

論文の内容の要旨

論文題目 A STUDY ON RESIDENT KNOWLEDGE, WILLINGNESS TO ENGAGE, AND
PARTICIPATION IN WASTE MANAGEMENT IN DELHI, INDIA

(インド・デリー市の廃棄物管理における市民の知識、参画意欲、および、参加行動に関する研究)

氏 名 バウル ムカージ スディプタ

Developing countries have been witnessing rapid urbanization, increasing population and economic development, leading to an increase in living standards and demand for goods and services. This has resulted in an accelerated rate of municipal solid waste generation. Inadequate infrastructure and services, poor implementation of legislation, weak institutions, and lack of public participation, are some of the challenges that solid waste management systems in developing countries are faced with.

Delhi, the capital of India, generates about 8,370 tonnes of municipal solid waste per day, and this is projected to increase to 17,000 to 25,000 tons per day by the year 2021. Households are the largest source of municipal solid waste and there is very low compliance to solid waste management rules. Due to lack of segregation at source, the mixed waste reaches the landfill. This causes health hazards to informal waste workers who earn their livelihood by picking recyclables at the local community bins and landfills. The composition of MSW at generation source and collection point comprises of a major organic fraction (40–60%), ash and fine earth (30–40%), paper (3–6%) and plastic, glass and metals (each less than 1%). The low calorific value of organic waste, the presence of inert material, as well as construction and demolition waste in the municipal solid waste, makes it inappropriate for further treatment and disposal.

The objectives of this study are summarized as follows. Firstly, this research seeks to explain the situation in Delhi about segregation, storage, collection and disposal of waste. Secondly, the attempt is to understand the relationships between knowledge, willingness to engage in waste management and waste segregation. Thirdly, this research also explores how resident knowledge varies between different socio-economic categories. Lastly, this research explores the reasons for low public participation in waste management and possible ways of improving it. The methodology includes a questionnaire survey of a stratified random sample ($n = 3,047$), covering all districts and municipalities of Delhi, with socio-economic classification as the stratifying variable; semi structured interviews with 45 key informants representing different stakeholder groups; seven focus group discussions (FGD) and five field visits to pilot project sites of decentralized waste management.

Questionnaire survey results indicate that 60% residents do not know the difference between biodegradable and non-biodegradable waste, and only 2% of them segregate waste. One of the major reasons for lack of segregation at source was that the waste collector mixes the segregated waste, as reported by 58% of the respondents. This implies that for segregation to begin, the mixing of segregated waste by the doorstep waste collector needs to stop. Also, the residents were segregating

their waste to the extent that it has economic value to the *Kabariwala* (itinerant waste buyer), 97% of the respondents reported that they sell items to the *Kabariwala*. The survey also revealed that 87% households are covered by doorstep waste collection service.

Schahn and Holzer (1990), follow two definitions of knowledge in their research on recycling: abstract knowledge (AK), which focuses on awareness of general environmental issues, and concrete knowledge (CK), which evaluates awareness of local services for example, recycling service. In this research, we modify these definitions further, and understand abstract knowledge as knowledge about general issues regarding waste management, and define concrete knowledge as knowledge about issues specific to waste management in Delhi. Abstract knowledge, is seen to have a significant positive correlation with willingness to engage in waste management. Willingness to engage in waste management is seen to have a weak negative correlation with waste segregation, perhaps because residents' understanding of willingness to engage, does not necessarily incorporate the concept of segregation into biodegradable and non-biodegradable waste. Differences between the socio-economic groups indicate that the highest (most educated and rich) as well as the lowest socio-economic category (least educated and poor) have higher abstract knowledge. This is understandable as mostly the poor people perform the task of waste management, as domestic helpers, and informal recyclers. Older age-groups have higher abstract knowledge, because of their habit of resource conservation. Women are closely engaged with household waste management, and have higher abstract knowledge. Therefore, socio-economic groups with higher abstract knowledge can be involved in decentralized models of waste management.

It can be suggested that the Residents Welfare Association (comprising of women and elderly), could monitor and supervise the segregation, recycling and composting in their residential area, and ensure that the doorstep collector collects segregated waste from the households, since the survey shows that majority of the households already have a doorstep collection service. Such an arrangement would involve the active participation of the groups with higher abstract knowledge (elderly, women, lowest and highest socio-economic category).

As revealed in key informant interviews and focus group discussions, in the past, there has been a failure in reaching out to the common people, due to the absence of adequate and appropriate advocacy tools and sustained awareness campaigns targeting different sections of the population. It would be essential to impart general knowledge (abstract knowledge) regarding waste management to the residents, since abstract knowledge has significant positive correlation with willingness to engage in waste management. To encourage source segregation, there needs to be interesting awareness campaigns focusing on waste management as a public health issue, highlighting its impact on environmental pollution. Abstract knowledge can be disseminated with the help of print and electronic media, through television advertisements, pamphlets, flyers and other IEC materials. Students can be taught the importance of waste segregation and prevention of littering in schools, as a part of their curriculum and Eco-club activities. They eventually carry home the message and communicate it with their family members. Public events such as street shows, flash mobs and cleanliness drives by celebrities will have an impact on the people. Residents can also be engaged in 3R activity workshops to encourage learning by doing. Training programs can be conducted to teach residents to make useful products from waste. Religious and spiritual teachings can also encourage non-materialistic values, thereby reducing consumption and disposal.

Apart from lack of knowledge and facilities for waste segregation, the other reasons for the lack of public participation in waste management is the culture of the city of Delhi, which fosters a lack of belongingness, lack of a sense of ownership, and a high consumption high disposal society. The differences arising from caste and class, also creates a division in society, with lower castes often synonymous with lower socio-economic category being compelled to engage in waste management tasks, whereas the higher castes or higher socio-economic categories generally do not participate or take

active interest in waste management as they feel that it is not their work. To address these problems, there can be non-monetary incentives, such as rewards for households that segregate their waste, or for residential areas that have a high percentage of segregating households, or rewarding waste diversion based on quantity. There could be monetary incentives, such as discount on municipality house tax, or free bus passes for segregating households. Sliding fiscal incentives, based on non-segregation, may go a long way in ensuring that residents segregate their waste. There can be a penalty for non-segregating households, interviewees have suggested boycotting the households that are not segregating their waste. In such a situation, the household would feel pressurized to segregate the waste. The doorstep waste collector can be given the responsibility of collecting the penalty from the household that is not segregating the waste, as majority of the households are covered by doorstep collection. The doorstep waste collectors would be monitored by a supervisor, thereby reducing the cost of establishing a separate task force for monitoring segregation at the household level. It should be noted that preventing mixing of waste by doorstep waste collectors is very important, as the questionnaire survey revealed that people do not segregate their waste because waste collectors mix the waste during collection.

The other suggested solution for improving public participation is decentralization of waste management. Beginning at the household level, each household should segregate waste into two bins (dry/non-biodegradable and wet waste/biodegradable). This is logically possible as most households in this study had a bin inside the house. It is also suggested that colored bins for storing segregated waste can be distributed to the households by the Resident Welfare Association. Financial incentives or extrinsic motivation drives residents to segregate their waste, since most respondents answered that the reasons for selling waste to the itinerant waste buyer was due to the value of the waste. The tradition of reuse and recycle within Indian homes should be promoted, keeping in mind the waste hierarchy.

To initiate segregation at the household level, a door-to-door campaign needs to be initiated. In this research, doorstep waste collection service by associations of informal sector waste workers have been seen to have a superior capacity than doorstep collection organized by the private contractors. The informal sector worker can perform the task of collection in narrow lanes in low income localities, with their cycle rickshaws, whereas, the private contractor collects the waste in tipper vehicles which cannot enter narrow lanes in many residential areas. The residents living in multi-storied apartment houses tend to throw their waste into these tipper trucks, and very often, this results in littering on the roads. These tipper trucks or hopper vehicles operated by private waste management companies pollute the environment, unlike cycle rickshaws that are hand pulled by informal sector waste workers. Such hopper vehicles are expensive, and they also deprive the informal sector of its livelihood. However, they can act as feeder vehicles, and the informal sector can be linked to them. The trained informal sector doorstep waste collector, can personally collect the waste from each household and ensure the segregation into wet and dry components. The costs for such a doorstep waste collection system can be borne with a combination of user fee collected from residents. The role of the local NGO would be to formalize and organize the waste workers for this task, and the role of the Residents association would be to reach out to the residents to convince them to pay user fee, and to give their segregated waste to the doorstep waste collector, in a systematic manner.

Additionally, the government can provide space and facilities for MRFs. The construction of Material Recovery Facility (MRF) has been suggested by some of the interviewees from research institutions. Alternatively, the existing *dhalao* (community bin) can be converted to a MRF. Such an MRF could be a multi-storied structure, with separate bins for horticulture waste, construction and demolition waste, hazardous waste and other dry waste. The establishment of waste collection points for hazardous waste, and improvement in the condition of community bins, has also been suggested by several interviewees in our study. Trained and organized informal sector waste workers could be employed here to do further segregation of the dry waste, facilitate the collection by the recyclers, and compost the wet waste. As seen in the best

practice example from Delhi, certain recycling techniques (such as green waste to pellets, plastic to fuel) can be conducted at the MRF itself. Residents need to see the benefits of source segregation of waste to be encouraged to segregate; for example, if they see their dry waste getting recycled and compost being generated out of their wet waste (and that compost is being used in their gardens) then they may understand the value of segregation, and feel motivated to segregate their waste.

To improve waste management in Delhi, it would be important to ensure the involvement of all stakeholders. NGOs and RWAs can help in conducting awareness campaigns and facilitating doorstep collection in a systematic manner. The government can provide space and facilities for MRFs. Furthermore, the government should provide identity cards to waste workers, to legitimize them as providers of public services, and establish protocols and standards for the professionalization of their work. The government can share waste collection schedules with the citizens, and provide avenues where the people can submit their complaints. Private waste management companies can help in the regular transport of waste, and in the processing of hazardous domestic waste. Companies manufacturing products with potential for extended producer responsibility can collaborate with the *Kabariwala* network to facilitate proper collection. Segregation at and near source would significantly reduce the burden on the waste collection vehicle from the community bin to landfill as it would then only be responsible for transportation of hazardous waste to a centralized processing facility, and take the inert waste to landfills. Further research can explore the attitudes and perceptions of residents, economic feasibility of decentralized models of waste management, and conduct a stakeholder analysis for effective partnerships.

Key Words: Household Municipal Solid Waste; Resident Knowledge; Willingness to Engage; Waste Segregation, Waste Collection; Waste Storage; Waste Disposal; Informal Recycling Sector; Public participation in waste management; Decentralization of waste management.