

Household Solid Waste Management in a Developing World: An Overview

Madhumita Ghosh Datta

Department of Environmental Science, Tezpur University, Napaam – 784028, Assam, India
✉ madhutp@gmail.com

Received February 24, 2021; revised and accepted April 21, 2022

Abstract: Households in developing countries are the primary waste generators. Therefore, this study aims to identify the composition and factors responsible for household solid waste generation. It also studies the current status of household waste management in India and strategies for waste minimisation and management. Findings revealed that household waste is heterogeneous. The urban household produces substantial amounts of waste, and vegetables and food waste are major components. Family size has either a positive or negative impact on waste generation. A higher-income household with more purchasing power has a clear positive impact on waste generation. People living together share food items and consumer goods, so fewer food scraps, leftovers, and packaging wastes are there. With advanced education, household wastes are higher, whereas households with secondary education produce the least waste. There is an accumulation of fresh graduates but few are aware of current environmental issues. Municipalities are responsible for collecting and disposing of solid waste, but at present, they focus mostly on the collection part, while innovation in waste treatment is scarce. Nevertheless, a few cities in India have taken a positive approach to the selection of waste management strategies. Also, household solid waste can be converted from burden to resource by sensitising people to segregate waste at the source and following sustainable strategies.

Key words: Household solid waste, composition, factors, strategies, waste minimisation.

Introduction

Waste management has become a multidimensional challenge, especially in developing countries like India, which generate waste of about 62 million tonnes yearly (Census, 2011). Only about 25% of the waste is processed and recycled; the rest is dumped (CPCB, 2013). The amount of waste will be 165 million tonnes in 2031, and 436 million tonnes in 2050 (Planning Commission Report, 2014). The central government has put the agenda of “Clean India” at the top of its agenda with the Swachh Bharat Mission. But with the increasing population, urbanisation, use of non-biodegradable products (plastics, polyethylene), shortage of land for waste disposal, and the costs involved in waste management have aggravated the waste management issue.

Households in developing countries are major waste generators. There is a significant amount (55-80%) of heterogeneous waste generated by household activities such as cooking, washing clothes, cleaning rooms, and gardening that contribute to urban solid waste in developing countries (Al-Khatib et al., 2010; Azevedo et al., 2021; Delgado et al., 2019; Hussein et al., 2018; Sujauddin et al., 2008). Household solid wastes are not always collected and are sometimes thrown here and there by inhabitants, resulting in junkyards and leading to heavy metal pollution of soil, water, and plants, followed by outbreaks of contagious diseases among waste pickers, and floods (Vongdala et al., 2018). Wastes should be properly disposed of to preserve the environment and natural resources, as well as to protect human health, which has an impact on the sustainability of the region (Tonini et al., 2018). The study is divided

into three sections: first, it analyses the factors that affect household waste composition and generation, and second, it examines the state of household solid waste management in India. Finally, it focusses on strategies for effectively managing household solid waste.

Composition of Household Solid Waste

Increased household activities in the urban environment are linked to the generation of high volumes of domestic wastes consisting of organic waste, paper, plastics, metal, glass, textile and unclassified wastes (Ogwueleka, 2013). Among them, vegetable and food waste is the largest component (62-65.5%) followed by other recyclable waste and inert waste (Sujaudhin et al., 2008). Table 1 shows the type of waste generated in a house.

Table 1: Type of household solid waste

<i>Solid waste</i>	<i>Examples</i>
Organic waste	Food waste (peels of fruits and vegetables, coconut shell, egg shell, leftover foods, fish bones, meat bones, pastries, processed foods, used tea leaves) Garden waste (leaves, grasses, twigs, branches, weeds)
Paper	News print, magazines, cardboard, text books, note copies)
Plastic	Plastics sheets, polythene carry bags, plastic bottles, refill packets, plastic foams
Glass	Bulbs, tubes, packing glass
Metals and Alloys	Iron vessels, Steel utensils, aluminium utensils
Other inorganics	Ceramics
Hazardous waste	Electrical and electronic goods
Medical waste	Syringe, expired medicines
Miscellaneous	Wood, textiles, diapers, sanitary napkins, leather belts, shoes, soap

The average composition of solid waste produced by Indian cities is approximately 41 wt.% organic, approximately 40 wt.% inerts, with approximately 19 wt.% potentially recyclable materials (Sharholi et al., 2008).

Factors that Affect Household Solid Waste Generation

The factors that influence household waste generation bring a change in lifestyle, resulting in a drastic shift in

household consumption patterns. This has led to changes in waste volume and composition. Factors include:

Family Size

Family size refers in particular to the people living in the same house. The solid waste production varies with the number of family members and also on the number of family household units (single family or multi-family). While it is evident that more members in a family will generate more waste and hence have a positive relationship between household size and waste generation (Trang et al., 2017). But due to group living and common consumption, the food items are shared. Therefore, less amount of food scrubs and leftovers and packaging will be produced (Ojeda-Benitez et al., 2008). As a result, many studies support the negative relationship between household size and waste generation (Miezah et al., 2015).

Monthly Income

The opulence or income level of a household is one of the direct influencing factors in deciding waste generation rates and compositions (Zhu et al., 2008). The higher income of a household the higher the purchasing capacity and this is the reason for being a positive impact on the amount of waste. Bio-degradable per capita household waste generation was nearly double for the high income group in comparison to the low-income group whereas, in the case of non-biodegradable waste per capita was more than four times for the high income group in comparison to the low-income group. On the contrary Qu et al., 2009 found that family income has a negative impact on waste generation. Also, Trang et al. (2017) indicated that higher-income households prefer to eat outside more frequently than cooking at home thereby generating less organic waste. The study revealed a statistically significant difference between household size and daily per capita household waste generation in the high-income group; a slightly significant difference between household size and daily per capita household waste generation in the medium income group and no statistically significant difference between household size and daily per capita household waste generation in the low-income group (Ogwueleka, 2013).

Education Status

The education status of the household dwellers influences awareness programs aimed at creating solid waste management strategies. The more aware a family member becomes of the detrimental effects of improper solid waste management, the more it realizes how critical

it is to manage solid waste. Higher domestic wastes with advanced education and households with secondary education produced the lowest waste generation (Qu et al., 2009).

Gender of Head of Household Unit

People have different attitudes towards environmental issues, and hence a gender-sensitive approach to waste management plans can promote resource distribution and avoid unnecessary costs. Some studies have said that gender differences have no significant role in waste generation. However, in the study by Noufal et al. (2020), there was a slight positive correlation between household waste generation and the gender of the household head.

Age of the Head of Household

The age of household waste affects waste generation. People have different waste generation behaviours according to age. It is seen that aged people generate less waste due to modest living and respond more to social responsibility. Lebersorger and Beigl (2011) found no significant correlation between older people and low solid waste generation.

Housekeeping Activities

Women are playing an active role in waste management activities, besides carrying the responsibility for food preparation and house cleaning. Thus, they are directly engaged in the generation and management of household wastes. The cleansing procedures of residential houses, which take place in the morning, affect the characteristics of waste in this context. This is because housecleaners mix wastes produced from house cleaning with food waste and other kinds of garbage in the same container or waste bag.

Seasonal Differences and Geographical Condition

There are seasonal differences in the composition and volume of waste generation. Waste generation increases during the warm seasons due to increased consumption of drinks and bottled water. As a result, there are more vessels in which they are sold. Side by side it is seen that tree trimming and grass cutting are more rigorous during May and August leading to the generation of garden waste (Armijo de Vega et al., 2008).

Geographical conditions of a country, region, city or village put their mark on the waste management systems as wastes from rural areas are more biodegradable in nature. Thus, in terms of the low population served by poor infrastructure, the waste that is generated is uncollected and is disposed off in open dumps polluting

the local environment. Urban areas have better solid waste management than rural areas, although urban areas have more problems. Both areas have putrescible waste followed by plastic. While community container collection is the most common in urban areas, open refuse dumping is common in rural areas.

Infectious Disease Outbreak

The widespread occurrence of an infectious disease in a community or globally affects household waste generation. For instance, the COVID-19 pandemic reduced air and noise pollution but significantly affected waste management producing heaps of hazardous waste from the health care and household sectors (Sarkodie and Owusu, 2021).

Current Status of Household Waste Management in India

In general, all cities in India face similar problems with their household solid waste management. The waste is collected, transported to an un-engineered land filling site, and dumped haphazardly, mostly on the outskirts of the city in an inefficient way using outdated equipment and techniques. Besides these, wastes are usually dumped in open streams or burned in empty spaces. Rag pickers collect old newspapers, metals, and glasses for recycling and exchange steel utensils for old dresses. However, according to recent data given in the *Swachhata Sandesh Newsletter*, 62,657 blocks have attained cent percent waste segregation at the household level and 81,073 blocks have achieved cent percent door-to-door collection (Swachhata Sandesh, 2020). Also, Ambikapur, Indore, Rajkot, Surat, Mysore, and Navi Mumbai are garbage-free cities. It was fruitful in improving urban cleanliness through such surveys and the locals were encouraged to segregate their waste at the source into separate wet and dry waste categories. India's cleanest city for the past 3 years has taken one step further by earning 4 crores from the garbage. A plant was set up to process 300 tons of dry waste through artificial intelligence (Swachhata Sandesh, 2020a). To ease the management process, Chennai has devised several innovative techniques where citizens have attempted to reduce carbon footprints by carefully managing domestic wastes and recycling to the extent possible. To ensure that the recycled products are put to proper use, the Madras waste exchange platform has been initiated. Thus, this exchange is helping to move the city towards zero waste status by bringing in the concept of a circular economy (Swachhata Sandesh, 2020b).

The issue of household waste management is two-fold. First, households are not obliged to manage waste through segregation or payment for the amount of waste they generate. Second, there is an absolute failure of financial and human capacity, and accountability of our municipal systems. For this reason, Kerala has withdrawn from local waste collection. People decompose kitchen biodegradable waste into compost and sell the old newspapers, and old household items to rag pickers. The state must reform its local governance along with enhancing the capacity of the lower-level staff of municipal systems.

In Arunachal Pradesh, random dumping is the usual practice among local communities. The state lacks waste separation procedures. Landfill sites constructed are also not well designed. Meghalaya has only one compost plant situated in the Mawiong dumpsite, 8 km from the city of Shillong. However, due to very few waste separation procedures adopted, the compost facility is facing problems with inefficient operation. The municipal solid waste generated from the Imphal municipality area is now haphazardly dumped at a privately-owned low-lying ground at Lamphelpat. In Kohima, the only recycling carried out to some extent is by the rag pickers. Wastes are generally dumped in open streams or burned in empty spaces. This is due to the limited waste storage capacity available in the city. In Agartala, all the garbage collected from the city is disposed off in two open dump yards without proper processing.

In Guwahati, the municipality has been dumping its waste on a wetland site. No definite method of segregation has been implemented until the implementation of solid waste management rules in 2016. The local non-governmental organisations are engaged in the primary collection of household waste with the help of tricycles, hand-driven carts, and hydraulic mounted trailer auto tippers, from 31 wards. While the secondary waste collection is supervised by the municipality. Municipalities purchase dry waste from citizens and process it directly in compactors. Due to this, the adjoining areas near the transfer station are declared dustbin free areas. A trial project has been initiated for composting daily waste for 100 household units in ward number 14 by PBK Waste Solutions Private Limited (DAILY DUMP).

Strategies Suggested for Waste Minimisation and Management

Globally, millions of tons of solid waste are generated every day. Urban waste management is drawing

increasing attention to it. The following are measures that can be taken for waste minimisation and management.

Waste Separation at Source Level

Waste separation at the source (at the family level) is easier, more straightforward, and more effective than separation at another level (final disposal site). Also, it reduces costs and the pollution of recyclable materials that are sent to industrial facilities. Therefore, waste separation practices should be explored at the source. Gangtok city has a trial project in two localities, Ranipul and Tadung, where an all-women team is working with residents on waste segregation. Despite initial opposition, people were persuaded to separate wet and dry waste. Inhabitants have already started collecting plastic, paper, glass and metal, which are sold to ragpickers. Kitchen waste is handed over to the Gangtok Municipal Corporation collection trucks. Community supervisors have also started allotting two bins to every household in both areas. In another instance, Aizawl is running projects in five areas. This includes investing in construction and infrastructure for a waste facility. The infrastructure for solid waste separation has been completed and rag-pickers are being trained for systematic segregation of the waste. As an example, Aizawl and Gangtok should be emulated.

Reuse of Electric Appliances

There are opportunities and growth for reuse activities both generally and involving third sector organisations (profit making or non-profit making organisations). Reuse of electric appliances, electronic goods with some directives and textiles along with furniture reuse can lead to carbon dioxide savings and tonnage diversion. These activities have other benefits in a society like the creation of jobs for low-skill workers, distribution of essential commodities to low-income communities and leverage of resources through volunteering. Barriers to waste reduction include modern consumerism culture and general confusion in the belief that waste prevention is equivalent to recycling (Cox et al., 2010).

Encourage Composting or Anaerobic Digestion and Resource Recycling

Composting provides a means of accomplishing all 3 R's i.e., reduce, reuse and recycle. Through composting, the amount of garbage sent to the landfill is reduced, the organic matter is condensed rather than dumped and it is recycled into soil fertiliser. Tea leaves when composted are a valuable source of organic material for the garden as they contain nitrogen compounds.

Green waste from gardens is a low-cost, lignocellulosic-rich resource, which is currently composted or used in anaerobic digestion. The potential of using urban green waste as a raw resource for the production of lignocellulosic fillers by dry fractionation (combination of sorting and grinding processes) from the branches-rich fraction displaying superior reinforcing properties (Viretto et al., 2021). Vermicomposting of solid waste, before landfilling, is rich in plant nutrients and is devoid of pathogenic organisms. The utilisation of vermicast generated from household bio-degradable waste in agriculture will lower the use of inorganic fertiliser and stop the land degradation problem (Singh et al., 2011).

Developing Public-Private Partnership

In recent years, there has been a growing contribution of public administration and public-private partnership. It is an aspiring governance arrangement, with its key objective to involve the private sector in the management of community assets through the creation of new contractual and organisational relations between the public and private sectors. The purpose of such links is simple: to make public services more profitable. In an effort to improve the dismal performance of urban services, many developing countries, such as India (Chakrabarti et al., 2009), have built public private partnerships in an attempt to improve the cost-effectiveness of service delivery.

Changing Human Behaviour Through Awareness Programmes

Human behaviour is central to most environmental problems hence the promotion of pro-environmental behaviour is a pathway towards sustainability. To reduce waste, there is a need to inspire eco-friendly behaviours like cutting down on washing clothes, double-sided printing, sharing electronic goods like phones and laptops, or repurposing household trash. However, the city struggles with waste separation and handling, resulting in illegal dumping on hills and into rivers. The municipal corporation has partnered with several non-profit organisations recently to encourage residents to separate their waste.

There is a value in implementing user charges, fines, and prizes to encourage effective solid waste management. Further, advanced techniques such as remote sensing, the internet of things, education information and communication-based systems, could be useful to inform people quickly. School children should know their roles, merits and demerits of waste management. This will help in creating sensible citizens

who regard waste as a resource opportunity (Kumar et al., 2017).

Monitoring of Waste

Monitoring household waste is essential for implementing a treatment process. The average percentage of moisture content and C:N ratio are monitored for sustainable and effective planning for a community composting unit in a city. The trend and nature of waste generated by a particular area can be understood using aerial photography, optical, thermal and microwave sensors, which provide options for dealing with solid wastes. For example, the incineration process can be applied to the management of inorganic dry waste to obtain heat and electricity (Zaman, 2010). The pyrolysis of hazardous waste can produce a syngas mixture, liquid tar, and solid residue called char. The energy can also be recovered by anaerobic digestion or by segregating high calorific fractions to obtain refuse-derived fuels (Bharti et al., 2017).

Conclusion

India is witnessing an increase in the amount of waste generation. Family size, monthly income, education level, gender of the household head, age of the household head housekeeping activities, seasonal differences and geographical conditions, and the spread of infectious disease are significant factors to predict solid waste generation and composition trends. Municipal authorities are responsible agencies for solid waste collection and disposal, but the magnitude of the problem is beyond their capacity to tackle. But a few cities have implemented waste management strategies. Simple but effective steps practiced at the household level will help a long way such as segregation of waste into dry and wet, practicing composting, donating clothes, and sharing electronics.

References

- Al-Khatib IA, Monou M, Abu Zahra AS, Shaheen H.Q. and D. Kassinos (2010). Solid, waste characterization, quantification and management practices in developing countries. A case study Nablus district- Palestine. *Journal of Environmental Management*, **91**(5): 1131-1138.
- Armijo de Vega, C., Ojeda Benitez, S. and M.E. Ramirez Barreto (2008). Solid waste characterization and recycling potential for a university campus. *Waste Management*, **28** (Suppl): S21-S26. doi: 10.1016/j.wasman.2008.03.022

- Azevedo, B.D., Scavarda, L.F., Caiado, R.G.G. and M. Fuss (2021). Improving urban household solid waste management in developing countries based on the German experience. *Waste Management*, **120**: 772-783.
- Bharti, V., Singh, J. and A.P. Singh (2017). A review on solid waste management methods and practices in India. *Trends in Biosciences*, **10(21)**: 4065-4067.
- Census (2011). Provisional population totals, India. Retrieved from <http://censusindia.gov.in/2011-prov-results/datafiles/india/povpoputotalpresentation2011.pdf>
- Chakrabarti, S., Majumdar, A. and S. Chakrabarti (2009). Public-community participation in household waste management in India: An operational approach. *Habitat International*, **33(1)**: 125-130.
- Cox, J., Giorgi, S., Sharp, V., Strange, K., Wilson, D.C. and N. Blakey (2010). Household waste prevention: A review of evidence. *Waste Management and Research*, **28(3)**: 193-219.
- CPCB (2013). Status report on municipal solid waste management. Retrieved from http://www.cpcb.nic.in/divisionsofheadoffice/pcp/MSW_Report.pdf http://pratham.org/images/paper_on_ragpickers.pdf
- Delgado, O.B., del Consuelo Hernandez Berriel, M., Paniagua, I.Y.H. and M. del Consuelo Manon Salas (2019). Households as sources contributing the most to urban solid wastes production: Implications for a better management and disposal. *Journal of Environmental Protection*, **10(08)**: 1072-1084.
- Kumar, S., Smith, S.R., Fowler, G., Velis, C., Kumar, S.J., Arya, S., Rena, Kumar, R. and C. Cheeseman (2017). Challenges and opportunities associated with waste management in India. *Royal Society Open Science*, **4(3)**: 160764.
- Lebersorger, S. and P. Beigl (2011). Municipal solid waste generation in municipalities: Quantifying impacts of household structure, commercial waste and domestic fuel. *Waste Management*, **31(9-10)**: 1907-1915.
- Miezah, K., Obiri-Danso, K., Kadar, Z., Fei-Baffoe, B. and M.Y. Mensah (2015). Municipal solid waste characterization and quantification as a measure towards effective waste management in Ghana. *Waste Management*, **46**: 15-27.
- Noufal, M., Yuanyuan, L., Maalla, Z. and A. Sylvia (2020). Determinants of household solid waste generation and composition in Homs City, Syria. *Journal of Environmental and Public Health*, **2020(2)**: 1-15.
- Ogwueleka, T.C. (2013). Survey of household waste composition and quantities in Abuja, Nigeria. *Resources, Conservation and Recycling*, **77**: 52-60.
- Ojeda-Benitez, S., Vega, C. and M.A. Montenegro (2008). Household solid waste characterization by family socioeconomic profile as unit of analysis. *Resources, Conservation and Recycling*, **52(7)**: 992-999.
- PBK Waste Solutions Private Limited (DAILY DUMP). Retrieved from (<https://assam.gov.in/en/main/Waste%20Management>)
- Planning Commission Report (2014). Reports of the task force on waste to energy (Vol-I) (in the context of Integrated MSW management). Retrieved from http://planningcommission.nic.in/reports/genrep/rep_wte1205.Pdf
- Qu, X.Y., Li, Z.S., Xie, X.Y., Sui, Y.M., Yang, L., and Y. Chen (2009). Survey of composition and generation rate of household wastes in Beijing, China. *Waste Management*, **29(10)**: 2618-2624.
- Salas, C.M. (2019). Households as sources contributing the most to urban solid wastes production: Implications for a better management and disposal. *Journal of Environmental Protection*, **10(08)**: 1072-1084.
- Sarkodie, S.A. and P.A. Owusu (2021). Impact of COVID-19 pandemic on waste management. *Environment, Development and Sustainability*, **23**: 7951-7960.
- Sharholi, M., Ahmed, K., Mahmood, G. and R.C. Trivedi (2008). Municipal solid waste management in Indian cities: A review. *Waste Management*, **28**: 459-476.
- Singh, R.P., Singh, P., Araujo, A.S.F., Ibrahim, M.H. and O. Sulaiman (2011). Management of urban solid waste: Vermicomposting a sustainable option. *Resources, Conservation and Recycling*, **55(7)**: 719-729.
- Sujauddin, M., Huda, S.M. and A.T. Rafiqul Hoque (2008). Household solid waste characteristics and management in Chittagong, Bangladesh. *Waste Management*, **28(9)**: 1688-1695.
- Swachhata Sandesh (2020a). A monthly newsletter of the Ministry of Housing and Urban Affairs (MoHUA), Government of India, **3(1)**: 1-12.
- Swachhata Sandesh (2020b). A monthly newsletter of the Ministry of Housing and Urban Affairs (MoHUA), Government of India, **3(5)**: 1-12.
- Tonini, D., Albizzati F. P. and T.F. Astrup (2018). Environmental impacts of food waste: Learnings and challenges from a case study on UK. *Waste Management*, **7**: 744-766.
- Trang, P.T.T., Dong, H.Q., Toan, D.Q., Hanh, N.T.X. and N.T.X. Thu (2017). The effects of socio-economic factors on household solid waste generation and composition: a case study in Thu Dau Mot, Vietnam. *Energy Procedia*, **107**: 253-258.
- Viretto, A., Gontard, N. and H. Angellier-Coussy (2021). Urban parks and gardens green waste: A valuable resource for the production of fillers for biocomposites applications. *Waste Management*, **120**: 538-548.
- Vongdala, N., Tran, H.D., Xuan, T.D., Teschke, R. and T.D. Khanh (2018). Heavy metal accumulation in water, soil, and plants of municipal solid waste landfill in Vientiane, Laos. *International Journal of Environmental Research and Public Health*, **16(1)**: 22.
- Zaman, A.U. (2010). Comparative study of municipal solid waste treatment technologies. *International Journal of Environmental Science and Technology*, **7(2)**: 225-234.
- Zhu, D., Asnani, P., Zurbrugg, C., Sebastian A. and M. Shyamala (2008). Improving municipal solid waste management in India: A sourcebook for policymakers and practitioners, The World Bank, Washington, DC, USA.