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Household Waste Disposal Practices And Behavioral Determinants In Dimapur, Nagaland

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Abstract- This study explores household waste disposal practices in Dimapur, Nagaland, and investigates the role of infrastructure and behavioral awareness in shaping disposal behavior. A cross-sectional survey of 460 households was conducted to assess disposal methods and reasons for informal disposal. Chi-square and Spearman rank correlation tests were applied to examine associations between drainage infrastructure, segregation awareness, and disposal behavior. Results show that 60% of households rely on municipal garbage trucks, while 40% continue informal practices such as burning, dumping, and open disposal. Lack of provision for waste disposal facilities was the most cited reason for such behavior. The statistical analysis revealed no significant association between drainage type and disposal method ($p = 0.431$) and no significant correlation between awareness and responsible behavior ($p = 0.579$). The findings highlight the need for integrated strategies combining service delivery with public engagement.

Keywords- Household waste disposal; Behavioral determinants; Waste segregation awareness; Drainage infrastructure; Statistical analyses; Informal waste practices.

I. Introduction

In an era marked by urbanization and changing consumption patterns, waste management has become not only a critical urban service but also a fundamental pillar of environmental stewardship. Waste management being an important aspect of modern urban life, encompasses a range of activities aimed at efficiently and responsibly handling various types of waste materials. This includes the systematic collection, transportation, processing, recycling, and disposal of waste, all with the overarching goal of safeguarding public health, preserving the environment, and conserving valuable resources. In this comprehensive exploration, we delve into the multifaceted world of waste management, probing the challenges, innovations, and sustainable solutions that play pivotal roles in shaping our cities and influencing the well-being of future generations. As solid waste management is a very important aspect of environmental hygiene, hence it is imperative to be incorporated with our environmental planning. Goal of the 8 Millennium Development Goal is to 'ensure environmental sustainability' **(UNESCO, 2011).**

As urban centres expand and consumption patterns evolve, the responsible management of waste materials has emerged as a pressing global concern. Waste management transcends geographical boundaries, affecting cities and communities' worldwide. With increasing population and industrial growth the amount and varieties of solid waste materials have been increasing day by day. This creates a great threat to the environment and development. Solid waste is on its way as a result of urbanization and industrialization **(Sharma, 2004)**. The rapid pace of urbanization in India has outpaced the capacity of municipal systems to manage solid waste effectively. Although national missions like Swachh Bharat have improved infrastructure and awareness, waste disposal behavior still varies significantly based on service availability and household awareness (Gupta et al., 2015; Panwar et al., 2019).

One such community facing the complexities of modern waste management is Dimapur, a rapidly growing city nestled in the northeastern state of Nagaland, India. The challenges and solutions discussed here are emblematic of the broader sustainability goals and urban development challenges faced not only by Dimapur but by cities around the globe.

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Dimapur, with its unique blend of cultural heritage and economic dynamism, is undergoing transformative changes. However, alongside its growth, the city confronts a mounting challenge in managing its waste streams ranging from open dumping to inconsistent waste collection and poor drainage systems. Informal disposal practices are particularly common in peri-urban wards lacking access to regular municipal services. The surge in population and rapid consumerism lifestyle among the citizens have led to an exponential increase in waste generation, placing immense pressure on the city's limited waste management infrastructure. Our environment is facing a potential threat from an unsustainable waste disposal system which is a burning issue in almost all urban cities and peri urban pockets. Some Wastes are secondary resource products; these are recovered products or form recycling as recovered materials **(Choudhury,2015)**. With constrained resources and a need for increased awareness about sustainable waste practices, Dimapur grapples with a situation that demands immediate attention.

This problem has worsened because there is not as much room in cities for all the garbage. In the past, cities like Kohima (the capital city of Nagaland) and Dimapur had plenty of open spaces where waste could naturally break down, especially since most of it was biodegradable. However, things have changed significantly. Now, much more garbage is produced, there is less space for it, and the presence of non-biodegradable materials has created even more challenges. This makes it really hard for the government to deal with all the trash. They collect garbage from homes and put it in one place, which might make the people think we're getting rid of it properly. But that's not the case. Despite high rates of awareness reported nationally, gaps persist between what people know and what they practice (Zhang et al., 2015). Clearing waste materials from the households becomes a social problem as those collected wastes are dumped in the roadside exposed for days. The whole area smells awful, attracts animals like dogs which becomes agents of further littering the collected wastes and carries back disease to society. Not only from the hygiene point of view but such dumping sites become the most filthy sites from an aesthetic point of view. Such unscientific waste management systems only proliferate and worsen the problem of waste management.

With 23 Wards and a population size of 122834, Dimapur also faces the task of classifying waste based on its content, origin, and potential hazards. The city generates a diverse array of waste materials, including paper, metal, plastic, organic matter, and inorganic materials, each with its unique characteristics and disposal requirements. Hazardous waste categories, such as toxic or non-toxic waste, further complicate the waste management landscape. Waste originates from various sectors, including households, businesses, industries, institutions, and construction and demolition activities, making it essential to adopt comprehensive strategies for effective waste management.

To tackle the waste management challenges, Dimapur needs a multi-faceted approach, focusing on both sustainable practices and community involvement. One of the most effective steps is implementing source segregation at the household level, where residents separate biodegradable waste, such as food scraps, from non-recyclable materials. This simple yet impactful action would significantly reduce landfill pressure, minimize odors at disposal sites, and improve recycling efficiency. Along with this, encouraging responsible consumption and reducing waste generation at its source is crucial. However, widespread participation is essential for the success of these practices, and efforts must be made to ensure that all households properly segregate their waste, preventing biodegradable materials from ending up on streets or landfills.

Objectives

1. To assess household waste disposal practices and patterns in Dimapur.
2. To identify the infrastructural and behavioral determinants influencing disposal behavior.
3. To statistically evaluate the relationship between segregation awareness, infrastructure, and disposal practices.

II. Material And Method

A survey was conducted among 460 households selected through stratified random sampling across 23 wards of Dimapur. Data were collected using a structured questionnaire with sections on household characteristics, disposal method, drainage type, and awareness of segregation practices. Households were purposively selected

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the study's sample, with careful consideration given to ensure that the sample represented the entire population of interest.

Statistical Analysis

Statistical analysis in this study focused on evaluating the association between physical infrastructure (drainage system) and household waste disposal methods, as well as the relationship between segregation awareness and responsible disposal behavior. Two distinct non-parametric statistical tests were employed- Chi-square test of independence and Spearman's rank correlation, both chosen for their suitability in handling categorical and ordinal data.

III. Chi-Square Test

The Chi-square (χ^2) test of independence was used to assess whether there exists a statistically significant association between the type of drainage available to a household and the method of waste disposal practiced. The Chi-square test compares the observed frequencies in a contingency table with the frequencies expected if there were no association between the variables.

The chi-square test statistic was calculated using the formula:

$$E_{(ij)} = \frac{(R_i \times C_j)}{N}$$

Where:
- R_i = total number of observations in the i^{th} row
- C_j = total number of observations in the j^{th} column
- N = total number of observations

The test statistic is computed using the formula:

$$x^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

The degrees of freedom (df) are calculated as:

$$df = (r - 1) \times (c - 1)$$

Where r = number of rows and c = number of columns.

In this study, a 3 × 7 contingency table was constructed to represent drainage type and disposal method. The significance level was set at 0.05.

IV. Spearman's Rank Correlation

To evaluate the relationship between familiarity with waste segregation and the responsibility level of disposal method, a Spearman's rank correlation (ρ) was computed. Spearman's correlation assesses how well the relationship between two variables can be described using a monotonic function.

The Spearman correlation coefficient is defined as:

$$\rho = 1 - \frac{6 \Sigma d_i^2}{n(n^2 - 1)}$$

Where:
- d_i = difference between the ranks of corresponding values
- n = number of paired observation

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Segregation Familiarity was ranked as:
1 = Not Familiar
2 = Somewhat Familiar
3 = Very Familiar
Disposal methods were ranked into three ordered categories based on environmental responsibility:

- 1 = Less Responsible (Burning, Dumping, Others, Bury)
- 2 = Moderately Responsible (Burn & Compost)
- 3 = Responsible (Compost, Garbage Truck)

This ordinal ranking was used to assess whether increased familiarity with segregation was associated with more responsible disposal behavior using Spearman's rank correlation.

Analytical Procedure And Software

All statistical tests were conducted using IBM SPSS (Version 24). Categorical variables were properly coded prior to analysis. Rank values were manually assigned in accordance with environmental responsibility. A 5% level of significance ($\alpha = 0.05$) was adopted for all hypothesis testing.
The Chi-square test was used to determine if structural infrastructure (e.g., drainage) influences behavior relating to waste disposal. Spearman's rank correlation was used to evaluate whether increasing familiarity with segregation practices correlates with more responsible waste disposal. This combination provides both structural and behavioral insights into household waste management practices in Dimapur.

V. RESULT AND DISCUSSION

Disposal Methods
Out of 460 households, 276 (60%) use municipal garbage trucks. However, 40% still rely on informal methods, such as burning (19.35%), burying (7.39%), composting (6.09%), and dumping in open spaces (3.04%). Table 1 summarizes the disposal methods.

Table 1: Household Waste Disposal Methods (Source: Field Survey)

Waste Disposal Method	Households	Percentage (%)
Garbage Truck	276	60.00
Burn/Incinerator	89	19.35
Bury	34	7.39
Compost	28	6.09
Others	14	3.04
Burn & Compost	8	1.74
Dump on Roadside	11	2.39
Total	**460**	**100.00**

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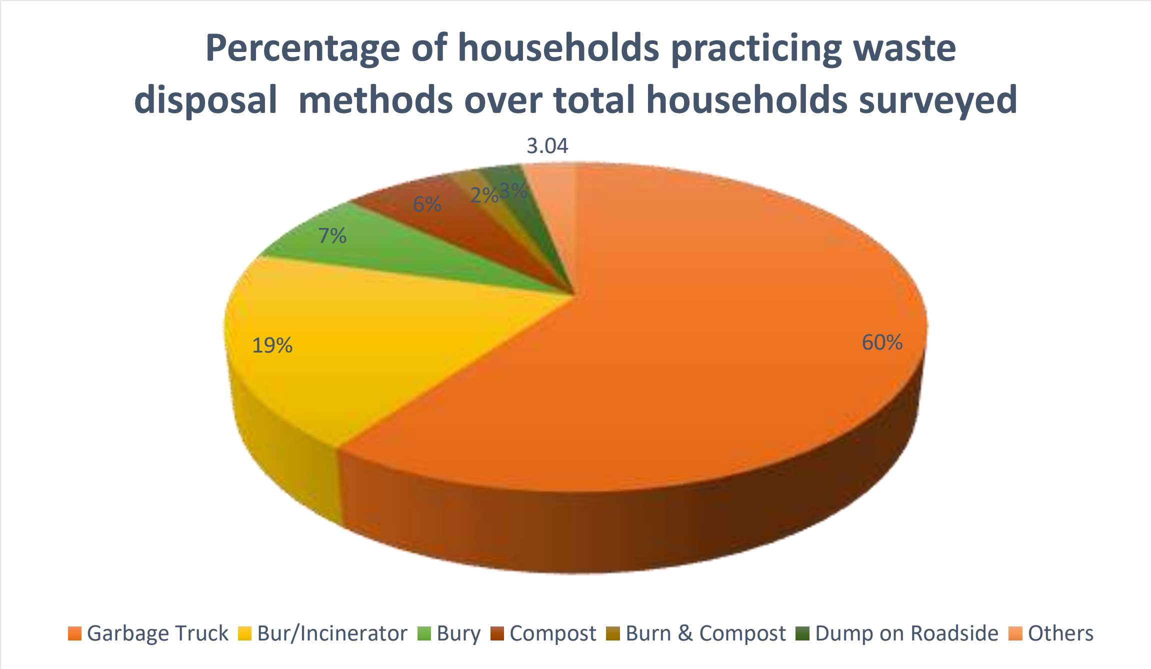

Reasons for Informal Disposal

Among the 148 households practicing burning, roadside dumping, or open disposal, the top reason was lack of waste disposal facilities (52.70%). Other reasons included inconvenience (21.62%), lack of knowledge (16.22%), and lack of time (9.46%).

Table 2: Reasons for Informal Waste Disposal (Source: Field Survey)

Reason	Households	Percentage (%)
Lack of Provision of Facility	78	52.70
Inconvenience	32	21.62
Lack of Knowledge / Awareness	24	16.22
Lack of Time	14	9.46

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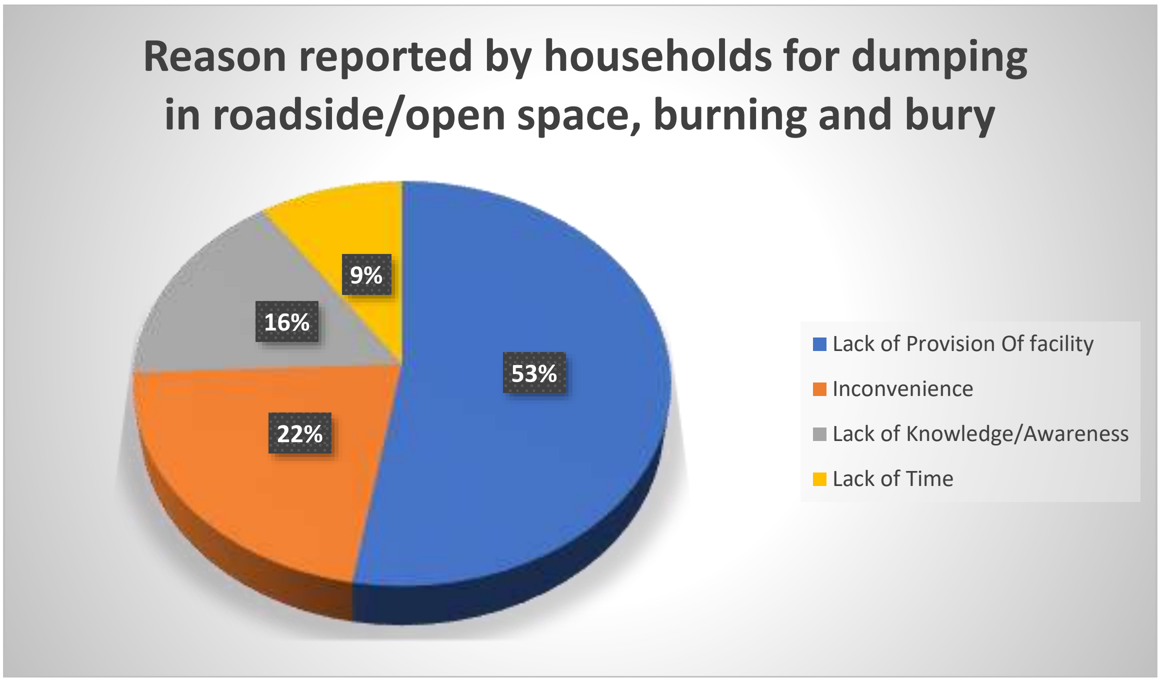

Chi-Square Test Results

To examine the relationship between household drainage type and garbage disposal method, a chi-square test of independence was conducted. The hypotheses were formulated as follows:

- **Null Hypothesis (H_0)**: There is no association between household drainage type and garbage disposal method in the study population.
- **Alternative Hypothesis (H_1)**: There is a significant association between household drainage type and garbage disposal method in the study population.

The analysis included 460 households categorized by three drainage types (closed drainage, no drainage, open drainage) and seven disposal methods (burn & compost, burn/incinerator, bury, compost, dump on roadside, garbage truck, others). Prior to analysis, the following assumptions were verified: each observation represented an independent household, both variables were categorical in nature, and expected cell frequencies met the criterion that all cells should have expected frequencies ≥ 5, or at least 80% of cells should meet this threshold. The chi-square test statistic was calculated using the formula:

$$x^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

where O_{ij} represents the observed frequency in cell (i,j) and E_{ij} represents the expected frequency calculated as:

$$E_{ij} = \frac{(\text{Row Total} \times \text{Column Total})}{\text{Grand Total}}$$

Table presents the cross-tabulation of drainage type and garbage disposal methods. The most common disposal method across all drainage types was garbage truck collection (n = 282, 61.3%), followed by burn/incinerator (n = 78, 17.0%). Open drainage systems were most prevalent (n = 233, 50.7%), followed by closed drainage (n = 161, 35.0%) and no drainage (n = 66, 14.3%).

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Table 3: Cross tabulation of drainage type and garbage disposal methods (Source: Field Survey)

Disposal Type / Drainage type	Burn & Compost	Burn/Incinerator	Bury	Compost	Dump on Roadside	Garbage Truck	Others	**Row Total**
Closed Drainage	1	33	16	9	3	92	7	**161**
No Drainage	3	7	6	5	1	41	3	**66**
Open Drainage	4	38	13	18	5	149	6	**233**
Column Total	**8**	**78**	**35**	**32**	**9**	**282**	**16**	**460**

Table 4. Expected Frequencies for Drainage Type × Garbage Disposal Method (Source: Field Survey)

Drainage Type	**Burn & Compost**	**Burn/Incinerator**	**Bury**	**Compost**	**Dump on Roadside**	**Garbage Truck**	**Others**	**Total**
Closed Drainage	2.80	27.30	12.26	11.20	3.15	98.78	5.60	161
No Drainage	1.15	11.20	5.03	4.59	1.29	40.52	2.30	66
Open Drainage	4.05	39.50	17.72	16.21	4.56	142.70	8.10	233
Total	**8**	**78**	**35**	**32**	**9**	**282**	**16**	**460**

The chi-square test of independence revealed no statistically significant association between household drainage type and garbage disposal method, χ^2 (12, n = 460) = 12.19, p = .431. The effect size was small (Cramér's V = .115), indicating minimal practical significance.

The absence of a significant relationship between drainage infrastructure and waste disposal practices suggests that household garbage disposal behavior operates independently of drainage system type. This finding indicates that factors other than drainage infrastructure may be more influential in determining waste management choices among households in the study area. The uniform distribution of disposal methods across drainage categories implies that waste management interventions should consider factors beyond infrastructure type when targeting behavioral change initiatives.

These results contrast with the hypothesis that drainage infrastructure might influence waste disposal patterns through accessibility or environmental awareness pathways. The predominance of garbage truck collection across all drainage types (61.3%) suggests that formal waste collection services are widely utilized regardless of drainage infrastructure, which may explain the lack of association between these variables.
The Chi-square test found no significant relationship between drainage type and disposal method: χ^2 (12, n = 460) = 12.19, p = 0.431.

Spearman's Rank Correlation Analysis
Methods
To evaluate the relationship between familiarity with waste segregation and the responsibility level of disposal methods, a Spearman's rank correlation was conducted. The hypotheses were formulated as follows:

- **Null Hypothesis (H_0)**: There is no monotonic relationship between familiarity with waste segregation and disposal method responsibility.
- **Alternative Hypothesis (H_1)**: There is a significant monotonic relationship between familiarity with waste segregation and disposal method responsibility.

Spearman's correlation assesses how well the relationship between two variables can be described using a monotonic function, making it appropriate for ordinal data. The analysis included 460 households with paired observations of familiarity levels and disposal method responsibility. Prior to analysis, assumptions were verified: data were at least ordinal level, observations were independent, and the relationship was assumed to be monotonic. The Spearman correlation coefficient was calculated using the formula:

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$$\rho = 1 - \frac{6\,\Sigma\,d_i^2}{n(n^2 - 1)}$$

where d_i represents the difference between the ranks of corresponding values and n is the number of paired observations.

Familiarity with waste segregation was ranked ordinally as: 1 = Not Familiar, 2 = Somewhat Familiar, 3 = Very Familiar. Disposal methods were ranked by environmental responsibility from 1 (least responsible: burn, dump on roadside, others) to 5 (most responsible: garbage truck), with intermediate rankings of 2 = Bury, 3 = Burn & Compost, and 4 = Compost.

VI. Results

Table 5 presents the cross-tabulation of familiarity levels and disposal method responsibility categories. The majority of respondents were somewhat familiar with waste segregation (n = 251, 54.6%), followed by very familiar (n = 153, 33.3%) and not familiar (n = 56, 12.2%). Regarding disposal responsibility, less responsible methods were most common (n = 237, 51.5%), followed by responsible methods (n = 177, 38.5%) and moderate responsibility (n = 46, 10.0%).

Table 5. Cross-tabulation of Familiarity Level × Disposal Method Responsibility (Source: Field Survey)

Familiarity Level	Responsible (3)	Moderate (2)	Less Responsible (1)	Row Total
Not Familiar	12	3	41	56
Somewhat Familiar	71	22	158	251
Very Familiar	94	21	38	153
Column Total	**177**	**46**	**237**	**460**

The analysis was conducted using frequency-weighted data, where each unique combination of familiarity level and disposal responsibility was weighted by its observed frequency. The Spearman's rank correlation analysis revealed a weak and statistically non-significant relationship between familiarity with waste segregation and disposal method responsibility ($\rho = .026$, $p = .579$). The correlation coefficient indicates virtually no monotonic association between these variables.

VII. Discussion

The absence of a significant correlation between familiarity with waste segregation and responsible disposal behavior suggests that knowledge or awareness alone does not translate into environmentally responsible waste management practices. This finding challenges the assumption that educational interventions focused solely on increasing awareness will automatically lead to behavioral change in waste disposal patterns.

The weak positive correlation ($\rho = .026$) indicates that while there may be a slight tendency for more familiar individuals to adopt marginally more responsible disposal methods, this relationship is negligible and could be attributed to random variation. Notably, even among very familiar respondents, a substantial proportion (38/153, 24.8%) still engaged in less responsible disposal practices, while some unfamiliar respondents (12/56, 21.4%) adopted responsible methods.

These results suggest that factors beyond awareness, such as infrastructure availability, economic constraints, cultural practices, or convenience, may play more significant roles in determining waste disposal behavior. Future interventions should consider addressing structural barriers alongside educational components to effectively promote sustainable waste management practices.

The correlation between segregation awareness and responsible disposal was weak and not significant:

$\rho = 0.026$, $p = 0.579$.

These results suggest that infrastructure alone does not drive behavior change. Despite having access to drainage systems or reporting awareness, households still engage in unsafe disposal when service delivery is irregular or when personal inconvenience is a factor. It is important to pair infrastructure with education and reliable municipal services.

VIII. Conclusion

The study reveals that household waste disposal practices in Dimapur are characterized by a duality between formal and informal systems, reflecting both infrastructural and behavioral complexities. Although municipal garbage trucks serve a majority of households (60%), a significant minority (40%) still resort to informal practices such as burning, burying, or roadside dumping. This persistence of unsafe disposal, despite partial service coverage and moderate levels of segregation awareness, underscores a systemic gap between service provision, behavioral response, and enforcement.

Statistical analyses reinforce this interpretation. The Chi-square test found no significant association between drainage infrastructure and disposal method ($p = 0.431$), implying that infrastructural characteristics alone do not shape household waste behavior. Similarly, the Spearman's rank correlation test revealed no significant relationship between segregation awareness and responsible disposal ($\rho = 0.026$, $p = 0.579$), indicating that awareness, while essential, does not automatically translate into action. Together, these results demonstrate that both structural and cognitive interventions remain insufficient when implemented in isolation. The behavioral component of waste management in Dimapur is thus influenced less by awareness or physical infrastructure and more by contextual factors such as convenience, service reliability, and enforcement consistency.

From a policy perspective, the findings highlight the need for integrated waste management strategies that combine improved service delivery with community-based behavioral transformation. First, the municipal framework should ensure regular and inclusive waste collection coverage, particularly in peri-urban wards where informal disposal remains common. The development of neighborhood-level collection points, public composting facilities, and partnerships with informal waste collectors could bridge accessibility gaps. Second, public engagement initiatives must go beyond awareness campaigns and adopt participatory, incentive-based approaches, such as segregation-linked fee reductions or reward systems for compliant households, to convert knowledge into sustained behavioral change. Third, local enforcement mechanisms need to be strengthened through ward-level monitoring, community volunteers, and coordination with civil society organizations to discourage illegal dumping and burning.

Furthermore, policy formulation must reflect Dimapur's local environmental and socio-economic context. The physiographic constraints of the region, coupled with limited landfill capacity, demand a gradual shift from disposal-oriented management to a circular economy model emphasizing waste minimization, recycling, and material recovery. The introduction of segregated collection systems, decentralized composting, and small-scale recycling units would not only reduce the environmental burden but also generate livelihood opportunities within the informal sector. Integration of private sector participation through performance-based contracts could improve efficiency and accountability in waste collection and segregation.

In the long term, sustainable waste management in Dimapur requires a multi-dimensional approach, one that combines infrastructure, policy enforcement, and social psychology. The weak linkage between awareness and behavior observed in this study suggests that behavioral inertia and socio-cultural norms are equally important barriers. Therefore, future initiatives must focus on behavioral nudges and social marketing techniques that make responsible disposal a community norm rather than an individual choice. Educational institutions and community organizations can play a critical role in embedding these habits at an early stage.

In conclusion, while Dimapur's growing adoption of formal waste collection is encouraging, the persistence of informal practices signals that infrastructural expansion alone is insufficient. Waste management must be treated as a shared social responsibility, one that integrates municipal governance, private participation, and citizen accountability. A balanced approach, where reliable infrastructure meets sustained behavioral engagement, will be crucial for achieving long-term environmental sustainability and improving urban livability in Dimapur.

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