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Research Paper

People's Perspectives on Solid Waste Management During the (coronavirus disease 2019) COVID-19

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Abstract—The COVID-19 pandemic has triggered a global surge in the usage of personal protective equipment (PPE), including masks, gloves, and PPE kits, as well as an increased demand for medical facilities such as injections and medicines. In response to this, countries like India have implemented comprehensive rules and regulations governing the management of various waste streams, including solid waste, hazardous waste, and biomedical waste. Effective waste management necessitates the collection, segregation, and transportation of these wastes in an organized and responsible manner. The Solid Waste Management Rule of 2016 in India places the onus on waste generators to collect waste in a segregated manner and transfer it to designated waste collectors. This research study delves into an analysis of solid waste generation within households and evaluates public awareness and adherence to waste management practices. Employing both quantitative and qualitative research methods, the study reveals a spectrum of behaviors and attitudes among individuals. Findings indicate that while some individuals diligently collect and segregate waste, adhering to established regulations, others lack awareness and engagement in responsible waste management practices. Encouragingly, a notable proportion of the population expresses readiness to participate in training programs aimed at enhancing their knowledge in this area. This research underscores the importance of a holistic approach to waste management, emphasizing that solid waste should be perceived as a valuable resource, aptly termed "wealth" rather than "waste."

Keywords— waste management, awareness, quantitative, qualitative, COVID-19, people

1. Introduction

Solid waste constitutes an integral facet of our lifestyles, necessitating meticulous management for the promotion of health and the preservation of an unpolluted environment. It bestows upon us opportunities for recreation and employment, offering respite from the daily monotony, especially when approached through collaborative social efforts and creative deployment of technology. Such management endeavors not only facilitate the reduction and renewal of solid waste but also confer multifaceted benefits encompassing the realms of social, environmental, economic, and aesthetic dimensions. Nonetheless, it is imperative to acknowledge that improper handling of solid waste is culpable for environmental pollution, thereby warranting serious consideration.

The burgeoning volume of waste production emerges as a pressing predicament, casting adverse repercussions not only upon the environment but also upon human well-being. Without judicious disposal, waste has the potential to taint water sources, subsequently infiltrating aquatic ecosystems and adversely impacting fish and other marine life. This contamination can reverberate through the food chain, ultimately affecting human health, with pronounced implications, especially in communities reliant on well water for their sustenance. Consequently, prudent recycling practices and efficacious waste management mechanisms assume paramount significance in mitigating the escalating waste conundrum, while concurrently fostering sustainable living practices.

In the contemporary backdrop of the COVID-19 pandemic, a distinctive set of circumstances has emerged, compelling us to prioritize the maintenance of cleanliness in our surroundings and ensure the safety of those engaged in the solid waste management sector. This research endeavor undertakes an analytical exploration of individuals' perspectives on solid waste management. It seeks to comprehend their contributions to waste generation and scrutinizes their actions in this regard. The research objectives and goals encompass a comprehensive analysis of various parameters pertinent to waste management, assessing public awareness, and delineating behavioral patterns concerning this critical issue.

2. Related Work

This segment of the document consists of three specific subsections. The initial subsection delves into the essential principles of waste, covering its origins, classifications, and the benefits associated with proficient waste management. The subsequent subsection explores COVID-19 and the precautionary measures linked to it. The third and concluding subsection presents a comprehensive review of the present waste management scenario in India.

2.1. What are wastes?

Waste comprises discarded items that are no longer useful, with the caveat that they are deemed waste only if they cannot be recycled. Typically, waste is managed through curbside collection or direct delivery to a landfill to ensure proper handling, safeguard groundwater, and protect the environment from harm.

Sources of waste:

Waste pertains to materials that are unwanted and devoid of utility, often labeled as garbage when encountered in our immediate surroundings. Garbage predominantly includes various categories of solid waste, such as household waste generated in residences, municipal waste originating from schools, offices, and other public areas, as well as industrial waste produced by factories (Goel, October 2008)

Waste sources are broadly classified into four types: (Rouf Ahmad Bhat, April 2018)

Industrial Waste: Generated in factories and industries, often leading to environmental pollution. Examples include plastics and glass.

Commercial Waste: Produced in educational institutions, shops, and offices, including materials like plastics and paper.

Domestic Waste: Consists of household waste accumulated during routine activities such as cooking and cleaning, including items like leaves, vegetable peels, and excreta.

Agricultural Waste: Comprises waste generated in agricultural fields, including cattle waste, weeds, and husks.

Type of waste:

Waste is commonly categorized into two types:

1. **Biodegradable or Wet Waste:** This classification encompasses kitchen waste, incorporating items such as leftover food and garden debris. Biodegradable waste, alternatively known as moist or wet waste, can undergo composting to yield valuable organic fertilizer. It naturally decomposes over time, with decomposition rates contingent on the specific material involved.

2. **Non-biodegradable or Dry Waste:** This category consists of items such as old newspapers, shattered glass, and plastics. Non-biodegradable waste, known as dry waste, is eligible for recycling and reutilization. Unlike biodegradable waste, these materials do not naturally decompose and pose significant environmental concerns as persistent pollutants.

In addition to these categories, other types of waste include:

1. **Hazardous Waste:** Comprising household products with corrosive, toxic, ignitable, or reactive ingredients, excluding used oil.

2. **Sanitary Waste:** Human-generated waste, encompassing both liquid and solid materials, including potential components from medical waste.

3. **E-waste:** Encompassing all forms of electronic waste.

What is waste segregation and why it is important? (Solid Waste | India Water Portal, 2021)

Waste segregation is the systematic identification, classification, division, and sorting of garbage and waste materials to promote reduction, reuse, and recycling. It plays a pivotal role in mitigating environmental impact, preventing health hazards associated with improper disposal, and facilitating cost-effective recycling practices.

Benefits of waste collection and segregation: (CENTRAL POLLUTION CONTROL BOARD, 2014)

Waste collection involves the physical process of gathering waste materials and transferring them into approved transport vehicles for removal from their original location. This step is integral to efficient waste management.

Waste segregation is mandated by law due to its significant role in facilitating recycling processes. When waste is effectively segregated, a reduced amount ends up in landfills, resulting in cost savings and improved environmental outcomes. Additionally, waste segregation plays a crucial role in promoting public health by minimizing exposure to harmful substances.

Benefits and uses of proper waste disposal can be broadly categorized into four key areas: aesthetics, environment, economy, and society. (CPCB)

1. **Aesthetical:**
   - Organization: Effective waste disposal contributes to a well-organized space. Regular waste removal ensures a clean and orderly environment, allowing for improved organization and mobility.
   - Landscape Maintenance: Proper waste disposal prevents the cluttering of landscapes with old furniture, broken appliances, and debris. This helps maintain visual appeal and prevents pest infestations. Strategic use of skip bins aids in keeping surroundings neat.
   - Health and Sanitation: Adequate waste disposal is critical for health and sanitation. Accumulated waste can foster the growth of harmful bacteria and mold, posing health risks. Timely waste management prevents issues like skin rashes and allergies.

2. **Environmental:**
   - Environmental Protection: Proper waste disposal is a vital aspect of environmental responsibility. It reduces the impact of excessive plastic and material production

while encouraging eco-friendly practices like composting, thus mitigating climate change.
- Physical Safety: Indiscriminate disposal of trash can pose physical hazards, especially with sharp objects like glass shards and rusty nails, as well as caustic chemicals. Professional waste management enhances physical safety.

3. Economical:
- Energy Generation: Waste disposal can yield energy benefits through incineration processes in certain landfills and smaller facilities. The gases produced during disposal can also be harnessed for electricity generation.
- Financial benefits: The process of sorting and identifying recyclables, as well as selling appliances, furniture, and reusable materials like plastics, glass, and wooden products, can generate avenues for additional income.

4. Social:
- Pest Control: Proper waste disposal reduces pest infestations by preventing the attraction of insects and rodents. Timely disposal of perishable items is crucial for minimizing pest-related issues.
- Biohazard Protection: Correct waste disposal methods, including the use of liners, prevent the harmful leakage of biohazards from gadgets, metals, and chemical waste, thus safeguarding soil and water from contamination.
- Community Health Improvement: Communities benefit from improved health outcomes with the adoption of proper waste disposal practices, which reduce respiratory problems and systemic diseases that previously stemmed from improper waste burning in landfills and backyards.

2.2. What is COVID-19?

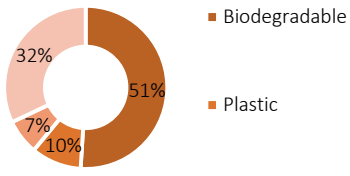
"COVID-19, an illness resulting from a novel strain of coronavirus, acquires its name from the combination of 'CO' for 'corona,' 'VI' for 'virus,' and 'D' for 'disease.' Initially, this malady was identified as '2019 novel coronavirus' or '2019-nCoV.' The COVID-19 virus belongs to the same viral family as Severe Acute Respiratory Syndrome (SARS) and specific variants of the common cold." (UNICEF, 2020)." (UNICEF, 2020)

Preventive Measures to Mitigate COVID-19 Transmission: (UNICEF, 2020)
- Hand Hygiene: Regular and thorough hand cleansing with alcohol-based hand sanitizers or soap and water.
- Physical Distancing: Maintaining a minimum distance of 1 meter (3 feet) from others.
- Avoiding Crowded Areas: Steer clear of densely populated places to reduce exposure risk.
- Avoiding Face Touching: Refrain from touching one's eyes, nose, and mouth with unwashed hands.
- Respiratory Etiquette: Practice good respiratory hygiene by covering the mouth and nose with the bent elbow or a tissue when coughing or sneezing. Dispose of used tissues promptly and wash hands thoroughly.
- Self-Isolation: Stay at home and observe self-isolation, even with minor symptoms such as cough, headache, or mild fever, until fully recovered. If leaving home becomes necessary, wearing a mask is recommended to prevent the potential spread of infection to others.
- Seeking Medical Advice: In case of fever, cough, or breathing difficulties, contact healthcare providers by phone in advance. Follow the guidance of local health authorities.
- Keeping Informed: Stay current with the most recent information from trustworthy sources like the World Health Organization (WHO) or local and national health authorities.

- Child Safety: Ensure that alcohol-based hand sanitizers are kept out of the reach of children. Educate them on proper sanitizer usage and supervise its application.

3. Theory

In 1947, cities and towns across India produced an approximate 6 million tonnes of solid waste, a figure that escalated to about 48 million tonnes in 1997. Presently, India generates 62 million tonnes of waste annually. Of this, approximately 43 million tonnes (70%) are collected, with around 12 million tonnes undergoing treatment and 31 million tonnes being deposited in landfill sites. According to estimates from the Indian Council for Research on International Economic Relations (ICRIER), the annual waste generation was 72 million tonnes in 2017 (calculated based on 450 gm per capita daily generation and an urban population of 440 million*) and 64 million tonnes (based on 400 gm per capita daily generation and urban population of 440 million*) (Ahmed, 2016). The Central Pollution Control Board (CPCB) reported an estimated annual generation of 52 million tonnes for the year 2014-2015. Additionally, the Ministry of Urban Development (MoHUA) and the Task Force on Waste to Energy from the Planning Commission provided estimates of 52 million tonnes and 62 million tonnes annual waste generation for the years 2012-2015 and 2013-2014, respectively.



Graph 1: Composition of MSW in India (% of total)
Source: State Pollution Control Boards

It is estimated in the 2014 report by the "Task Force on Waste to Energy," under the Planning Commission, that urban India will generate 2,76,342 tonnes per day (TPD) of waste by 2021; 4,50,132 TPD by 2031; and 11,95,000 TPD by 2050. Now let's look at the scenario in different cities in India. Following is municipal solid waste generation in cities in 2016. Although Mumbai is highly populated city, the waste generation is less as compared to Delhi. Same is with the

Chennai and Kolkata. The scenario is not different if we consider Lucknow and Kanpur. So, it can be said that waste generation is not always depend on the population.

Table 1: Top MSW generating cities door to door collection and segregation of waste

S. N.	City	State	Population (million)	Households Door to door collection (%)	Segregation at Source (%)
1	Mumbai	Maharashtra	20.0	80	Nil
2	Delhi		19.1	39	2
3	Bengaluru	Karnataka	10.4	71	50
4	Chennai	Tamil Nadu	10.0	80	Nil
5	Hyderabad	Telangana	9.1	73	Nil
6	Ahmedabad	Gujrat	7.5	95	Nil
7	Surat	Gujrat	5.8	60	12
8	Pune	Maharashtra	5.8	50	52
Note above are Large cities are with population greater than 5 million (data for Kolkata are not available)					
9	Indore	Madhya Pradesh	2.5	90	53
10	Bhopal	Madhya Pradesh	2.1	100	Nil
11	Ludhiana	Punjab	1.7	25	Nil
12	Chandigarh		1.2	95	Nil
13	Mysuru	Karnataka	1.0	95	55
Note above are Mid-size cities are with population between 1 million and 5 million					
14	Warangal	Telangana	0.9	90	Nil
15	Tirunelveli	Tamil Nadu	0.5	100	100
16	Alappuzha	Kerala	0.2	100	76
17	Suryapet	Telangana	0.1	100	Nil
18	Gangtok	Sikkim	0.1	90	30
19	Warangal	Telangana	0.9	90	Nil
Note above are small cities are with population less than 1 million					

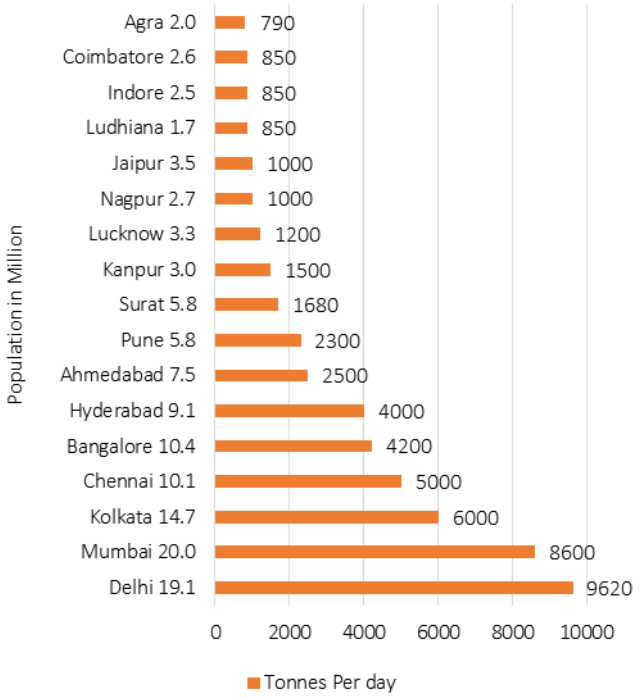
Source: State Pollution Control Boards, Municipal Corporations, and UN population estimates

Cities with populations exceeding 5 million, such as Mumbai and Chennai, exhibit varying levels of door-to-door waste collection, with Mumbai at 80% and Chennai at 80%. However, they currently lack segregation at the source. In contrast, Ahmedabad, among these large cities, stands out with a 95% door-to-door collection rate but also lacks source segregation.

Moving to mid-sized cities, Mysuru in Karnataka showcases a robust waste management system with a 95% door-to-door collection rate and 55% source segregation.

In the category of small cities with populations below 1 million, Tirunelveli, Tamil Nadu, leads the way with 100% door-to-door collection and complete source segregation, while Suryapet, Telangana, maintains a 100% door-to-door collection rate but has yet to implement source segregation.
Delhi and Ludhiana are the cities where door to door collection is very low and below 40 % (Table 1).

Cities like Delhi and Mumbai, with populations of 19.1 and 20 million, respectively, generate substantial daily waste, amounting to 9620 and 8600 tonnes. Kolkata, with a population of 14.7 million, manages a daily waste load of 6000 tonnes. In Chennai, a city of 10.1 million residents, daily waste production reaches 5000 tonnes. (Isher Judge Ahluwalia, April 2018)
Among mid-sized cities, Bangalore stands out with a population of 10.4 million and daily waste production of 4200 tonnes. Hyderabad, hosting 9.1 million residents, produces 4000 tonnes of waste daily. Ahmedabad, with a population of 7.5 million, manages a daily waste load of 2500 tonnes.



Graph 2: Top MSW generating cities in India 2016*
Source: State Pollution Control Boards

Moving to smaller cities, Pune generates 2300 tonnes of daily waste, while Surat produces 1680 tonnes. Kanpur and Lucknow, with populations of 3.0 and 3.3 million, respectively, handle daily waste loads of 1500 and 1200 tonnes. Nagpur and Jaipur, each with populations around 2.7 and 3.5 million, manage daily waste loads of 1000 tonnes. Ludhiana and Indore, with populations of 1.7 and 2.5 million, respectively, handle daily waste loads of 850 tonnes. Coimbatore, with 2.6 million residents, manages a daily waste load of 850 tonnes, while Agra, with a population of 2.0 million, handles 790 tonnes of daily waste (graph 2).

3. Rule for waste management

3.1. Solid Waste Management Rules: (GOVT of India, April 2016)
The Solid Waste Management Rules of 2016 in India provide comprehensive guidelines for the effective management of solid waste. These rules require waste generators to segregate waste into categories like biodegradable, non-biodegradable, and domestic hazardous waste. It promotes decentralized waste management, ensuring that local bodies are responsible for waste collection, transportation, and disposal. Landfills are to be engineered to minimize environmental impact, and waste processing and recycling facilities are encouraged. The rules also lay emphasis on public awareness and citizen participation to ensure the proper implementation of waste management practices, aiming to improve urban and rural sanitation while reducing the burden on landfills and promoting a cleaner environment.

3.2. E- Waste Management Rules: (Govt of India , November 2022)
The E-Waste (Management) Rules, 2016 in India provide a regulatory framework for the environmentally sound and sustainable management of electronic waste. These rules aim to control the generation, collection, and responsible recycling of e-waste, which includes old electronics and electrical equipment. They encourage the establishment of collection centers and recycling facilities while ensuring the safe handling, storage, and transportation of e-waste. The rules promote the principle of extended producer responsibility (EPR), requiring manufacturers to manage the end-of-life products they introduce into the market. E-waste management is essential to mitigate environmental pollution and health hazards caused by improper disposal of electronic waste.

3.3. Plastic Waste Management Rules: (CPCB, October 2019)
The Plastic Waste Management Rules, initiated in 2016 in India, focus on the efficient handling of plastic waste to mitigate environmental harm. These regulations stress the responsibility of waste generators to segregate, store, and dispose of plastic waste in an environmentally friendly manner. It encourages the recycling and recovery of plastic waste, setting recycling targets for local authorities and industries. Extended Producer Responsibility (EPR) is a key feature, making manufacturers accountable for plastic waste collection and recycling. It prohibits the use of non-recyclable multilayered plastic and promotes public awareness on plastic waste reduction and recycling. These rules aim to reduce the ecological impact of plastic pollution while promoting a circular economy.

3.4. Hazardous Waste Management Rules: (MOEFCC, April 2016)
The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 in India regulate the handling and management of hazardous waste to prevent environmental and health risks. These rules specify stringent requirements for the identification, classification, and safe disposal of hazardous waste. They mandate the proper treatment, storage, transportation, and disposal of such waste, emphasizing the role of authorized operators and facilities. These rules also set criteria for importing and exporting hazardous waste, ensuring transboundary movement is conducted safely and in accordance with international agreements. The rules promote safety and environmental protection in the management of hazardous waste, reducing its adverse effects on human health and the environment.

3.5. Bio- Medical Waste Management Rules: (Government of India, March 2016)
Biomedical waste management rules govern the safe and responsible disposal of waste generated by healthcare facilities, laboratories, and similar establishments. These rules mandate the segregation, collection, treatment, and disposal of biomedical waste to prevent contamination and protect public health and the environment. Biomedical waste includes sharps, infectious waste, pharmaceuticals, and other hazardous materials. Compliance with these regulations involves proper segregation of waste, the use of color-coded bins, and the use of authorized treatment and disposal methods. Biomedical waste management rules are essential for minimizing the risks associated with biohazardous waste and ensuring the safety of both healthcare workers and the general population.

3.6. Construction and Demolition Management Rules: (Govt India, March 2016)
The Construction and Demolition Waste Management Rules, 2016, in India aim to minimize environmental impacts caused by construction and demolition activities. These rules stress responsible waste management practices by promoting waste segregation at the source, efficient collection, transportation, recycling, and the establishment of waste processing facilities. By encouraging the reuse of construction and demolition waste materials, these regulations help conserve natural resources and reduce the burden on landfills. Compliance with these rules is essential to mitigate environmental degradation, minimize pollution, and promote sustainable construction practices in the country.

3.7. Batteries Waste Management Rules: (Govt of India, August 2022)
Battery waste management rules aim to regulate the environmentally responsible disposal and recycling of batteries. These rules encompass various types of batteries, such as lead-acid, nickel-cadmium, and lithium-ion batteries. The regulations establish guidelines for collection, storage, transportation, and recycling processes, emphasizing the need to minimize hazardous waste generation and protect human health and the environment. Compliance with these rules ensures the safe and sustainable management of battery waste, reducing the risk of toxic substances leaching into soil and groundwater while promoting the recycling and recovery of valuable materials.

4. Experimental Method

Quantitative and qualitative data were collected through a random online survey conducted over a 15-day period, spanning from May 20th to June 5th, 2021, in India. The survey questionnaire was crafted by drawing inspiration from various prior studies. It consisted of three sections aimed at gauging people's attitudes toward waste and its management.
The first section included two demographic questions inquiring about the respondents' cities of residence and their ages.

In the second section, participants were presented with 10-12 questions pertaining to waste collection, segregation practices at their homes, and associated issues in their vicinity. This section also delved into the types of waste generated and the quantities thereof.

The third section of the questionnaire probed respondents about their knowledge and awareness regarding waste management rules and their interest in participating in waste management campaigns and online learning sessions.

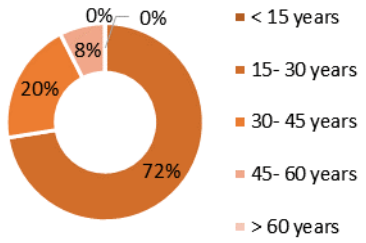
The survey and questionnaire links were disseminated through various social media platforms. Participants were encouraged to further share the survey with their family members, friends, or colleagues. Only respondents who completed all sections of the survey were included in this study. After eliminating missing or unclear data using online survey programming options, a total of 200 participants contributed to this study.

5. Results and Discussion

Quantitative and qualitative data for analysis are collected via an online survey, with each parameter scrutinized independently. This approach ensures a comprehensive examination of both numerical and descriptive aspects, providing a well-rounded perspective for a thorough and nuanced analysis of the gathered information.

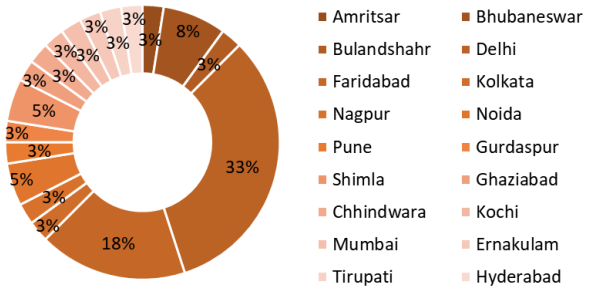
5.1. Section 1: Demography- Age and location

In this research, it was discovered that among the total participants, 72% fell within the age range of 15-30 years, 20% were between 30-45 years old, and 8% were in the age group of 45-60 years (see Graph 3).



Graph 3: Age of people participated in the survey
Source: Author, Primary Survey, May 2021

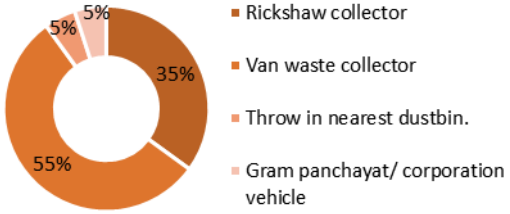
Furthermore, the study featured participants from diverse Indian cities, including but not limited to Delhi, Mumbai, Kolkata, Noida, Ghaziabad, Bhubaneshwar, Nagpur, Faridabad, Amritsar, Shimla, Pune, Hyderabad, Bulandsaher, Gurdaspur, Ernakulam, Chhindwada, Tirupati, and Kochi (refer to Graph 4). This broad representation ensures the study's inclusivity and applicability across a wide range of urban settings in India. (see Graph 4).



Graph 4: People participated from different cities in the survey
Source: Author, Primary Survey, May 2021

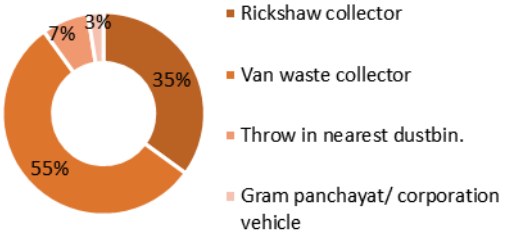
5.2. Section 2: Waste Collection and Segregation at Participants' Homes and Associated Issues

Among the total participants, it was found that 35% used to hand over their waste to private or rickshaw collectors before the pandemic. Additionally, 57% of respondents relied on van waste collectors or municipal corporation vehicles for waste disposal prior to the pandemic. A small percentage, 3%, entrusted their waste to the gram panchayat, while 5% disposed of it in the nearest dustbin (see Graph 5).



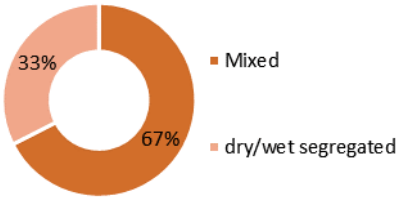
Graph 5: Who takes the waste from your house before pandemic
Source: Author, Primary Survey, May 2021

Out of the total participants, it was observed that 35% continued to hand over their waste to private or rickshaw collectors during the pandemic. Furthermore, 55% relied on van waste collectors or municipal corporation vehicles for waste disposal during the pandemic. A smaller percentage, 3%, chose to give their waste to the gram panchayat, while 7% opted to dump it in the nearest dustbin (as depicted in Graph 6).

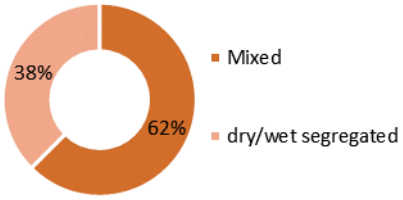


Graph 6: Who takes the waste from your house during pandemic
Source: Author, Primary Survey, May 2021

Within the overall participant cohort, it was identified that, prior to the pandemic, 67% practiced mixed waste disposal (see Graph 7), while 33% followed a segregated approach. Moreover, before the pandemic, 62% were involved in mixed waste disposal, with 38% adopting waste segregation methods. This highlights the varied waste disposal practices among participants and underscores the need for targeted waste management education initiatives. (refer graph 8)

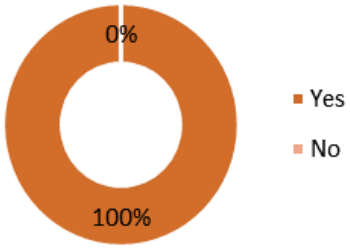


Graph 7: Collection of waste before pandemic
Source: Author, Primary Survey, May 2021

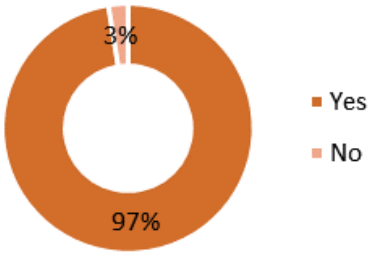


Graph 8: Collection of waste during pandemic
Source: Author, Primary Survey, May 2021

Virtually all respondents demonstrate awareness of wet, dry, and hazardous waste categories, as illustrated in Graph 9. Approximately 97% of the participants exhibit understanding and knowledge concerning waste segregation. This high level of awareness suggests a strong foundation among the surveyed individuals, emphasizing the potential for effective waste management practices through continued education and awareness initiatives. (as demonstrated in Graph 10).

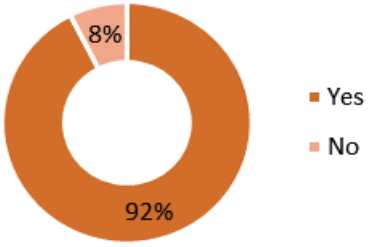


Graph 9: Knowledge of wet, dry and hazardous waste
Source: Author, Primary Survey, May 2021

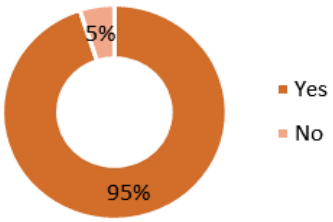


Graph 10: Knowledge of waste segregation
Source: Author, Primary Survey, May 2021

Among all the participants, a noteworthy 92% are well-informed about composting, (as indicated in Graph 11). Approximately 95% of the participants are well-informed about waste reuse, reduction, and recycling, (as illustrated in Graph 12).

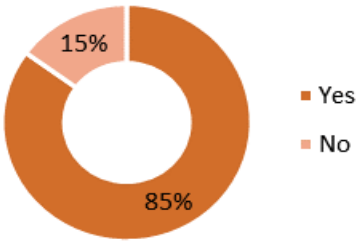


Graph 11: Knowledge of composting
Source: Author, Primary Survey, May 2021



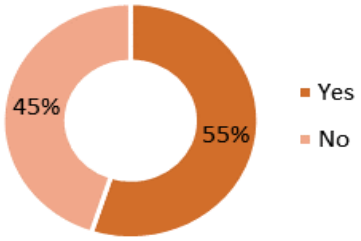
Graph 12: Knowledge of reuse/ reduce/ recycle
Source: Author, Primary Survey, May 2021

Moreover, roughly 85% of the participants are actively engaged in various household activities such as composting, reducing waste, reusing items, recycling, and upcycling waste, (as depicted in Graph 13)

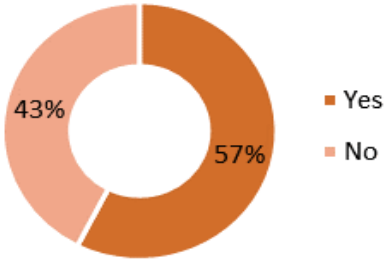


Graph 13: Activities performed by responders for waste management
Source: Author, Primary Survey, May 2021

Prior to the pandemic, approximately 55% of the participants engaged in waste segregation, (as depicted in Graph 14). During the pandemic, about 57% of the participants continued to practice waste segregation, (as illustrated in Graph 15).



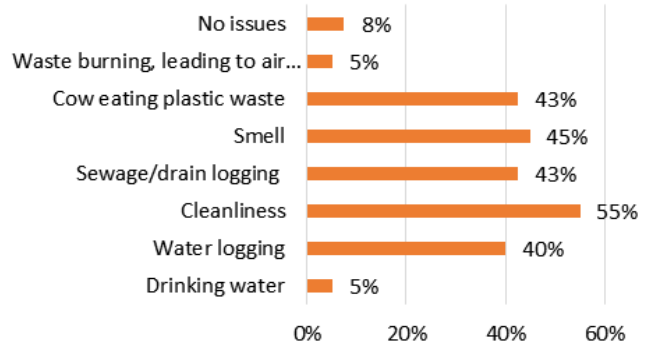
Graph 14: Waste segregation (before pandemic)
Source: Author, Primary Survey, May 2021



Graph 15: Waste segregation (during pandemic)
Source: Author, Primary Survey, May 2021

According to the survey responses, 22% participants expressed concerns about cleanliness, while 18% respondents reported issues related to unpleasant odors. Additionally, 16% participants mentioned waterlogging as a problem, and 17% individuals highlighted sewage or drain logging. Furthermore, 17% respondents were concerned about cows consuming

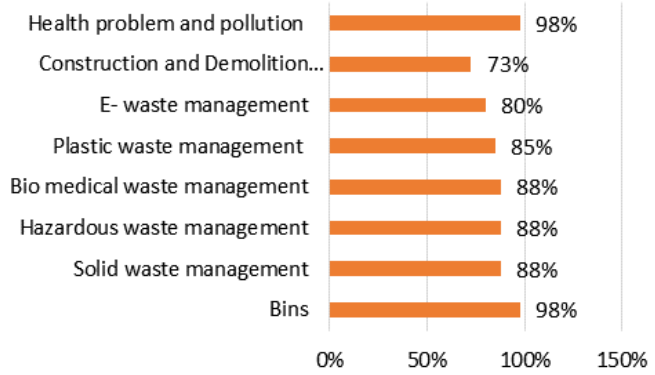
plastic waste, and only 3% respondents stated they had no specific issues. Lastly, both drinking water and waste burning leading to air pollution were noted as concerns by 2% participants each.



Graph 16: Issues faced due to Waste
Source: Author, Primary Survey, May 2021

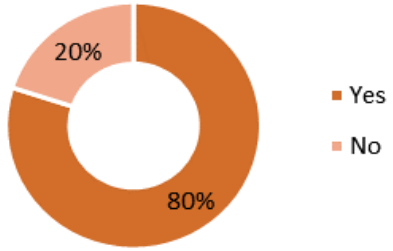
5.3. Section 3: Waste Management Rules Awareness and Campaign Participation Interest

A significant majority of respondents, at 98%, expressed awareness or concern about issues related to bins and their management. Approximately 88% of the participants indicated awareness or concern regarding solid waste management, hazardous waste management, and biomedical waste management (graph 17).



Graph 17: Awareness about different waste management rules
Source: Author, Primary Survey, May 2021

In terms of environmental concerns, 85% of respondents indicated awareness or interest in plastic waste management, while 80% showed interest in e-waste management. About 73% of the participants demonstrated awareness or concern regarding the management of construction and demolition waste. A high percentage of respondents, at 98%, indicated awareness of health problems and pollution issues (graph 17)



Graph 18: People Campaign Participation Interest
Source: Author, Primary Survey, May 2021

Out of the respondents, 80% individuals express a positive inclination toward participating in a waste management campaign or program led by experts, while 20% respondents indicate a lack of interest in such initiatives.

Results

This section is providing a Conclusive Findings on People's Engagement in Waste Management. Within the entire participant cohort, it is evident that, prior to the pandemic, a majority of 67% were disposing of their waste in a mixed manner, while 33% adhered to a segregated waste disposal approach. However, pre-pandemic statistics indicate that 62% of participants opted for mixed waste disposal, with 38% practicing waste segregation.

Furthermore, it is noteworthy that approximately 85% of the participants actively engage in various household activities encompassing composting, waste reduction, item reuse, recycling, and upcycling. Before the pandemic, approximately 55% of the participants were actively involved in waste segregation, as depicted in Graph 14. During the pandemic, roughly 57% of the participants continued to uphold waste segregation practices. A substantial 80% of respondents express a strong willingness to participate in waste management campaigns or programs led by experts, underscoring their commitment to such initiatives. In contrast, 20% of respondents exhibit a lack of interest in such endeavors.

In summation, these findings resoundingly emphasize the integral role of waste management in the lives of individuals and their active engagement in endeavors related to waste management and environmental stewardship.

People are very much concerned about the health issues due to waste dismanagement. Achieving this objective necessitates the development and implementation of strategies that are comprehensible to both local communities and waste collectors. Key concerns revolving around cleanliness and safety can be effectively mitigated through the diligent enforcement of policies, all while ensuring the active participation and behavioral shift of the community towards responsible waste management and environmental safety.

6. Conclusion and Future Scope

The escalating concerns surrounding health issues attributed to waste mismanagement have spurred a critical need for the development and execution of comprehensible strategies. These strategies must resonate with both local communities and waste collectors, aiming to address key issues of cleanliness and safety through robust policy enforcement. The active engagement and behavioral transformation of communities towards responsible waste management are pivotal for achieving this objective.

In order to curb the adverse effects of improper waste disposal, it is imperative to implement and reinforce policies

that prioritize cleanliness and safety. These policies should be designed to resonate with the local population, making them easily understandable and encouraging compliance. Such measures will not only contribute to a healthier and safer environment but will also foster a sense of civic responsibility.

The findings from surveys conducted on waste management issues underscore the necessity of educational sessions for the general public. These sessions can play a crucial role in raising awareness and disseminating knowledge on proper waste management and disposal practices. Empowering individuals with information equips them to make informed choices and take proactive steps towards maintaining a cleaner and safer environment.

Educational initiatives should focus not only on the technical aspects of waste management but also on fostering a sense of responsibility among the community. By instilling an understanding of the broader environmental impact of their actions, individuals are more likely to adopt sustainable practices. Moreover, providing incentives for active participation can serve as a powerful motivator. These incentives may include rewards, recognition, or community-driven initiatives that celebrate and acknowledge the contributions of individuals towards cleanliness and environmental preservation.

In the future, there is a promising scope for the expansion and enhancement of waste management education programs. Integrating these programs into school curricula, community events, and workplace training sessions can ensure a broader reach. Collaboration with local authorities, non-governmental organizations, and educational institutions can further amplify the impact of these initiatives.

To foster a sense of ownership and responsibility towards waste management, community involvement is paramount. Creating platforms for open dialogue and collaborative decision-making involving residents, local leaders, and waste management experts can lead to more effective and sustainable solutions. Community-driven initiatives, such as neighborhood clean-up campaigns and recycling drives, can further strengthen the bonds of collective responsibility.

In conclusion, by actively involving the broader community in waste management education and encouraging their participation, significant strides can be made towards creating a cleaner, safer, and more sustainable environment. The key lies not only in policy implementation but also in fostering a cultural shift towards responsible waste management practices. As we move forward, the collaboration between stakeholders, the dissemination of knowledge, and the celebration of community contributions will be instrumental in shaping a future where waste is managed responsibly, and environmental preservation becomes a shared commitment.

Data Availability

Due to the lockdown during COVID 19 the data collection survey was conducted online through email and message circulation. This was the biggest limitation of the research study.

Conflict of Interest

There is no conflict of interest.

Funding Source

None

Authors' Contributions

There is only one author. Author has researched literature and conceived the study, involved in protocol development, gaining ethical approval, patient recruitment, and data analysis, wrote the first draft of the manuscript.

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