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ANALYZING THE ROLE OF INSTITUTIONAL SUPPORT, PUBLIC AWARENESS, AND POLICY COMPLIANCE IN SOLID WASTE MANAGEMENT USING STRUCTURAL EQUATION MODELING

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ABSTRACT

India is experiencing a "solid waste management (SWM)" crisis as a consequence of rapid development, industrialization, and shifts in consumer habits. The "Solid Waste Management Rules, 2016" represent a move toward solving waste disposal issues, but the accumulation of waste still has a detrimental effect on the surroundings and people's health. Hence, strong governance, governance infrastructure, and citizens' engagement are required to successfully implement these rules. The study seeks to evaluate the influence of institutional backing and public awareness on policy compliance and the combined effects of these factors on effective SWM. It considers the mediating influence of policy compliance on the overall implementation of the SWM Rules, 2016. A quantitatively cross sectional survey was conducted with 415 respondents in the Delhi National Capital Region. Hypothesized relationships between institutional support, public awareness, compliance with policy and effectiveness in SWM were tested through Structural Equation Modeling (SEM) using SmartPLS. The findings showed that both institutional support (β = 0.390) and public awareness (β = 0.458) have an important optimistic consequence on policy compliance. Based on the findings, policy compliance was found to have a substantial intermediating conclusion among institutional/public factors and the effectiveness of solid waste management (SWM). The model also provided a good fit, indicating the legitimacy and dependability of the paradigms and the integrity of the framework proposed. The study highlights that conformity can hardly be enhanced if there are no efforts to build up the institutional capacity and keep the public informed. Policy-wise, the suggested measures feature the creation of technology-driven compliance monitoring instruments, local financial incentive schemes, and means for their implementation in a participatory government setting so that SWM Rules enforcement can be made more effective.

KEYWORDS: Solid Waste Management, Institutional Support, Public Awareness, Policy Compliance, Structural Equation Modeling.

1. INTRODUCTION

The urbanization of India's cities is happening at an alarming pace, which has resulted in a tremendous increase in solid waste production that cannot be handled through traditional waste management methods and creates even greater environmental risks. The fast-paced development of the economy and migration of people have worsened the waste management problem that has caused ecological imbalances and health risks to the public not seen before (Mohanty et al., 2021). "The government introduced "Solid Waste Management (SWM) Rules, 2016" as a revolutionary regulatory framework for waste separation, recycling, and disposal. The rules also highlight the role of institutional backing and public education in securing effective compliance, incidentally, outside the adverse effects of waste accumulation (Kumar & Bhati, 2022).

Thus, the solid waste generation aspect that is trending is connected to the extraordinary rise in urban population, fast industrialization, and changing consumption patterns in modern India (Bhattarai & Conway, 2020). The waste production during the last few decades has not only short-circuited. However, it has also challenged the existing waste management systems both in the old and new ways- the latter being unable to manage the increasing demand of the present-day cities (Sharma et al., 2020). The SWM Rules, 2016, are bold initiatives of the government with clearly stated goals for the partition of waste at the source, ecological recycling, and proper disposal of waste as per the environmental standards to overcome this challenge (Talballa & Gichuru, 2023). However, apart from regulatory mandates, the successful implementation of these rules would require robust institutional frameworks and an adequately informed public, which is actively engaged in waste management initiatives (Awino & Apitz, 2024). Institutional support through well-coordinated governmental agencies plays a critical role in operating these regulations. Public awareness may also act as necessary to effect behavioral changes and community involvement (Mohanty et al., 2021).

Table 1: Overview of India Waste Management.

Waste Stream	Metric	Value	Remarks
C&D Waste (FY 2022-23)	Operational processing facilities	36	Total capacity ≈ 13,560 tpd
	Proposed processing facilities	29	Total proposed capacity ≈ 4,050 tpd
Plastic Waste (2021-22)	Estimated generation	3,901,780 tpa	Based on 36 States/UTs
	Recycling capacity	935,290.005 tpa	
	Co-processing capacity	237,119.29 tpa	
E-Waste (FY 2021-22)	Estimated generation	1,601,155.36 tpa	From 21 types of EEE
	Dismantlers/Recyclers	567 units	Operating in 22 States
	Quantity dismantled & recycled	527,131.57 tpa	
Biomedical Waste (2022-23)	Generation	764 tpd	
	Treated & disposed	721 tpd	
	CBWTFs in operation	215 sites	
	CBWTFs under installation	35 sites	
Hazardous Waste (2021-22)	Generated	12.35 Mt	
	Recycled/Utilized	7.59 Mt	
	Disposed via SLFs & Incinerators	2.93 Mt	(Common SLF 2.36 Mt; Incinerator 0.19 Mt; Captive SLF 0.27 Mt; Captive Incinerator 0.09 Mt)
Fly-Ash Utilization (2021-22)	Utilization rate	95.95 %	Of 270.82 Mt generated
Contaminated Sites (as on Dec 2022)	Sites identified	240	
	Probable contaminated	113	(Preliminary assessment underway)
	Under remediation	127	DPRs completed/remediation required

(Source: Mohan, et. al., (2021).

India is the highly populous country with major cities and mega cities that continue to grow; and as this happens, the waste management problems also grow significantly (Pal & Bhatia, 2022). The waste in India is regulated and managed by the Ministry of Environment, Forests and Climate Change (MoEFCC), the institution which divides the waste according to origin, composition and environmental impacts (Meena et al., 2023). Municipal solid waste (MSW) occupies a large segment of waste, with

Maharashtra being a leading state manufacturing the highest quantity of MSW (Kulkarni, 2020). One of the most significant components of MSW generating environmental concern is plastic waste. Hazardous wastes are those that are toxic, corrosive, flammable, or reactive; their generation increased by over 30 percent year on year in 2022 (Chauhan et al., 2024). Electronic waste has been increasing in generated quantity in India on a continuous basis since 2018 (Nithya et al., 2021). By 2023, India had utilized the greater part of waste it produced-at over 75% of the total waste-but seldom recycle rates reached beyond 30% for all waste types (Meena et al., 2023). For this reason, landfilling remains the primary option, and only 20% of plastic waste is recycled (Kosior & Crescenzi, 2020). Incineration or composting is another treatment done to waste (Chen et al., 2021). There are specific waste streams for which there will be a mixture of some treatment methods for effective waste management (Kladnik et al., 2025).

Table 2: Super Swachh League Cities 2025.

Category	Population Range	Super Swachh League Cities
Very Small	< 20,000	Panchgani, Patan
Small	20,000 – 50,000	Vita, Saswad
Medium	50,000 – 300,000	Ambikapur, Tirupati, NDMC (New Delhi Municipal Council)
Big	300,000 – 1,000,000	Noida, Chandigarh
Million-Plus	> 1,000,000	Navi Mumbai, Indore (cleanest city of India), Surat

(Source: Ministry of Housing & Urban Affairs).

Union Minister Manohar Lal Khattar today introduced the redesigned toolkit for the upcoming "9th edition of Swachh Survekshan—the world's largest urban cleanliness survey"—and also announced the launch of a new initiative called the 'Super Swachh League.' The final assessment fieldwork will take place from February 15 to March 2025. The updated toolkit has been created with user-friendliness in mind, making it easier for citizens and local urban bodies to engage. The core of the initiative is to have an evaluation method that is open and based on the data and the five new classifications of cities: Very Small, Small, Medium, Large, and Million-Plus, which are determined by their population size. The conduct of the survey took the programs encouraging behavior change such as Swachhata Targeted Units and Swabhav Swachhata Sanskar along with school assessments into account for the first time. The yardsticks which will be used for assessment include ten categories like cleanliness, waste segregation, sanitation facilities, and worker welfare where the cities with top performances in their respective categories e.g. Panchgani, Noida, and Indore will be competing in the Super Swachh League if they score at least 85%.

Even though the rules concerning Solid Waste Management are quite forward-looking, they still face some difficulties that are making it hard to use the systems to their full potential (Kumar et al., 2025). It is asserted that non-compliance and poor coordination among the different parties involved have been the main reasons for the fragmented implementation of waste management strategies (Ansari et al., 2024). The involvement of the public has been very disappointing, and one of the main reasons for this is that people do not know very much about the importance of the environment and also there are behavioral barriers which make it difficult for them to practice waste segregation and recycling (Lakhouit, 2025). Also, inefficiencies within the institutions make the problem worse, as they are seen as the main reasons for the inability to systematically collect, separate, and dispose of waste (Kosarkar & Barthwal, 2025). These flaws in the system not only take away the power of the Solid Waste Management Rules but also pose a danger in the long run to the sustainability of the urban environment and public health. This research is expected to not only contribute to but also lead the discussion on the interaction between the institutional support, public awareness, and policy compliance by offering new and creative insights to handle the challenging issue of hazardous waste management that has persisted for a long time.

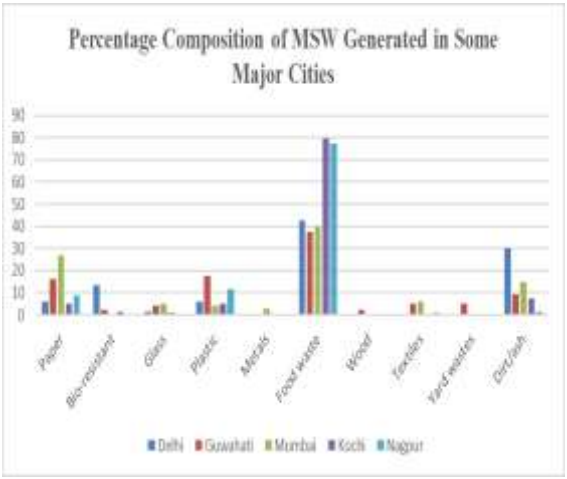

Figure 1: Composition of MSW Generated in Some Major Cities.
(Source: CPCB (2024)).

The secondary research encompassed five Indian cities—Delhi, Mumbai, Kochi, Guwahati, and

Nagpur—that exemplify the various geographical, economic, and demographic aspects of the country. The selected cities exhibited different population densities, levels of industrialization, urban infrastructure, and governance practices. The diversity of the selected cities allows for the mapping of MSW generation and management not only across different contexts but also regionally, with the accompanying challenges. In these cities, food waste is generally the largest component of waste, and Kochi (79.8%) and Nagpur (77.2%) report the highest shares, thus referring to a large volume of organic waste. The city of Mumbai has a significant paper component (27%), while plastic occurrence is the city's (Guwahati) characteristic with 17.4%. The presence of dirt/ash in Delhi (30%) is an indication of different levels of segregation/disposal practices. The intercity variations in the solid waste composition components ratio between the five Indian cities pointed at the necessity of not only better institutional arrangements but also stronger awareness campaigns and stricter policies to deal with the different waste streams. Kochi (79.8's) and Nagpur (77.2's) organic flow is contrastingly against Mumbai's (27%) paper-curing load, while Guwahati's (17.4's) plastic content and Delhi's (30%) ash and dirt-laden waste composition are in between. Collectively, they illustrate India's diversity in geography, economy, and even in the policies, since these are the factors that are reflected directly in the types and treatment of municipal solid waste produced. Delhi (North) and Mumbai (West) are the two mega-cities with service sector economies, while Kochi (South) and Guwahati (East) are the young urban centers with high growth potential. Nagpur (Central), on the other hand, is a significant transit city. Such urban environments, along with their prevailing growth trends, influence household waste behaviors, e.g., before plastic and bio-waste, as well as determine the level of government investment in waste management infrastructure, regulation management and enforcement. Each city has different municipal laws, administrative and enforcement practices, providing each site with the opportunity to be seen as a case study of hazardous waste management and disposal gap analysis.

Food waste is the most significant component of municipal waste in these 5 Indian cities, especially in Kochi (79.8%) and Nagpur (77.2%), which indicates the high amount of organic waste. Paper is the major component in Mumbai (27%); Guwahati is marked by a high percentage of plastic waste (17.4%). The dirt/ash content in Delhi (30%) is also an indicator of different levels of segregation/disposal methods. The different waste composition in various areas points to the necessity of establishing more sophisticated institutional frameworks, conducting awareness-raising campaigns and enforcing stringent regulations to facilitate the management of different waste streams more practically. The cities Kochi, Nagpur, Mumbai, Guwahati, and Delhi were selected because their waste patterns cover the complete range of India's municipal waste: the organic-laden flows of Kochi (79.8%) and Nagpur (77.2%) are in sharp contrast with the paper-dominant load of Mumbai (27%), the significant plastic component of Guwahati (17.4%) and the ash-and-dirt-laden content of Delhi (30%) respectively. The diagram illustrates five metropolises, Delhi, Mumbai, Kochi, Guwahati, and Nagpur, to indicate the diversity of India in geography, economy, and policies that influence the municipal solid waste generation at different levels. Delhi (North) and Mumbai (West) are the two main mega-cities whose service sectors are well developed. On the other hand, Kochi (South) and Guwahati (East) are growing cities and Nagpur (Central) is a significant point of transit. The different urban settings and the growth of the cities affect, among other things, the type of waste produced in households, that is, plastic or biodegradable, and influence the amount of government money spent on waste management facilities. Furthermore, each city has its own waste regulations and enforcement of state and municipal laws, which sometimes results in a lack of knowledge concerning the disposal of hazardous wastes.

Figure 2: Municipal Solid Waste Composition. (Source: CPCB (2024)).

Most of the organic waste (43.19%) and inert materials (28.03%) in Oriental are contained in the Perungudi Open Dumpyard. This indicates a

significant proportion of biodegradable and non-recoverable components (Kumar1, 2024). Other materials include Pastors (14.16%) and paper/cardboard (5.47%), which make a significant contribution, though the other classes, such as rubber, leather, glass, and wood, contribute very little. Hazardous items (batteries 0.08% and aluminum 0.15%) reflect insufficient separation practices (CPCB, 2024). Waste composition reflects the problems on waste management, highlighting the importance of policies for organic and inert waste reduction, waste recovery, and safe disposal (Bonifazi et al., 2025).

Table 3: Key Components of SWM Rules, 2016.

Section	Key Points
Scope and Applicability	Applies to every urban local body, census towns, villages (population > 3,000), SEZs, airports, ports, railways, defense establishments. Excludes industrial, hazardous, biomedical, e-waste, lead-acid batteries, and radioactive waste.
Key Definitions	- Biodegradable Waste: Decomposable organic material. - Combustible Waste: Non-biodegradable, non-recyclable waste with calorific value > 1500 kcal/kg. - Bulk Waste Generator: Generates >100 kg of waste per day (hospitals, hotels, schools). - Decentralized Processing: Processing waste near the source. - Door-to-Door Collection: Waste collection directly from premises.
Responsibilities of Waste Generators	- Segregation: Separate biodegradable, non-biodegradable, and hazardous waste. - Storage: Use designated bins. - Delivery: Hand over segregated waste to authorized collectors. - Payment: Cover waste management service costs.
Waste Processing and Disposal	- Composting and Bio-methanation: Preferred methods for biodegradable waste. - Recycling and Co-processing: For non-biodegradable and non-recyclable waste. - Sanitary Landfills: For residual waste only. - Buffer Zones: Maintain around processing sites.
Duties of Local Authorities	- Collection and Segregation: Ensure door-to-door collection. - Processing and Disposal: Adhere to environmental standards. - Awareness: Educate citizens on waste management. - Monitoring: Maintain records and conduct regular checks.

(Source: The Solid Waste Management Rules, 2016).

The importance of the study can be reflected in the previously shown table of results, as it bring up the main controversies regarding the "Solid Waste Management Rules, 2016" request. It specifies the responsibilities and the methods laid down by the regulations, which will cover the segregation, collection, processing, and disposal of waste, besides the participation of local government and waste generators. The present study gives a practical foundation for measuring the extent to which these laws are followed and for identifying the shortcomings and difficulties that hinder proper waste management (Solid Waste Management Rules, 2016). The investigation confirms the awareness of the enforcement procedures and also offers the amendments to the current policies for the "SWM Rules, 2016" to be more effectively implemented through the observation of the compliance indicators as well as the reactions of the institutions involved". Thus, the study aims at promoting ecological unwanted administration follows and environmental accountability. The significance of the study lies in enriching the evidence base that would strengthen institutional mechanisms in "Solid Waste Management (SWM)". The study has also contributed to the comprehension of compliance factors induced by behavior and policy, thus clarifying the different attitudes of individuals and organizations towards waste management regulations. The study indicates the points of intervention by presenting the gaps and difficulties related to current practice, besides giving specific suggestions for the upgrading of SWM Rules, 2016, support of green waste management practices, and taking care of the environment.

2. REVIEW OF LITERATURE

2.1. Evolution of Solid Waste Management in India

India has seen increased challenges in solid waste management since the population grew larger, lifestyles changed, and more inorganic waste started coming into being, all of which caused

environmental and public health problems (Meena et al., 2023). Setting up decentralized solid waste processing units and developing a formal recycling industry are important to strengthen municipal solid waste in urban India (Bhattarai & Conway, 2020). The increase in per capita municipal solid waste generation in cities of India affects the health of the citizenry and thus requires scientific disposal and the application of cleaner technologies (Pal & Bhatia, 2022). The multipath convolutional neural network (mp-CNN) effectively detects and localizes waste dumps on streets and roadsides, thus facilitating good waste management in India (Shahab & Anjum, 2022).

Progressive urbanization and industrialization have affected the organization of "solid waste in India". The disposal of waste was an arbitrary thing in the past but led to environmental degradation and health problems (Zhang et al., 2024). The Municipal Solid Wastes (Management and Handling) Rules introduced in 2000 constituted a milestone change in the process of policymaking by throwing light on the principle of organized waste management. However, many of the problems- poor infrastructure, limited funds, and the dependence on an informal mode of waste collection continued to make the process less effective (Kumari & Raghubanshi, 2023). The Solid Waste Management Rules, 2016 seemed to be a response to these factors through source segregation, participation of the informal sector, and promotion of waste-to-energy technologies (Ezeudu et al., 2021). However, the progress in efficiency and compliance levels continues to vary across the board in SWM practices.

Gap Identified: Although policy frameworks were established, the very efficacy of solid waste management is often inhibited by noncompliance with the policies from time to time. Factors that help bring about compliance must be known to be able to improve the waste management system as a whole.

Hypothesis H_3: Policy compliance significantly mediates the relationship between institutional support and the effectiveness of solid waste management.

2.2. Institutional Support and Governance in SWM

The waste management fundamentals of municipal corporations, the state pollution control boards, private agencies, and even NGOs have together constituted institutional support (Alam, 2023). Otherwise, Public-Private Partnerships (PPPs) create efficiency and innovation at the site of waste segregation and disposal (Filimonova et al., 2023). Hence, studies have shown that strong institutional frameworks and clear governance structures are more likely to lead to higher rates of compliance among all stakeholders (Samadi et al., 2022). However, bureaucratic inefficiency, technical inadequacies, and weaknesses in finances may temper the success of policy implementation on SWM (Meena et al., 2023).

Gap Identified: Evidence is needed empirically to demonstrate how institutional assistance relates to adherence of policies within the solid waste management sector.

Hypothesis H_1: Institutional support has a significant positive impact on policy compliance in solid waste management.

2.3. Public Awareness and Community Participation in Waste Management

Public awareness campaigns about waste segregation, recycling, and eco-friendly practices have actively involved the community to a large extent (Kalra, 2020). People got the message about the environmental and health impacts that wrong waste disposal would cause through mass media and community actions that were among the educational programs (Budihardjo et al., 2022). Nonetheless, such initiatives have not altered much the situation of public participation, which is still very limited due to behavioral inertia, cultural habits, and a lack of incentives (Pallegedara et al., 2024). Researchers point out that awareness, while very important, cannot function on its own; it has to be accompanied by practical engagement mechanisms and supportive policies to turn the knowledge-action switch on (Leknoi et al., 2024).

Gap Identified: There is a greater need for the consideration of awareness and public effect towards some SWM policies.

Hypothesis H_2: Public awareness has a significant positive impact on policy compliance in solid waste management.

2.4. Policy Compliance and Regulatory Effectiveness

The enforcement of SWM Rules, 2016's legislation, monitoring mechanisms and penalties are subject to non-compliance (Unegbu & Yawas, 2024). Enforceability facilitates the adherence to waste management standards, ensuring the health of the public and environment (Thakur & Kumar, 2022). A number of studies have identified some factors affecting compliance, which include but are not limited to, economic constraints, political will, and the effectiveness of enforcement mechanisms

(Chauhan & S., 2023). While differences in compliance levels have been noted in comparative studies between urban and rural areas, they are generally related to differences in resources and administrative capacities (Agya et al., 2024). Weak monitoring and weak enforcement strongly contribute to non-compliance and ironically form the basis of the need for a complied framework and regular evaluations of policy (Tran et al., 2025).

Gap Identified: Continuous need arises for more research into this relationship as pertaining to the third mediator, policy compliance, between public awareness and the effectiveness of SWM.

Hypothesis H_4: Policy compliance significantly mediates the relationship between public awareness and the effectiveness of solid waste management.

Empirical research into these hypotheses will certainly shed light on the working mechanisms of solid waste management in India. Concentrating on these institutional support mechanisms, public awareness, and compliance with policy allow stakeholders to work toward practical strategies to enhance the efficacy and sustainability of discarded administration practices.

2.5. Theoretical Framework

- Institutional Theory: As per Huang et al., (2022), Institutional Theory interprets how formalities such as government institutions and regulatory bodies affect organizational behaviors and policy compliance. In conformity with accepted norms and rules, organizations acquire legitimacy for their actions and survive. By SWM perspective, theory assumed that on institutional frameworks existence and efficiency in ensuring compliance among stakeholders with waste management-related policies, laxity leads to an environmental disaster and an obstacle to an effective waste management process (Li et al., 2025).
- Behavioral Change Models: Behavior change theories like Ajzen's theory of planned behavior, for example, inform about public participation in waste management practices (Unegbu & Yawas, 2024). As argued by TPB, intention to do this behavior could be due to attitude toward that behavior, subjective norms, or perceived behavioral control (Naskar & Lindahl, 2025). Therefore, when most people adopted these behaviors in the background of "solid waste management (SWM)" in the community, it showed that public awareness and attitudes would have a strong bearing on waste segregation and recycling. However, these empirical studies do recommend that TPB is helpful in predicting waste management behaviour (Massoud et al., 2021).
- Environmental Governance Models: Environmental governance is the one through which the referred institutional structures and policy outcomes related to sustainable development are viewed and scrutinized (Tan et al., 2025). They would be weighing the effectiveness of a governance style concerning the environmental outcomes and, accordingly, the conservation and management of resources. Good governance, characterized by participation, policy coherence, reflexivity, and adaptability, embodies the crucial elements for the sustainability challenge (Sarjito, 2024).

3. OBJECTIVES OF THE STUDY

Obj1: To assess the impact of institutional support on policy compliance in solid waste management.

Obj2: To examine the influence of public awareness on policy compliance in solid waste management.

Obj3: To analyze the mediating role of policy compliance in the relationship between institutional support and the effectiveness of solid waste management.

Obj4: To investigate the mediating role of policy compliance in the relationship between public awareness and the effectiveness of solid waste management.

4. RESEARCH METHODOLOGY

Research Design: Quantitative data were the primary focus of the research design, which was a measurable representation of the information. The study applied mediating and moderating analyses to determine the role of thinking style as a mediator in the influence of cognitive biases while the emotion regulation was the moderator of the impact of thinking style on Robo-Advisory adoption. Furthermore, the research not only aimed at giving quantitative insights to Robo-Advisory developers, policy makers, wealth managers and financial advisors about the user strategies that led to adoption and overcoming behavioral difficulties but it was also providing a quantitative perspective to them.

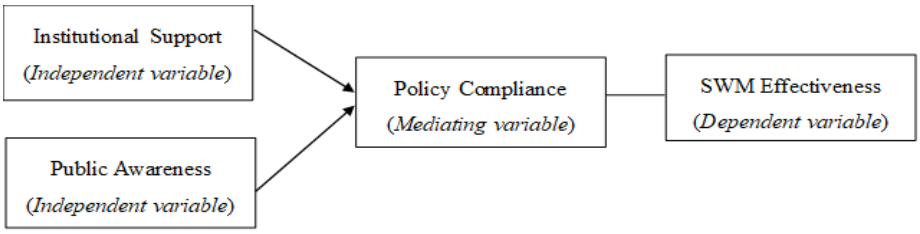

Figure 3: Conceptual Model.
Source: Self-prepared by author.

Data Collection: The data gathering method consisted of a systematic and structured questionnaire with a Likert scale to evaluate the constructs of institutional effectiveness, public awareness, and compliance with policy, among others. The targeted group consisted of various stakeholders such as city officials, waste management companies and their employees, and others. A stratified random sampling technique was applied to choose the sample from different regions, hence, improving the generalizability of the research. Cochran's formula was utilized to determine a target of 385 participants for the study. In total, 450 questionnaires were sent out with the aim of getting a detailed understanding of the study objectives. Out of those, 420 had been filled out by the respondents. Yet, upon checking, it was discovered that five questionnaires were not completed. Therefore, 415 valid respondents were left for analysis. A pilot study was carried out to test the accuracy and dependability of the data. One-fifth of the final sample size was utilized for this purpose, which turned out to be 83 questionnaires.

Data Analysis Techniques: The collected information verified the measurement constructs, and subsequently, the "Structural Equation Modeling (SEM)" through SmartPLS was used to test the hypotheses. The mediation question treated policy adherence as a mediator in the improvement of SWM efficiency. These methods established a strict framework for the verification of the conceptual model, and moreover, the reliability of the data was ensured by the incorporation of a pilot study in the research. The study performed descriptive analysis, regression analysis, and SEM analysis. The analytical software used was SmartPLS, SPSS, and MS Excel.

Study Area: The study focused on the National Capital Region (NCR) of Delhi, which comprised New Delhi, Ghaziabad, Noida, Gurugram, and Faridabad. The selection of Delhi NCR as a place for this research was based on its vivid diversity of various types of municipalities, from urban locations with a very high population density to fast-growing suburbs. The region displayed a wide variety of regulations regarding solid waste and public awareness campaigns. Such a mixture guaranteed a significant difference between the support systems of the institutions, citizens' levels of engagement, and obedience to the policies, which were all necessary factors for testing the suggested SEM model.

Ethical Considerations: Ethical considerations were observed strictly throughout the research. All participants gave informed consent, and data privacy and confidentiality were ensured. The anonymity of responses was provided, and participation was purely voluntary to ensure the sanctity of the research process.

Figure 4: Research Methodology
(Source: Self-prepared by author).

4.1. Results And Analysis

The consequences and inquiry of the data were

presented in this part. The results have been categorised based on aims, demographics, accuracy and legitimacy, and assumptions. The objectives and hypotheses have been updated to include a table showing the outcomes and a description of them.

Table 4: Reliability and Validity Statistics.

Reliability Statistics				
Label	Cronbach's Alpha	N of Items	KMO and Bartlett's value	Sig. value
Institutional Support	0.958	6	0.937	0.000
Policy Compliance	0.962	6	0.938	0.000
Public Awareness	0.965	6	0.924	0.000
Effectiveness of Solid Waste Management	0.945	6	0.880	0.000

Table 4 shows the reliability and validity of constructs-Institutional Support, Policy Compliance, Civic Cognizance, and Effectiveness of Solid Trash Administration. It has been found that there is an excellent internal consistency reflected by the very high Cronbach Alpha values for each construct: 0.945 for Institutional Support; 0.958 for Policy Compliance; 0.959 for Public Awareness; and 0.965 for Effectiveness of Solid Waste Management. The measures for each construct are, therefore, considered to be reliable in measuring the concept intended. Furthermore, the Kaiser-Meyer-Olkin values fall between 0.880 and 0.938 for all constructs, reflecting a high degree of sampling adequacy and suitability for factor analysis. Also, the implication assessment for "Bartlett's Test of Sphericity" was found to be 0.000 for all constructs, indicating that the respective correlation matrices are significantly different from identity matrices, thus allowing for justification for factor analysis. In instant, all results strongly support and are in favour of the ensuing statistical analysis carried out using the employed measurement tools.

Table 5: Demographic Characteristics of the Respondents.

Sr. no.	Demographics	Category	Frequency	Percentage
1.	Gender	Male	254	61.2%
		Female	161	38.8%
2.	Age	Below 25 years	80	19.3%
		25-35 years	90	21.7%
		36-45 years	95	22.9%
		46-55 years	78	18.8%
		Above 55 years	72	17.3%
3.	Education Qualification	Graduate	138	33.3%
		Postgraduate	150	36.1%
		Others	127	30.6%
4.	Marital Status	Married	231	55.7%
		Unmarried	184	44.3%
5.	Current Region/State	New Delhi	79	19.0%
		Ghaziabad	84	20.2%
		Noida	85	20.5%
		Gurugram	78	18.8%
		Faridabad	89	21.4%
6.	Location	Urban	197	47.5%
		Semi-urban	218	52.5%

Table 5 displays "the demographic characteristics of the respondents" regarding their location, age, marital relationship, gender, education, and present state or area. According to the statistics, the gender distribution is more male (61.2%) than female (38.8%). The bulk of people (22.9%) are between the ages of 36 and 45. In terms of education, a sizable percentage (36.1%) have a postgraduate degree. 55.7% of people are hitched. Regarding present states and zones, Faridabad accounts for the largest percentage of responders (21.4%). Lastly, semi-urban regions account for the bulk of responders (52.5%).

All things considered, the information offers an understanding of the demographics of the group being examined in order to analyse the role that proactive management plays in promoting ethical actions and staff involvement.

- Factor Analysis

Table 6: Communalities Table.

Communalities		
	Initial	Extraction
IS1	1.000	.784
IS2	1.000	.770
IS3	1.000	.775
IS4	1.000	.777
IS5	1.000	.770
IS6	1.000	.815
PC1	1.000	.812
PC2	1.000	.808
PC3	1.000	.810
PC4	1.000	.841
PC5	1.000	.825
PC6	1.000	.843
PA1	1.000	.824
PA2	1.000	.823
PA3	1.000	.809
PA4	1.000	.792
PA5	1.000	.809
PA6	1.000	.836
ESWM1	1.000	.825
ESWM2	1.000	.827
ESWM3	1.000	.834
ESWM4	1.000	.850
ESWM5	1.000	.840
ESWM6	1.000	.835
Extraction Method: Principal Component Analysis.		

Table 6 depicts the amount of variance each item has accounted for by the extracted components through Principal Component Analysis. Accordingly, all extraction values are relatively high, from 0.770 to 0.850, indicating that underlying factors account for most of the variance in the items. The items under Institutional Support (IS), Policy Compliance (PC), Public Awareness (PA), and Effectiveness of Solid Waste Management (ESWM) have fairly high communalities; especially IS6 (0.815), PC6 (0.843), PA6 (0.836), and ESWM4 (0.850) that have the highest values within their constructs. Such results indicate that the chosen items are properly represented by the extracted components, thereby confirming the appropriateness of the statistics for factor analysis and upholding the structural soundness of the measurement model.

Table 7: Rotated Component Matrix Table.

Rotated Component Matrix Component				
	1	2	3	4
IS1				.740
IS2				.752
IS3				.743
IS4				.766
IS5				.758
IS6				.793
PC1			.773	
PC2			.741	
PC3			.763	
PC4			.764	
PC5			.761	
PC6			.774	
PA1	.763			

PA2	.773			
PA3	.767			
PA4	.768			
PA5	.751			
PA6	.783			
ESWM1		.761		
ESWM2		.767		
ESWM3		.758		
ESWM4		.791		
ESWM5		.742		
ESWM6		.775		
Extraction Method: Principal Component Analysis. **Rotation** Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 7 iterations.				

Table 7 shows the Rotated Component Matrix following Principal Component Analysis with Varimax rotation presents a clear and distinct factor structure among the four constructs: Institutional Support (IS), Policy Compliance (PC), Public Awareness (PA), and Effectiveness of Solid Waste Management (ESWM). The groups of items load very much on their separate components, showing clear construct differentiation. All the PA items loaded on Component 1 from 0.751 to 0.783, while the ESWM items loaded on Component 2 very strongly, from 0.742 to 0.791. Policy Compliance items load on Component 3 (0.741 to 0.774), and Institutional Support items load on Component 4 (0.740 to 0.793). Overwhelmingly high and clean loadings with almost no cross-loadings demonstrate the one-dimensionality of each factor and provide evidence for the structural validity of the instrument. The items group logically under their respective constructs and therefore can be used for further factor-based or structural modeling analysis.

- Construct Validity

Table 8: Convergent Validity of the Constructs.

S. no.	Construct	Items	Standardized Loadings	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
1.	Institutional Support	IS1	0.889	0.943	0.955	0.779
		IS2	0.879			
		IS3	0.881			
		IS4	0.877			
		IS5	0.874			
		IS6	0.897			
2.	Policy Compliance	PC1	0.898	0.957	0.965	0.822
		PC3	0.901			
		PC4	0.899			
		PC5	0.918			
		PC6	0.908			
3.	Public Awareness	PA1	0.906	0.954	0.963	0.814
		PA2	0.906			
		PA3	0.900			
		PA4	0.886			
		PA5	0.902			
		PA6	0.914			
4.	Effectiveness of Solid Waste Management	ESWM1	0.901	0.951	0.961	0.804
		ESWM2	0.886			
		ESWM3	0.897			
		ESWM4	0.899			
		ESWM5	0.900			
		ESWM6	0.895			

Table 8 shows the convergent validity for the four constructs, Institutional Support, Policy Compliance, Public Awareness, and Effectiveness of Solid Waste Management, which demonstrates strong psychometric properties, confirming the consistency and rationality of the instrument. Every standardised

loading of factors is higher than the suggested cutoff of 0.70, suggesting that each item makes a substantial contribution to its corresponding domain. Strong internal cohesion is indicated by "Cronbach's Alpha values", which range from 0.943 to 0.957, and Composite Reliability (CR) values, which range from 0.955 to 0.965. Furthermore, all structures have "Average Variance Extracted (AVE)" values above 0.70, with ranges of 0.779 to 0.822, confirming good convergent validity. The dimensions that each construct covers indicate that Institutional Support consists of six factors, namely Government Support, Waste Segregation Management, and Training Provision, among others, which reflect high loadings (e.g., IS6 = 0.897). Policy Compliance replicates a firm adherence to solid waste regulations with Civic Responsibility and Enforcement Measures rated particularly high (e.g., PC5 = 0.918). Public Awareness is largely attributed to Media Promotion, Environmental Awareness, and Educational Initiatives, all showing very good loadings (e.g., PA6 = 0.914). The Effectiveness of Solid Waste Management is described through the characteristics of Clean Public Spaces, Timely Waste Collection, and Reduced Illegal Dumping, with the items having very high loadings (e.g., ESWM1 = 0.901). Thus, these findings guarantee the validity and reliability of the measure established and, therefore, make it a good basis for structural modeling and further analysis of solid waste management effectiveness.

Table 9: Discriminant Validity.

	ESWM	IS	PA	PC
ESWM	0.896			
IS	0.699	0.883		
PA	0.677	0.675	0.902	
PC	0.699	0.699	0.721	0.907

Table 9 shows the discriminant validity results, assessed using the Fornell-Larcker criterion, indicate that each construct in the model is distinct and measures a unique aspect of solid waste management. The square root of the Average Variance Extracted (AVE) for each construct, Effectiveness of Solid Waste Management (0.896), Institutional Support (0.883), Public Awareness (0.902), and Policy Compliance (0.907), is greater than its corresponding inter-construct correlations. For example, the correlation between Institutional Support and Policy Compliance is 0.699, which is lower than the square root of AVE for both constructs (0.883 and 0.907, respectively). Similarly, Public Awareness correlates moderately with other constructs but maintains higher AVE square roots, confirming distinctiveness.

Table 10: Goodness of Model Fit Indices.

	Saturated model	Estimated model
SRMR	0.025	0.025
d_ULS	0.194	0.194
d_G	0.173	0.173
Chi-square	414.991	414.991
NFI	0.961	0.961

These findings validate that the constructs are not only internally consistent but also conceptually and empirically different from one another, thereby affirming strong measuring model's discriminatory accuracy. Table 10 shows the approach corresponded values for both the predicted and overloaded designs, showing that the structural formula fits the data quite well. A very strong predictive accuracy is shown by the Standardised Root Mean Square Residual (SRMR) value of 0.025, which is much below the suggested cutoff of 0.08. System reliability and uniformity are reinforced by the low and similar d_ULS (0.194) and d_G (0.173) results between the two models, which measure the difference between the observational and system-implied correlated correlations. A strong Normed Fit Index (NFI) of 0.961, which is higher than the suitable limit of 0.90, complements the chi-square value of 414.991, which represents the complete accuracy of the model. However, chi-square is sensitive to sample size. Collectively, these indicators confirm that the measurement and structural models fit the observed data very well, supporting the robustness of the hypothesized model structure in the context of solid waste management effectiveness.

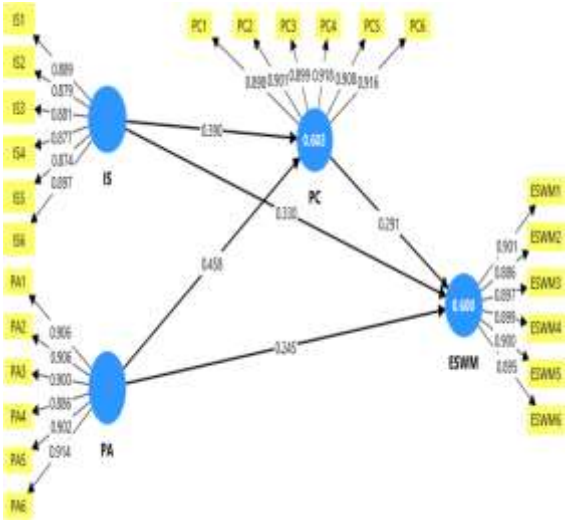

Figure 5: SEM Model.

Figure 5 shows the structural model shown in that illustrates the relationships among four key latent constructs: Institutional Support (IS), Public Awareness (PA), Policy Compliance (PC), and Effectiveness of Solid Waste Management (ESWM).

Each construct is measured by multiple observed indicators with high standardized loadings (all > 0.87), confirming strong item reliability. The model reveals explicit connections from IS and PA to PC, with path coefficients of 0.390 and 0.458, respectively, indicating that both institutional efforts and public awareness considerably contribute to the acceptance of waste management policies. PC has a direct influence on ESWM (β = 0.291), demonstrating that higher policy compliance results in better solid waste management. Besides, IS and PA are also direct paths to ESWM which have the coefficients of 0.330 and 0.245, respectively, thus showing the partial mediation through policy compliance. The R^2 of 0.603 for PC and 0.600 for ESWM signifies that a large part of the variance in these constructs is accounted for by the model. The model, in general, shows a very systematic and statistically appropriate way to represent the interaction of institutional and public-level factors in terms of policy compliance and the ultimate effectiveness of solid waste management.

Table 11: Hypothesis Testing.

Hypothesis	Predicted Relationship	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
H1	IS -> PC	0.390	0.390	0.064	6.084	0.000
H2	PA -> PC	0.458	0.458	0.068	6.700	0.000
H3	IS -> PC -> ESWM	0.114	0.113	0.032	3.500	0.000
H4	PA -> PC -> ESWM	0.133	0.133	0.038	3.522	0.000

For H1: The findings provide compelling evidence for the hypothesis that Institutional Support (IS) is a major factor affecting the level of compliance (PC) in the area of waste management. The path coefficient of 0.390 combined with a t-value of 6.084 and p-value = 0.000 indicates a significant and positive relationship that is statistically proven. This means that local governments when they give regular support like monitoring, training, and providing necessary facilities, make it easier for the different people involved (like residents, and vendors) to follow the waste management guidelines. Hence, the institutional setups become crucial for the regulations in solid waste management to be adhered to at the very least level..

For H2: The research has revealed that Public Awareness (PA) has a huge and positive effect on Policy Compliance (PC), because of the path constant of 0.458, the t-value of 6.700, and the p-value = 0.000. The result underscores the importance of the various measures taken to educate the public, school children, and communities in encouraging compliance. If people know about waste separation, health hazards, and their rights and duties, they will follow the rules about municipal solid waste management more closely. Hence, it can be said that raising public awareness is one of the key factors in making policy enforcement more effective.

For H3: The results confirm the mediating role of Policy Compliance (PC) in the relationship between Institutional Support (IS) and Effectiveness of Solid Waste Management (ESWM) with an indirect effect of 0.114, a t-value of 3.500, and a p-value of 0.000. This means that the interventions of the institutions do help to achieve better waste management results, however this impact is partly passed through adherence to waste policies. The effectiveness of institutional interventions, therefore, is increased when they are supported by compliance-promoting mechanisms at the individual and community levels.

For H4: The results showed that there was a notable mediation effect of Policy Compliance (PC) between Public Awareness (PA) and Effectiveness of Solid Waste Management (ESWM), with an indirect effect size of 0.133, a t-value of 3.522, and a p-value of 0.000. This shows that being informed is not the only factor that leads to proper waste disposal practices; rather, it has an effect through behavioral compliance. Therefore, the support of the policy and the efforts to make the public aware of it should be done simultaneously so that the information that is imparted to the public will eventually lead to a better situation in solid waste management.

4.2. Discussion

The research outcomes pointed out a robust and favorable association between the backing of institutions and adherence to the policy in solid waste management (SWM) and also a solid correlation between public perception and compliance with SWM policies. Further, the research pinpointed two major mediating impacts: compliance with policies on the connection between institutional support and SWM effectiveness (β = 0.114, $p < 0.001$), and public awareness on the total SWM consequence (β = 0.133, $p < 0.001$). The trade-offs of the research show that the governance setup and the interaction of the authority and citizens are the main factors for the success of the waste management practices. Furthermore, the research also pointed out that formalized and well-governed regulations, and inter-agency cooperation do increase the public's adherence to the SWM rules directly. The research was in line with the Institutional Theory as proposed by Huang (2022) which says that the behavior of compliance is largely

driven by formal institutions and regulations. Earlier research stated that institutions must not only in their capacity as rule makers but also as supporters in creating behaviors that are in line with the rules, and pointed out that institutional efficacy as the main factor in policy compliance (Tran et al., 2025). However, weak integration of institutions, particularly in the complicated governance framework of the NCR, has resulted in the 2016 SWM Rules being ineffective. The cross-sectional design of the study was one of the major limitations that restricted the understanding of causal relationships and overlooked the gradual nature of the development of institutional frameworks; besides, the findings might not be applicable to rural or peri-urban regions that do not have formal institutions.

The study demonstrated that increasing the public's knowledge will result in a better compliance rate which is also in line with Ajzen's Theory of Planned Behavior. The past researches support the view that the awareness campaigns prompted the public to get involved in the recycling and waste segregation (Kumari & Raghubanshi, 2023). Lakhouit (2025) and Agya (2024) suggested that value-based messaging which made a personal connection was the most powerful method but that the previous studies had often inflated awareness levels by depending on self-reports and not distinguishing between the channels of communication. Through the SEM method applied in this research, it was shown that compliance with the policy is a partial mediator of the effect of institutional support on the success of SWM. This means that, alongside leadership, infrastructure, and public trust, support from institutions still plays an important role. The role of awareness as a mediator is another that points out the necessity for feedback mechanisms such as citizen scorecards and gamified apps to turn passive awareness into active compliance—this is an area that future studies should tackle.

The more citizens feel their participation is important and their power in decision-making is recognized, the more they will be inclined to adopt compliance behavior, according to Kalra (2020). Nonetheless, it is hard to predict that a change in behavior will be permanent when there is no observation, feedback, and rewards provided. The psychological constructs of intention to behave in a certain way or peer influence are not part of the study and neither is the distinction between passive awareness and active responses made. It would be more productive if the awareness and compliance tools, like citizen scorecards and community incentives, were combined in such a way that the compliance is seen as a behavioral outcome rather than a legal obligation.

The research goes further than Lakhouit (2025) and Agya et al. (2024) in that it involved different awareness channels and was value-based messaging. Moreover, it also goes beyond Kumari & Raghubanshi (2023) by the focus on institutional dynamics in the study.

5. CONCLUSION

The present investigation looks into the role of institutional support and public awareness in enhancing the adherence to the 2016 Solid Waste Management (SWM) Rules, especially considering the increasing urbanization, waste generation, and the inefficacy of conventional methods. The study involves a total of five Indian cities with varying waste compositions and governance structures, and it attempts to find out the critical areas of difficulty and behavior that need to be changed. The analysis is intended to produce an empirical evaluation of the dynamic between policy implementation and compliance. The theoretical foundation of the research comprises Institutional Theory, Behavioral Change Models, and Environmental Governance, wherein institutions, individual behaviors, and governance mechanisms are integrated. This methodology gives researchers an understanding of how these factors interact to facilitate policy outcomes in waste management. Among the findings of the study, the most important ones are that institutional capacity ($\beta = 0.390$) and public awareness ($\beta = 0.458$) are the good facilitators of the rules and thus, the overall effectiveness of SWM has been influenced greatly by them. It has been pointed out through these results that in the case of sustainable waste governance, the rule being clear together with the efficient operation of local bodies and collaboration of various agencies, the awareness campaigns are all interdependent factors. Differences in waste composition and recycling rates across regions, together with the continued use of landfills, point to the existence of systemic inefficiencies. The changing urban landscape in India will call for a corresponding response in the form of Institutional reforms, participatory educational tools, and local interventions. Sustainable solid waste management will require a partnership between institutions and citizens, supported by policy solutions that are inclusive and make use of technology.

5.1. Limitations

The limitations of the study are a few in number. To begin with, it employed a cross-sectional survey

design which measured several variables at one point in time; hence, the causal relationships, if any, between institutional support, public awareness, policy compliance and SWM effectiveness were not established. Also, this research was limited to the National Capital Region (NCR), which is urban and not rural or culturally diverse, so the conclusions drawn were less applicable to those areas. Consequently, the findings may not accurately reflect the conditions in rural areas or regions with different cultural and administrative backgrounds, the generalizability of the results is restricted. Third, the sample selection approach was based on the willingness of participants to take part in the study, which means there was a risk of non-response bias. People who were more aware of waste management issues or had stronger opinions about them might have been more willing to take part in the study. Fourth, psychological constructs or dimensions like behavioral intention, social norm and related variables were not part of this research. Lastly, the study was based on self-reported data which had response biases like social desirability bias and an overestimate of awareness or compliance included in them.

5.2. Implications

The study shows that institutional support is a key determinant of policy compliance, and, thus, municipalities and urban local bodies need to make comprehensive investments related to administrative redesign, capacity-building, and intra-institutional coordination (among other things) to enhance SWM rule implementation. The compliance element of municipal solid waste policy acts as tension between targeted institutional efforts, public understanding, and the effectiveness of sustainable waste management, pointing to the need for awareness campaigns and policy-related programs to encompass compliance motivation mechanisms such as reward-based segregation and citizen score cards. Since public awareness is a major precursor to compliance, awareness campaigns should be more than just sharing information; they should integrate value-based messaging; support community engagement; and nudge behaviors with elements like gamified apps, local challenges, and public/institutional recognition systems.

5.3. Future Directions

Future research should help overcome the limitations of the current literature by using a longitudinal research design to examine changes in compliance and its impact on institutional and public behavior, thereby providing more rigorous evidence of causality. More comparative studies of urban and rural or high- versus low-capacity municipalities could shed light on how governance structure may influence the effectiveness of SWM. Incorporating potential mediators or moderators such as civic trust, perceived control or leadership could provide additional insight about the relationship between institutional support, awareness and compliance. Utilizing a mixed-methods approach in the future stating with quantitative data but also including qualitative E.g., interviews, focus groups, would deepen the understanding of compliance, especially in semi-urban settings. Examining how AI, mobile apps, and IoT (internet of things) based tracking systems can improve real-time monitoring relating to public engagement can continue to push towards adoption of more inclusive and adaptive policy models for theorizing sustainable SWM governance.

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REFERENCES

Agya, B.A., Rückert, A. and Dornack, C. (2024) Effectiveness of traditional solid waste management system of rural communities: A case study in the Kwahu East District, Ghana. Environmental Challenges, 15, 100869.

Alam, M. (2023) Environmental education and non-governmental organizations. In: The Palgrave Encyclopedia of Urban and Regional Futures, pp. 495–502. Cham: Springer International Publishing.

Ansari, A., Dutt, D. and Kumar, V. (2024) Catalyzing paradigm shifts in global waste management: A case study of Saharanpur Smart City. Waste Management Bulletin, 2(1), 29–38.

Awino, F.B. and Apitz, S.E. (2024) Solid waste management in the context of the waste hierarchy and circular economy frameworks: An international critical review. Integrated Environmental Assessment and Management, 20(1), 9–35.

Bhattarai, K. and Conway, D. (2020) Urban growth. In: Contemporary environmental problems in Nepal: Geographic perspectives, pp. 201–334. Cham: Springer International Publishing.

Bonifazi, G., Grosso, C., Palmieri, R. and Serranti, S. (2025) Current trends and challenges in construction and demolition waste recycling. Current Opinion in Green and Sustainable Chemistry, 53, 101032

Budihardjo, M.A., Ardiansyah, S.Y. and Ramadan, B.S. (2022) Community-driven material recovery facility (CdMRF) for sustainable economic incentives of waste management: Evidence from Semarang City, Indonesia. Habitat International, 119, 102488.

Chauhan, K., Khare, S., Rathore, S.S., Mishra, S., Srivastava, N., Varshney, S. and Khanna, C. (2024) Hazardous Waste: Chemical Identification and Safe Disposal. In: Waste Management for Smart Cities, pp. 81–104. Singapore: Springer Nature Singapore.

Chauhan, S. and S., (2023) A SWOT analysis for sustainable municipal solid waste management in Gurugram city, Haryana (India). Sustainability, Agri, Food and Environmental Research (DISCONTINUED). https://doi.org/10.7770/safer-v11n1-art77

Chen, H.L., Nath, T.K., Chong, S., Foo, V., Gibbins, C. and Lechner, A.M. (2021) The plastic waste problem in Malaysia: management, recycling and disposal of local and global plastic waste. SN Applied Sciences, 3, 1–15.

Ezeudu, O.B., Ezeudu, T.S., Ugochukwu, U.C., Agunwamba, J.C. and Oraelosi, T.C. (2021) Enablers and barriers to implementation of circular economy in solid waste valorization: The case of urban markets in Anambra, Southeast Nigeria. Environmental and Sustainability Indicators, 12, 100150.

Filimonova, I.V., Krivosheeva, O.I. and Mishenin, M.V. (2023) The economic effect of public–private partnerships in the implementation of climate projects for the disposal of municipal solid waste. Energy Reports, 9, 996–1002.

Huang, R., Xie, X. and Zhou, H. (2022) 'Isomorphic' behavior of corporate greenwashing. Chinese Journal of Population, Resources and Environment, 20(1), 29–39.

Kalra, N. (2020) Community participation and waste management. In: Sustainable Waste Management: Policies and Case Studies: 7th IconSWM—ISWMAW 2017, Volume 1, pp. 115–123. Singapore: Springer Singapore.

Kladnik, V., Schwarzböck, T. and Dworak, S. (2025) Assessing current practices and alternative scenarios for the management of public waste in the city of Vienna. Waste Management, 206, 115052.

Kosarkar, M. and Barthwal, S. (2025) Environmentally conscious but helpless: Consumer challenges for participation in formal e-waste collection initiatives of India. Cleaner Waste Systems, 100363.

Kosior, E. and Crescenzi, I. (2020) Solutions to the plastic waste problem on land and in the oceans. In: Plastic waste and recycling, pp. 415–446. Academic Press.

Kulkarni, B.N. (2020) Environmental sustainability assessment of land disposal of municipal solid waste generated in Indian cities—A review. Environmental Development, 33, 100490.

Kumar, P., Singh, D.J. and John, S. (2025) Multi-criteria decision support system for sustainable municipal solid waste management: A case study of Chandigarh, India. Environmental Development, 55, 101228.

Kumar, S. and Bhati, H.V. (2022) Waste management to zero waste: Global perspectives and review of Indian law and policy. Emerging Trends to Approaching Zero Waste, pp. 79–101.

Kumari, T. and Raghubanshi, A.S. (2023) Waste management practices in the developing nations: challenges and opportunities. Waste Management and Resource Recycling in the Developing World, pp. 773–797.

Lakhouit, A. (2025) Revolutionizing urban solid waste management with AI and IoT: a review of smart solutions for waste collection, sorting, and recycling. Results in Engineering, 104018.

Leknoi, U., Painmanakul, P., Chawaloesphonsiya, N., Wimolsakcharoen, W., Samritthinanta, C. and Yiengthaisong, A. (2024) Building sustainable community: Insight from successful waste management initiative. Resources, Conservation & Recycling Advances, 24, 200238.

Li, Y., Palaniappan, M., Alsaleh, N., Kumar, D.T., Elfar, A.A., Pinto, M.C.B. and Torres, A.M. (2025) Decision analysis on sustainable manufacturing practices: cross country perspective. Annals of Operations Research, 345(1), 277–315.

Massoud, M., Lameh, G., Bardus, M. and Alameddine, I. (2021) Determinants of waste management practices and willingness to pay for improving waste services in a low-middle income country. Environmental Management, 68(2), 198–209.

Meena, M.D., Dotaniya, M.L., Meena, B.L., Rai, P.K., Antil, R.S., Meena, H.S. and Meena, R.B. (2023) Municipal solid waste: Opportunities, challenges and management policies in India: A review. Waste Management Bulletin, 1(1), 4–18.

Mohanty, S., Saha, S., Santra, G.H. and Kumari, A. (2021) Future perspective of solid waste management strategy in India. In: Handbook of solid waste management: sustainability through circular economy, pp. 1–36. Singapore: Springer Singapore.

Naskar, S.T. and Lindahl, J.M.M. (2025) Forty years of the theory of planned behavior: a bibliometric analysis (1985–2024). Management Review Quarterly, pp. 1–60.

Nithya, R., Sivasankari, C. and Thirunavukkarasu, A. (2021) Electronic waste generation, regulation and metal recovery: a review. Environmental Chemistry Letters, 19, 1347–1368.

Pal, M.S. and Bhatia, M. (2022) Current status, topographical constraints, and implementation strategy of municipal solid waste in India: a review. Arabian Journal of Geosciences, 15(12), 1176.

Pallegedara, A., Kumara, A.S., Jayasena, D.M. and Soysa, R.N.K. (2024) Can interventions improve waste management by households? Lessons from a randomized experiment in Sri Lanka. Waste Management Bulletin, 2(1), 289–298.

Samadi, A., Gao, L., Kong, L., Orooji, Y. and Zhao, S. (2022) Waste-derived low-cost ceramic membranes for water treatment: Opportunities, challenges and future directions. Resources, Conservation and Recycling, 185, 106497.

Sarjito, A. (2024) Green Governance: Integrating Environmental Policy into Public Decision-Making. Public Policy Journal, 5(1), 39–54.

Shahab, S. and Anjum, M. (2022) Solid Waste Management Scenario in India and Illegal Dump Detection Using Deep Learning: An AI Approach towards Sustainable Waste Management. Sustainability. https://doi.org/10.3390/su142315896

Sharma, H.B., Vanapalli, K.R., Cheela, V.S., Ranjan, V.P., Jaglan, A.K., Dubey, B. and Bhattacharya, J. (2020) Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. Resources, Conservation and Recycling, 162, 105052.

Talballa, H.M. and Gichuru, J. (2023) Toward the circular Qatari zero-waste management sector. Gulf Studies, pp. 305–327.

Tan, Y., Lin, B. and Wang, L. (2025) Green finance and corporate environmental performance. International Review of Economics & Finance, 98, 103929.

Thakur, P. and Kumar, S. (2022) Evaluation of e-waste status, management strategies, and legislations. International Journal of Environmental Science and Technology, 19(7), 6957–6966.

Tran, T.Y.A., Herat, S. and Kaparaju, P. (2025) Current Status and Compliance Management of EPR Regulations for Packaging Waste in Vietnam. Circular Economy and Sustainability, pp. 1–38.

Unegbu, H.C.O. and Yawas, D.S. (2024) Optimizing construction and demolition waste management in Nigeria: challenges, regulatory frameworks, and policy solutions. Discover Civil Engineering, 1(1), 141.

Zhang, Z., Chen, Z., Zhang, J., Liu, Y., Chen, L., Yang, M. and Yap, P.S. (2024) Municipal solid waste management challenges in developing regions: A comprehensive review and future perspectives for Asia and Africa. Science of the Total Environment, 930, 172794.