Frameworks, Fragmented Institutional Knowledge, Pollution Impacts, Vulnerable Community, Waste- Pickers, Sustainable Futures, Urban Ecology, Technological Possibilities, Ai Driven Segregation, Decentralised Processing, Circular Economy Models.

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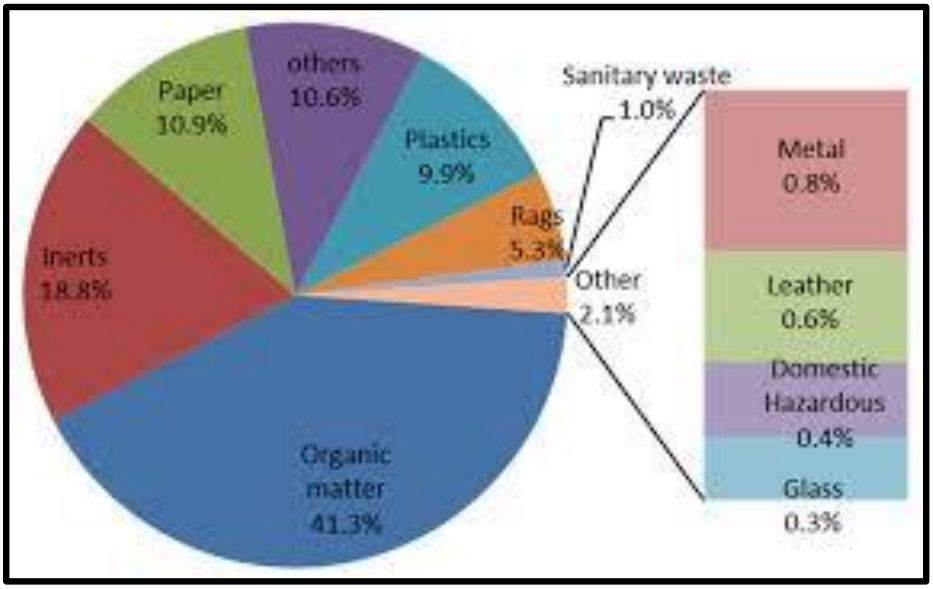
Introduction

The Mumbai Metropolitan Region (MMR) urban population is responsible for the huge amount of municipal solid waste (MSW). According to the data sourced from the Brihanmumbai Municipal Corporation (BMC), Mumbai alone is responsible for generating around 6,330–7,500 metric tonnes of waste per day in the past few years. Of Mumbai's two functional dumpyards Kanjurmarg and Deonar; the Kanjurmarg site processes around 88% of the waste using scientific technology such as the bio-reactor technology and composting,while the Deonar dumping ground bears the remaining burden by just dumping and simple levelling.

Despite the presence of legal frameworks such as the Solid Waste Management Rules (2016), which mandate waste segregation at source, scientific treatment, and responsible disposal, effective implementation across the Mumbai Metropolitan Region remains uneven. Decades of accumulated waste and the continued dependence on large dumpyards have turned waste management into a harsh reality for many communities. For residents living near these sites and for waste-pickers who work within them, the consequences are grave, they include persistent health risks, unsafe working conditions, and social marginalisation. These conditions raise critical questions of environmental justice, highlighting gaps between policy intent and ground realities, institutional neglect, and the ethical responsibility of the state and society towards vulnerable populations who disproportionately bear the burden of the city's waste.



Municipal Solid Waste Classification by Type

Review of Literature

Several studies examining the waste management practices in the cities across the country but this review provides a comprehensive overview of municipal solid waste generation, collection, treatment, and disposal practices across Indian cities. It highlights systemic challenges such as inadequate infrastructure, poor segregation, and over dependence on open dumping, offering a strong background for understanding urban waste issues in India. **Singh, S. P., Singh, P., & Sharma, V. P. (2007).** This article critically examines India's solid waste management laws, with

particular emphasis on the Solid Waste Management Rules, 2016. It identifies gaps between legislative intent and on-ground implementation, stressing the need for stronger institutional accountability and public participation. **Gupta, H. H., & Rathor, S. P. (2025).** This study explores decentralised waste management initiatives in Mumbai as alternatives to centralized dumping systems. It demonstrates how localized processing and segregation can reduce landfill dependency while also pointing out governance and flexibility challenges. **Decentralised solid waste management (2016).** ***Procedia Environmental Sciences.*** The study analyses household-level awareness, attitudes and practices related to waste management. It finds that while awareness of waste-related problems is increasing, behavioural change and consistent segregation practices remain limited due to lack of enforcement and incentives. **Alternative approaches for better municipal solid waste management in Mumbai, India.** This study evaluates different waste management options by comparing their economic, environmental, and social costs. The findings suggest that landfill-centric systems impose high external costs, particularly on surrounding communities, reinforcing the need for sustainable and socially just alternatives. **Social cost–benefit analysis of solid waste management options with application to Mumbai, India.** This case study focuses on sustainable waste management practices adopted in an Indian city, emphasizing segregation, composting, and citizen participation. It underscores the role of local governance and community engagement in achieving environmental sustainability. (**Bhilatiya, S. P et al.,)** This study assesses municipal waste management systems in a mid-sized Indian city, identifying operational inefficiencies and policy implementation gaps. Its findings are relevant for comparative analysis with larger metropolitan regions such as Mumbai. **(Dwivedi, A., et al., 2025)**

Research Objectives

1. To understand awareness level of the residents of Mumbai about the existing dumpyards, waste management practices, and the environmental and health risks associated with them.
2. To examine people's knowledge of waste management laws and their everyday waste disposal and segregation practices in the city.
3. To explore public perceptions of the working conditions and social challenges faced by waste collectors in Mumbai, with a focus on issues of safety, dignity, and fairness.

Hypothesis

1. H_0: Waste management laws, such as the Solid Waste Management Rules (2016), do not make a noticeable difference to how waste is processed in the Mumbai Metropolitan Region.

H_1: When the Solid Waste Management Rules (2016) are properly enforced, waste processing outcomes in the Mumbai Metropolitan Region improve.

2. **H_0:** The level of institutional understanding about waste generation, movement, and impacts does not affect waste-related planning and policy decisions.

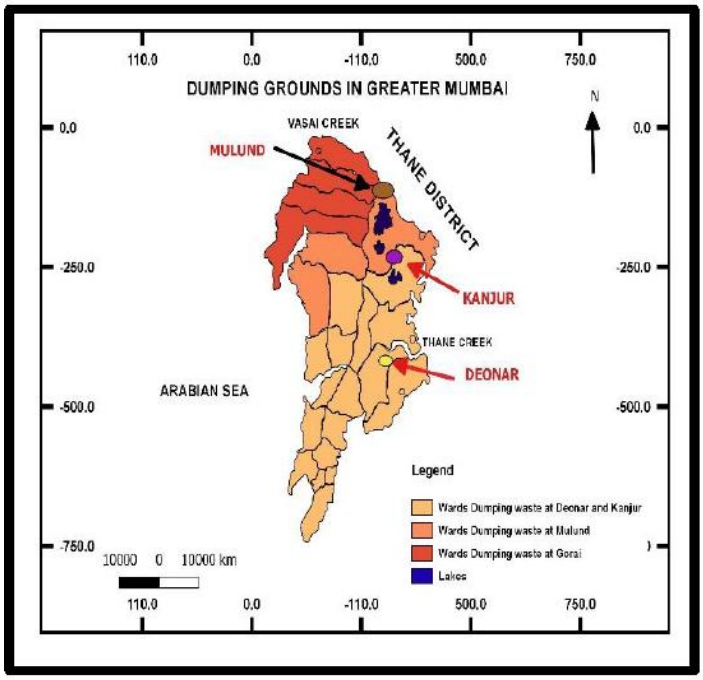
H_1: Poor coordination and fragmented knowledge among institutions weaken effective waste governance in the Mumbai Metropolitan Region.

3. **H_0:** Involving affected communities does not change public support for sustainable waste management policies.

H_1: Listening to communities and considering ethical concerns increases public support for fair and sustainable waste management policies.

Study Area

Mumbai is a large coastal city located on the western side of the country and is governed by the Municipal Corporation of Greater Mumbai (MCGM). Beyond the city lies the Mumbai Metropolitan Region (MMR), which includes nearby towns and municipal areas. Waste generated across this entire region is collected and managed through a shared system, making waste management a regional issue rather than only a city-level concern.



Mumbai's geography and high population density make waste management more challenging. Many parts of the city are low-lying and prone to flooding during the monsoon season. This increases problems such as bad odour, water contamination, and health risks near dumpyards. These issues are especially visible at the ward level, particularly in areas like M-East Ward, where the Deonar Dumping Ground is located close to residential neighbourhoods. For people living nearby and for waste-pickers working at the site, waste management affects everyday life.

Research Methodology

This study adopts a mixed-methods approach to examine public awareness of waste-related risks, the effectiveness of legal and institutional frameworks, and perceptions of the working conditions of waste collectors in Greater Mumbai and the wider MMR. Secondary data from municipal records, media reports, and policy documents were reviewed to understand waste flows, governance structures, and enforcement gaps under the Solid Waste Management Rules (2016). These insights provide context for testing the study's hypotheses on the role of law enforcement, institutional knowledge, and ethical engagement with affected communities in shaping public support for sustainable waste policies.

The study is aligned with National and Global sustainability priorities. Effective waste management directly contributes to the United Nations Sustainable Development Goals, particularly SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 3 (Good Health and Well-Being). It also reflects the policy direction

outlined by NITI Aayog, which emphasises decentralised waste processing, citizen participation, and inclusive urban governance as key to India's sustainable urban transition.

The primary data collection for this study involved a structured questionnaire survey conducted in selected residential, commercial, and institutional areas of Greater Mumbai. The survey was designed to understand respondents' levels of awareness, perceptions, and attitudes towards waste management practices in the city. It focused on issues such as knowledge of dumpyards, pollution hazards, waste segregation practices, awareness of waste management laws, and perceptions of the working conditions of waste collectors. The questionnaire consisted of closed-ended and Likert-scale questions, allowing for quantitative measurement of awareness levels, behavioural practices, and opinions related to waste management.

To ensure a balanced representation, 56 respondents were selected using a purposive sampling method. The sample included residents and waste generators from high-density urban areas where waste generation is high and effective waste management is critical. The data collected through the survey were coded and analysed using descriptive statistical tools such as percentage analysis and simple cross-tabulation. This analysis helped identify key trends in public awareness, compliance with waste management rules, and perceived gaps in governance and enforcement. The findings from the primary data thus provided an objective basis to assess the challenges faced in implementing sustainable and equitable waste management practices in Greater Mumbai.

Data Analysis and Discussion

1. Awareness of Dumpyards and Pollution

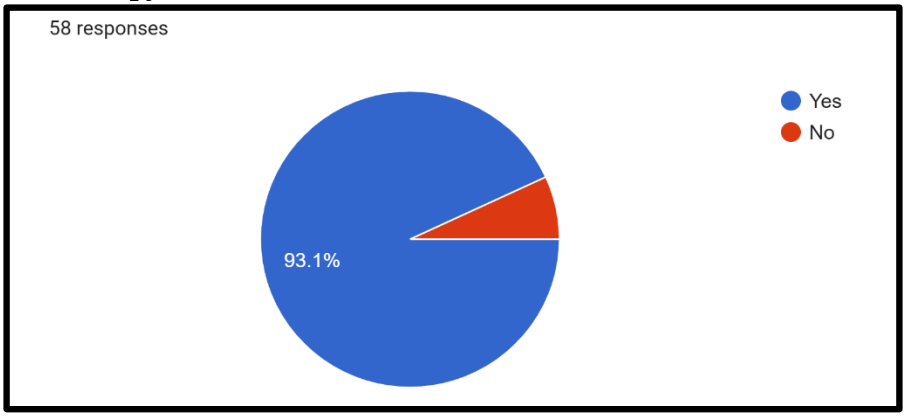


Fig No. 1

The survey results show a high level of awareness among respondents regarding major municipal dumpyards in Mumbai such as Deonar, Kanjurmarg, and Mulund. Out of 58 respondents, **93.1% stated that they are aware** of these dumpyards, while only **6.9% reported that they are not aware**. This indicates that dumpyards are a well-known feature of Mumbai's urban landscape and that issues related to waste disposal are visible to a large section of the population. The high level of awareness may be attributed to media coverage, proximity of dumpyards to residential areas, and everyday experiences such as odour, pollution, and waste transportation. This finding supports the study's objective of assessing public awareness and highlights the relevance of examining governance, health impacts, and environmental justice related to waste management in the city.

2. Proximity of Respondents to the Municipal Dumpyards

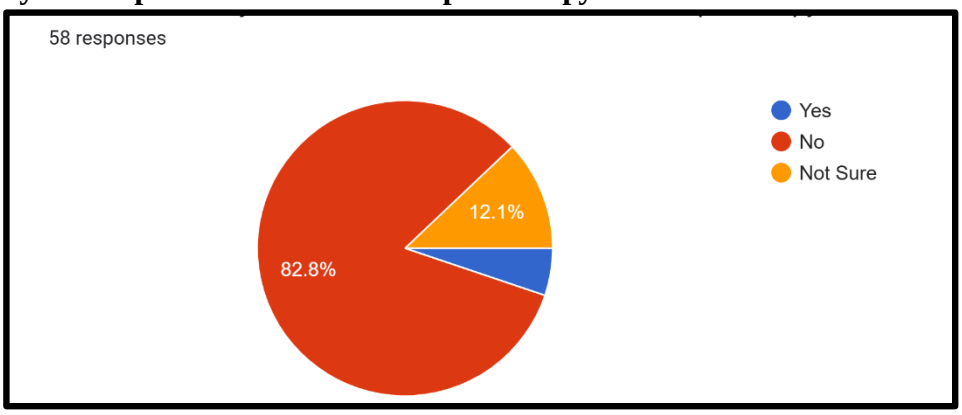


Fig No. 2

The survey reveals that a large majority of respondents **(82.8%) do not live or work within 5 km of a municipal dumpyard**, while only a **small proportion reported living or working nearby**. About **12.1% of respondents were not sure** about their distance from a dumpyard. This suggests that although most respondents are not directly located near dumpyards, they are still aware of waste management issues in Mumbai. The presence of respondents who are unsure about their proximity also highlights a lack of clear spatial awareness regarding dumpyard locations. This finding is important as it indicates that the impacts of waste management extend beyond immediate surroundings and affect the city as a whole.

3. Awareness of Environmental and Health Hazards Caused by Dumpyards

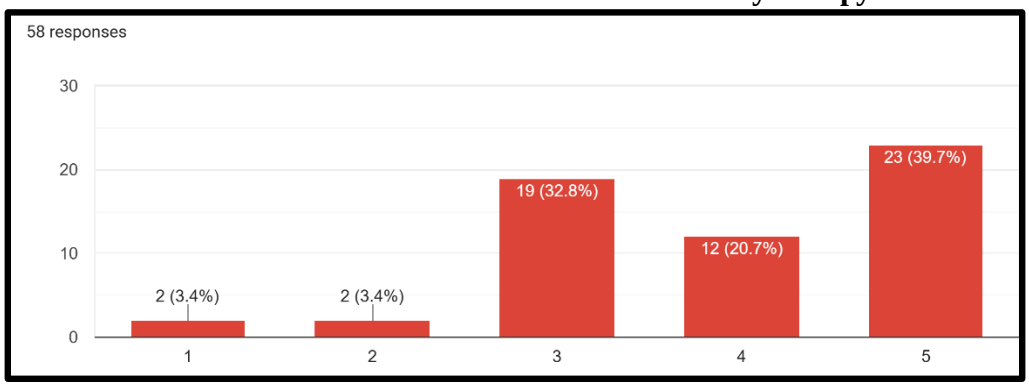


Fig No. 3

The survey shows that most respondents are **moderately to highly aware** of the environmental and health hazards caused by dumpyards in Mumbai. A majority rated their awareness at **levels 4 and 5 (60.4%)**, indicating strong awareness of issues such as air pollution, water contamination, and health risks. About **32.8% reported a moderate level of awareness**, while only a very small percentage showed low awareness. This suggests that awareness about dumpyard related problems is fairly high among residents, even among those living away from dumpyard sites. The findings highlight the need to convert this awareness into responsible waste practices and stronger public participation in waste management initiatives.

4. Perception of Pollution Caused by Dumpyards

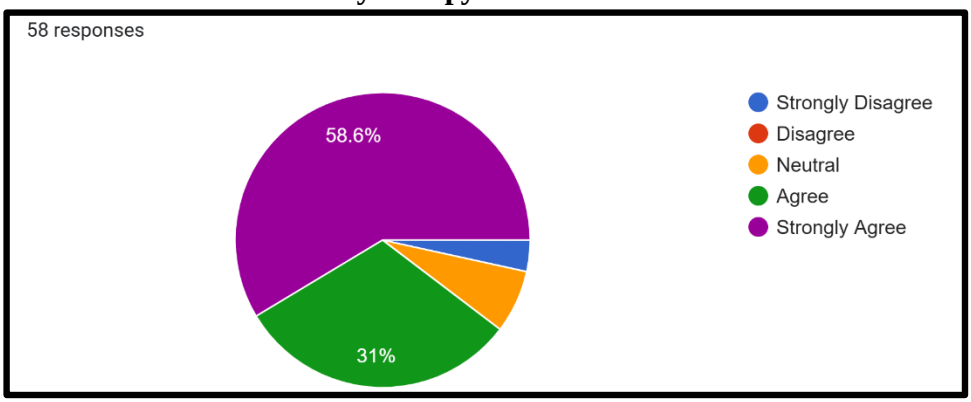


Fig No. 4

The survey results clearly show that most respondents believe that dumpyards in Mumbai significantly contribute to air, water, and soil pollution. A large majority, **58.6% strongly agreed** with the statement, while **31% agreed**, indicating a strong overall consensus. Only a very small proportion of respondents were neutral or disagreed. This strong agreement reflects high public concern about the environmental impacts of dumpyards. It supports the study's hypothesis that people recognize the environmental and ethical issues related to waste management and highlights the need for sustainable and community-supported waste management policies.

5. Household Waste Disposal Practices

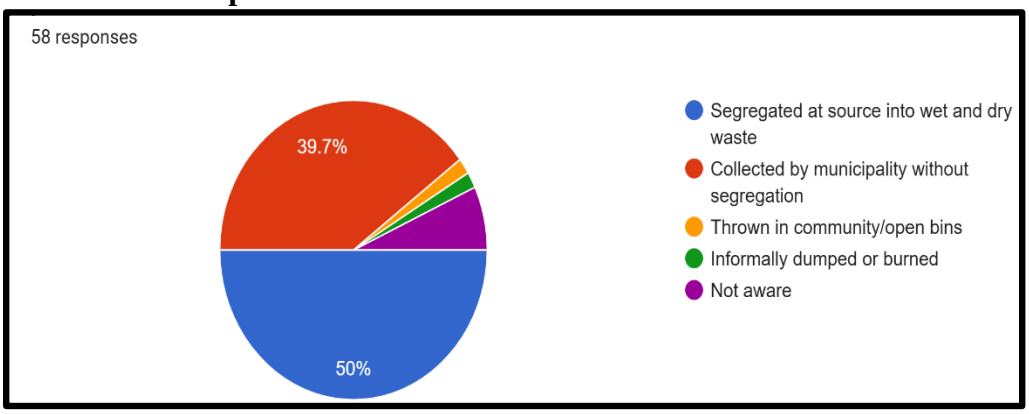


Fig No. 5

The survey shows mixed waste disposal practices across the study area. **Half of the respondents (50%) reported segregating waste at source into wet and dry waste**, which reflects growing awareness and partial compliance with the Solid Waste Management Rules (2016). However, a significant **39.7% stated that waste is collected by the municipality without segregation**, indicating gaps in effective implementation at the ground level. A small proportion of respondents reported disposal through **community/open bins or informal dumping/burning**, while a few were **not aware** of how waste is finally managed. These findings highlight that although awareness of segregation exists, consistent practice and institutional follow-through remain weak. This supports the hypothesis that **legal frameworks alone are not sufficient unless properly enforced and supported by local governance and public participation**.

6. Compliance with Municipal Waste Segregation Guidelines

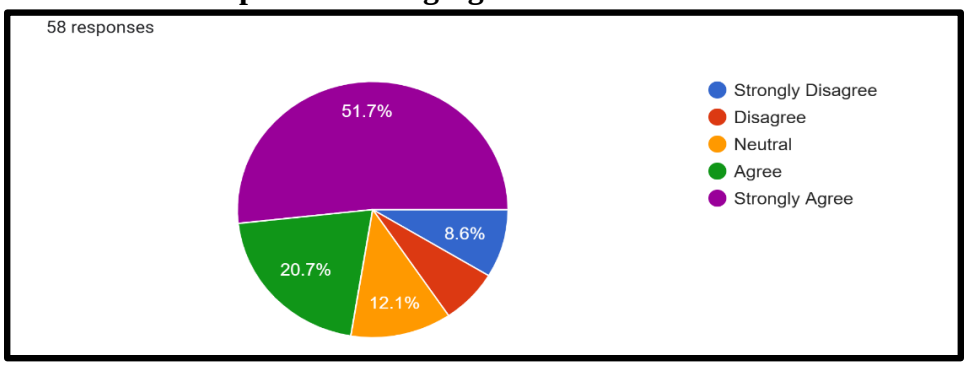


Fig No. 6

The responses show a **high level of awareness about municipal waste segregation rules**. A majority of respondents (**51.7% strongly agree and 20.7% agree**) that they regularly segregate waste at home as per municipal guidelines. This indicates that most citizens understand their responsibility under the Solid Waste Management Rules (2016). However, a small section of respondents remains **neutral or disagrees**, suggesting that regular segregation is not practiced uniformly. This gap highlights that while awareness exists, **consistent behaviour and enforcement are still lacking**. The findings support the hypothesis that **rules are effective only when supported by regular monitoring, infrastructure, and cooperation between citizens and local authorities.**

7. Awareness of Waste Management Laws and Rules

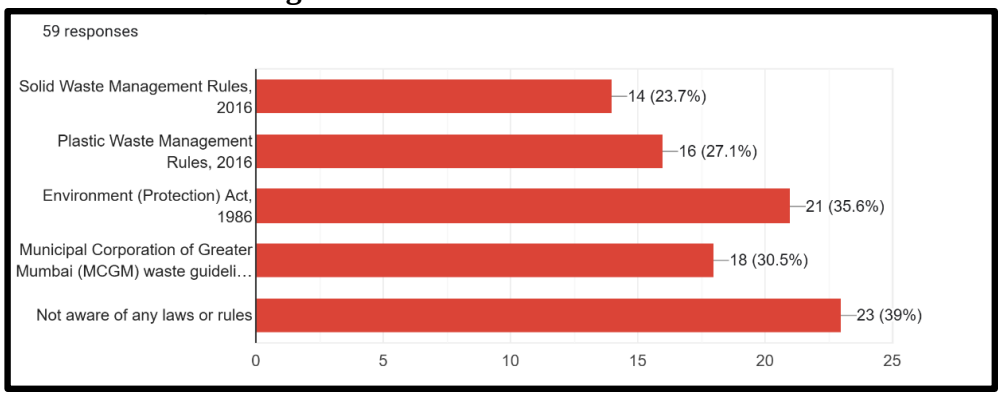


Fig No. 7

The responses show **limited awareness of waste management laws** among the respondents. The highest number of respondents (**37.9%**) stated that they are **not aware of any waste management laws or rules**, which highlights a major gap in legal awareness. Among those who were aware, the **Environment (Protection) Act, 1986 (36.2%)** and **MCGM waste management guidelines (31%)** were better known than the **Solid Waste Management Rules, 2016 (24.1%)** and **Plastic Waste Management Rules, 2016**. This suggests that people are more familiar with general environmental laws than with specific waste-related regulations. These findings support the hypothesis that **lack of awareness and communication of laws weakens effective waste management at the local level**. The results indicate a need for stronger public awareness programmes by municipal authorities, especially at the **ward level**, to promote responsible waste

disposal and compliance with national goals such as **SDG 11 (Sustainable Cities and Communities)** and initiatives supported by **NITI Aayog**.

8. Effectiveness of Enforcement of Waste Management Laws

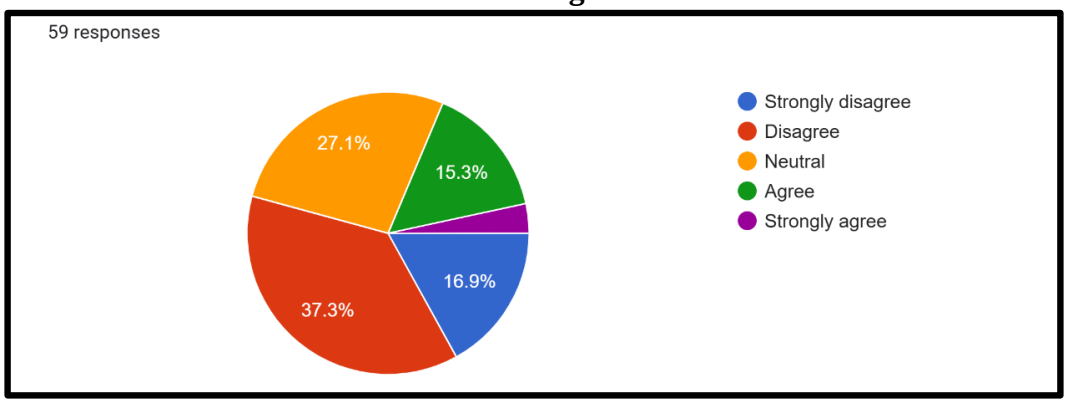


Fig No. 8

The responses indicate that most people feel waste management laws are not effectively enforced in Mumbai. A large proportion of respondents disagreed (37.3%) or strongly disagreed (16.9%) that local authorities enforce waste management rules properly. This shows dissatisfaction with the implementation of laws at the ground level. About 27.1% remained neutral, suggesting uncertainty or lack of direct experience with enforcement mechanisms, while only a small section agreed (15.3%) or strongly agreed that enforcement is effective. These findings support the hypothesis that weak enforcement and monitoring reduce the effectiveness of waste management policies, especially at the ward and neighbourhood level.

The results highlight the need for stronger local governance, better monitoring by municipal bodies, and community participation to meet national sustainability goals such as SDG 11 (Sustainable Cities and Communities) and policy directions emphasized by NITI Aayog.

9. Awareness of Occupational Health Risks faced by the Waste Collectors in Mumbai

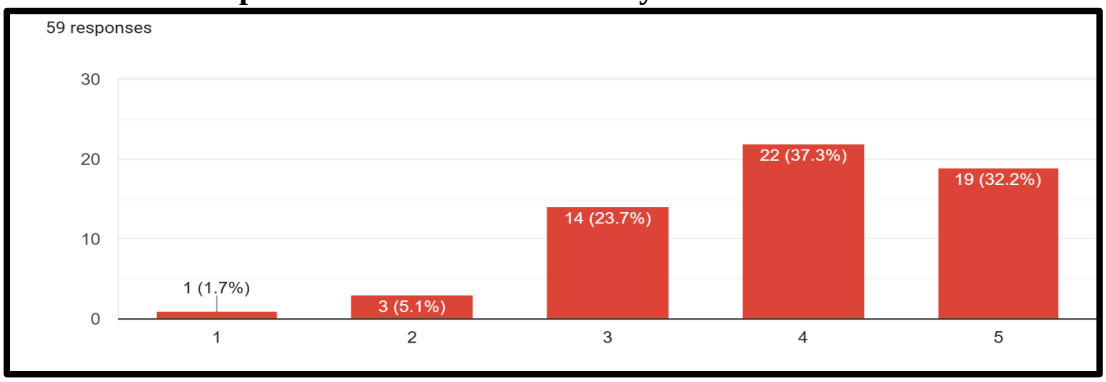


Fig No. 9

The graph shows that **most respondents are aware of the occupational health risks faced by waste collectors in Mumbai**. A very small percentage of respondents reported **very low awareness** (1.7% at level 1 and 5.1% at level 2). About **23.7% showed moderate awareness**, indicating some understanding of the issue. A majority of respondents reported **high awareness**, with **37.3% at level 4** and **32.2% at level 5**, suggesting that many people recognize the health

risks such as injuries, infections, and exposure to hazardous waste faced by sanitation workers. Overall, the findings indicate a **positive level of public awareness**, though the presence of moderate and low awareness groups shows the need for continued awareness campaigns and education.

10. Perception of Safety and Social Protection for Waste Collectors

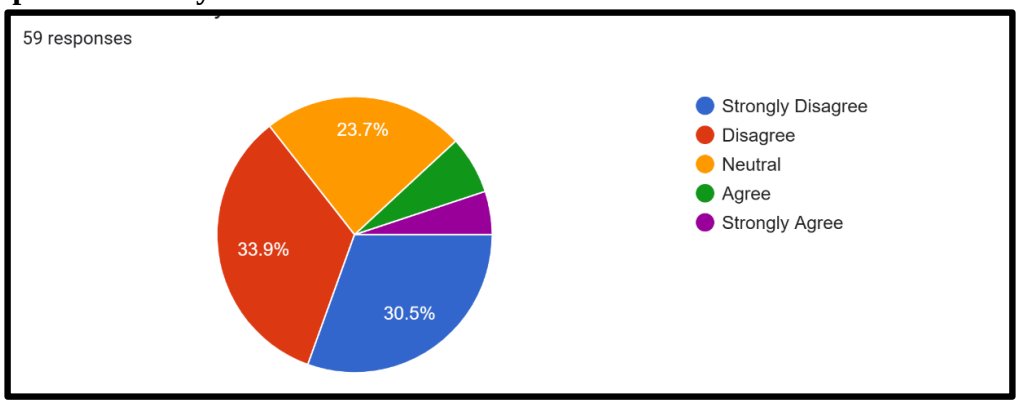


Fig No. 10

The responses clearly indicate that **most respondents believe waste collectors in Mumbai do not receive adequate safety equipment, legal protection, or social security benefits**. A large majority, **64.4% (30.5% strongly disagree and 33.9% disagree)**, expressed a negative perception, showing strong concern about the working conditions of waste collectors. About **23.7% of respondents remained neutral**, suggesting uncertainty or lack of detailed knowledge about existing protections. Only a **small minority (11.9%) agreed or strongly agreed**, indicating that very few people feel that sufficient safeguards are in place. Overall, the findings highlight a **significant gap in worker welfare and protection**, pointing to the need for stronger enforcement of safety measures and social security provisions for waste collectors.

Conclusion

1. Effectiveness of Waste Management Laws

H_0: Waste management laws, such as the Solid Waste Management Rules (2016), do not make a noticeable difference to how waste is processed in the Mumbai Metropolitan Region.

H_1: When the Solid Waste Management Rules (2016) are properly enforced, waste processing outcomes in the Mumbai Metropolitan Region improve.

The survey findings suggest that while many respondents are aware of waste management laws such as the Solid Waste Management Rules (2016), a large proportion feel that these laws are not effectively enforced on the ground. The high levels of disagreement regarding effective enforcement indicate gaps between policy and practice. Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted, concluding that proper enforcement of the SWM Rules is associated with better waste processing outcomes in the Mumbai Metropolitan Region.

2. Institutional Knowledge and Governance

H_0: The level of institutional understanding about waste generation, movement, and impacts does not affect waste-related planning and policy decisions.

H_1: Poor coordination and fragmented knowledge among institutions weaken effective waste governance in the Mumbai Metropolitan Region.

The results reveal limited public awareness of waste laws and widespread perceptions of poor implementation, reflecting institutional fragmentation and lack of coordination. Responses related to waste disposal practices and law enforcement point toward inefficiencies in planning and governance. Hence, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted, confirming that fragmented institutional knowledge and weak coordination negatively affect effective waste governance in the MMR.

3. Community Involvement and Ethical Governance

H_0: Involving affected communities does not change public support for sustainable waste management policies.

H_1: Listening to communities and considering ethical concerns increases public support for fair and sustainable waste management policies.

The graphs related to awareness of health hazards, concern for waste collectors, and perceptions of inadequate safety and social protection show strong public sensitivity toward ethical and social issues in waste management. These findings indicate that people are more supportive of sustainable waste policies when community welfare and ethical considerations are acknowledged. Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted, demonstrating that including community voices and ethical concerns enhances public support for fair and sustainable waste management policies.

Recommendations

1. Adopt Advanced Scientific Waste Processing Technologies

Mumbai should gradually shift from open dumping toward scientific waste treatment methods such as biomethanation, composting, refuse-derived fuel (RDF), and waste-to-energy plants. These technologies can reduce landfill dependency and minimize environmental and health hazards in the Mumbai Metropolitan Region.

2. Use Drones and GIS for Monitoring Dumpyards and Waste Movement

Drone-based surveillance and GIS mapping should be used to regularly monitor dumpyards like Deonar and Kanjurmarg. This can help track illegal dumping, assess landfill growth, identify fire-prone zones, and improve transparency and accountability in waste management operations.

3. Strengthen Enforcement of Waste Management Laws

Stricter enforcement of the Solid Waste Management Rules (2016) is required, particularly regarding source segregation, penalties for non-compliance, and accountability of bulk waste generators. Regular audits and ward-level reporting by municipal authorities can bridge the gap between policy and implementation.

4. Promote AI-Driven Waste Segregation and Smart Collection Systems

Artificial Intelligence–enabled sorting systems at transfer stations and processing plants can improve segregation efficiency and reduce human exposure to hazardous waste. Smart bins and sensor-based collection vehicles can further optimize waste collection routes and reduce operational inefficiencies.

5. Encourage Decentralized Waste Processing at Ward Level

Decentralized composting and biomethanation units should be promoted at the ward and housing society level. This will reduce the burden on large dumpyards, lower transportation costs, and encourage community participation in sustainable waste practices.

6. Implement Circular Economy Models

Mumbai's waste governance should adopt circular economy principles by treating waste as a resource. Recycling, reuse, and recovery of materials such as plastics, metals, and organic waste

can generate employment, reduce raw material extraction, and support Sustainable Development Goals (SDG 11 and SDG 12).

7. Improve Occupational Health and Social Security for Waste Collectors

Waste collectors must be provided with adequate personal protective equipment (PPE), regular health check-ups, insurance coverage, and access to social security schemes. Formal recognition of waste pickers as essential urban workers will enhance dignity, safety, and livelihoods.

8. Enhance Public Awareness and Community Participation

Awareness campaigns at the ward and school level should focus on segregation at source, health risks of improper waste disposal, and the role of citizens in sustainable waste management. Ethical engagement with affected communities will strengthen public support and ensure inclusive governance.

Implementing these recommendations can help Mumbai transition toward a more scientific, inclusive, and sustainable waste management system while addressing environmental justice and occupational health

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