A QUESTION OF DEVELOPMENT
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AN ANALYSIS OF WASTE TREATMENT COSTS BASED ON CASE STUDIES

Waste, how much does it cost?

The French Development Agency (AFD), along with Le Mans University, the Gevalor Association, Urbananalyse, and ALBWaste, conducted the ORVA2D (Organisation for Waste Recycling in Developing Cities) research program, aimed at developing a better understanding of the economic pattern of waste recovery procedures and to issue recommendations. This program covered six case studies in the cities of Antananarivo, Bogotá, Delhi, Lima, Lomé, and Surabaya.

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The sustainable Development Goals (SDGs) encourage the recovery of waste, however, the profits derived from the sale of recycled products rarely cover the expenses required for their conversion. Nevertheless, the absence of waste management causes negative externalities that are even more expensive. For example, the Global Waste Management Outlook of the United Nations Environment Program (UNEP) 2015 estimates that the global health and environmental costs related to the pollution by waste deposited in the wild or burned in open air, range from $20 to $50 USD/person/year, whereas the cost of a reasonable management would be between $5 and $7 USD/person/year (Wilson *et al.*, 2015).

Waste management at a reduced cost in developing countries (DCs)

Municipal waste management is less costly in the poorest countries than in emerging or developed countries: €8 per ton in Antananarivo, Madagascar, €38/ton in Bogotá, Colombia in 2016, according to the data collected by the ORVA2D Program, compared to an average cost of €212/ton in France in 2015 (ADEME, 2017, table 17). First of all, the amount of waste produced per capita is lower because the consumption of manufactured goods is smaller, and the reuse of material is more prevalent. In the poorest countries, municipal collection recovers waste in containers located on the main roads and does not provide door-to-door collection services. Public services rarely cover ad hoc spontaneous settlements, which are left to informal pre-collectors paid directly by households. Waste is often simply deposited in uncontrolled disposal sites, which costs less than properly sorting, burning, or burying it. In addition, the labour costs of salaried municipal service employees are lower than in richer countries.

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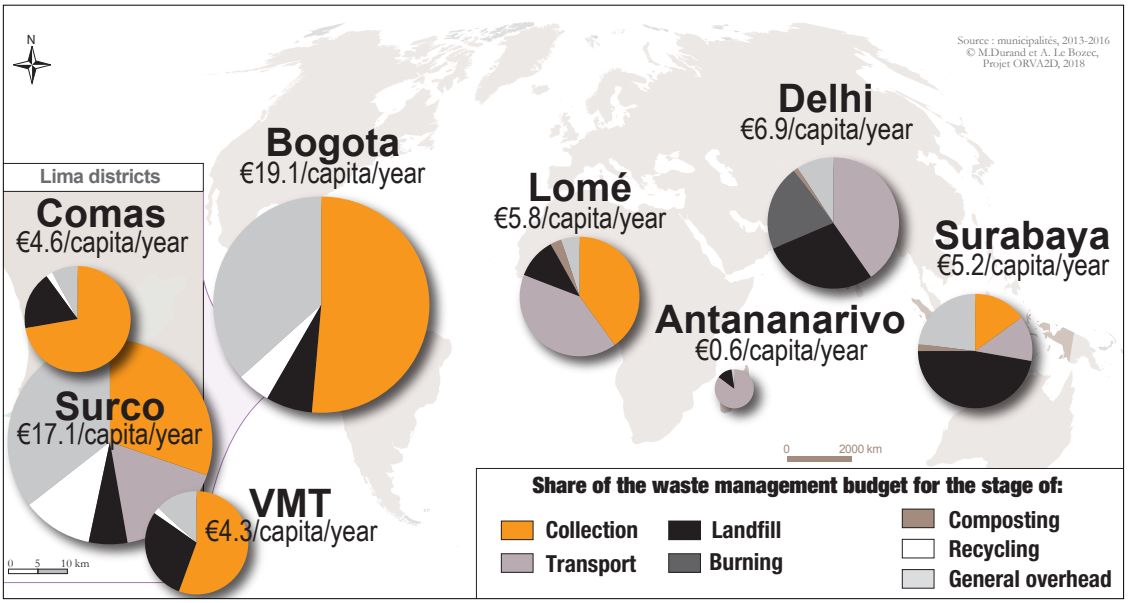
Treatment costs explode immediately after a community passes from an uncontrolled dumping zone to a regulated technical landfill. In Lomé, Togo, depositing waste in the Agoé Landfill cost €1.4/ton in 2016. Costs rose to €8.5/ton when Aképé Landfill opened in early 2018. They also increased when a door-to-door collection service was offered. For example, in Lima, Peru and Bogotá, between 50% and 75% of the management costs go towards collection services (see Chart 1).

Despite these moderate costs per ton, the budgets of the municipalities considered were not always able to ensure the removal and storage of all domestic waste generated by the city, e.g. the collection rate is 95% in Delhi, India but only 55% in Antananarivo.

CHART 1. WASTE MANAGEMENT EXPENSES PER CAPITA AND PER STAGE



Sources: ORVA2D Program (municipalities, 2013-2016).

Who pays for waste management?

The contribution of households through a tax or a fee varies widely from less than 1% in Delhi to more than 60% of the financing of the service in Bogotá. The dividing line between poor countries and emerging countries is irrelevant here, with Delhi not self-financing its service, as opposed to Lomé, for instance. In Delhi, the household waste collection tax (TEOM) is included in the property tax, however, the land registry of the Indian capital is not sufficiently updated to enable collecting this tax.

In terms of absolute value, the average household contributions remain low: €0.20/capita/year in Lomé, €3/capita/year in Bogotá, compared to €90/capita/year in France (ADEME, 2017). It should be noted that the inhabitants are already paying for door-to-door waste collection services of between €0.50 and €4 per household per month to official or informal pre-collectors in Antananarivo, Lomé, Delhi, and Surabaya, Indonesia.

In addition, the local tax collection rate is very low, for example it is approximately 20% in Lima. To address this issue, Bogotá and Surabaya combined the waste and water bills, considering that the risk of a water shut off would motivate users to pay their bills.

The tariff schedules vary the fees according to the type of district and housing, assuming that these criteria allow adjusting the tariff to the income level of the inhabitants. For smaller volumes of waste produced, incentive fees are practically non-existent. Some districts in Lima introduced a *bonoverde* (green bond),, representing a reduction of local taxes, to reward recycling practices. In Surabaya, the income from the resale of recyclables enables the payment of other utility bills for the entire district, which encourages waste recovery practices.

On average, the revenue collected from households and state government waste assistance cover less than 50% of costs. The local authorities must then resort to their general budget. In fact, waste is often the main item of expenditure, e.g. 43% of the administrative budget for Lomé in 2015.

Recycling, landfill disposal, composting, burning: which is the most expensive?

Uncontrolled landfills are now forbidden around the world because they pollute the surrounding air, soil, and water. Three types of treatment are possible. Waste can be (i) buried in landfills in waterproof bins, treatment of liquid discharges – leachate, (ii) converted into energy through biogas capture, methanation, and burning, or (iii)

recycled by various methods. Organic waste can be composted. The so-called "dry" waste (paper, cardboard, plastic, glass, and metal) can be transformed into raw material. Lastly, inert waste (sand, and rubble, etc.) can be reused for the construction of embankments, and even in the building industry.

TABLE 1. COSTS OF VARIOUS TYPES OF WASTE TREATMENT IN THE STUDIED CITIES

Waste management and treatment	Cost (in €/ton)
Door-to-door collection service[1]	11 to 33
Transport from the container to the disposal site	2 to 10
Regulated technical landfill	1.6 to 8.5
Composting	5 to 17
Burning[2]	27
Code: incineration in Europe	*120*

[1] Most cities studied do not have a door-to-door collection service. The pre-collection stage comes directly before the transport stage.

[2] This cost corresponds to the incinerator of the Jindal Company, which has a negative environmental impact. The new incinerators of Delhi, which are more demanding in terms of compliance with environmental standards, feature a much higher treatment cost (an amount not known yet).

Sources: ORVA2D Program (municipalities, 2013-2016).

According to the data collected by the ORVA2D Program, the least expensive treatment is burial in regulated landfills, with operating costs ranging from €1.6 to €8.5/ton depending on the country (see Table 1). However, the depreciation costs on the infrastructure need to be considered as well. In addition, it is regrettable to bury material that could have been recovered. Furthermore, when intending to establish new regulated landfills, public authorities usually have difficulties in finding suitable sites and obtaining the approval of the surrounding communities.

The second type of treatment, in terms of production cost, is often waste composting (roughly €10/ton), especially if it is performed within the district, being closer to the waste producers, which reduces the cost of collection and transport. The resulting compost is used in this case within the same area. Such is the case in Antananarivo and Surabaya, where it is used in the small intra-urban agricultural production, namely in *fokontany and kampung* (popular districts).

Finally, the option of burning waste is the most expensive. Admittedly, this type of treatment has the benefit of significantly reducing the volume of waste. In addition, the energy generated during the burning process can be injected into the power grid. But the incinerators operating in developing countries (DCs) generally release toxic substances into the atmosphere (UNICEF, 2016). They fail to burn everything: highly toxic residues remain, representing 20% to 25% on average of the processed volume, which should undergo a special treatment. However, the on-site investigations performed as part of the ORVA2D Program showed that this was not always the case. In Delhi, for example, the bottom slag ash is deposited in landfill sites, thereby contaminating the soil and surrounding waters. In addition, this mode of treatment bypasses the recovery of material, since it uses the main recyclable waste that has high calorific power such as paper, cardboard, and plastic...

In most cities, the municipalities delegate to private operators the transport of waste from collection points to treatment centres, and the management of landfill sites. Often, these companies are paid per ton of transported or buried waste, thereby causing a disincentive to reduce waste at the source or its recycling. This even leads to the collection of sand instead of waste.

The "avoided" collection and treatment costs

The sorting and selective collection of waste are virtually absent from the municipal policies of the cities studied. However, a significant proportion of recyclable waste is effectively sorted and recovered separately by informal companies. They are interested in products that have a quoted value on the secondary materials market such as metals, plastics, and paper. In order to support the economic activity of the formal waste collectors, the city of Bogotá finances their activity by offering €26/ton for the avoided collection and landfill costs for the municipal budget.

On the other hand, while organic waste accounts for more than 50% of the domestic waste content where the ORVA2D Program conducted its study, there is still no general recovery system in the cities under review. In this sample, only the municipalities of Surabaya and Delhi developed an organic recovery system. The cities of Lomé and Antananarivo are conducting experiments that remain at the pilot stage but are starting to be considered by the municipal services. In Lima and Bogotá, public debate on organic waste is only just beginning.

Unlike the main recyclable materials for which a commercial market has been established, compost sales are struggling to develop, especially due to the competition from subsidised chemical fertilizers and livestock residues available in rural areas.

The selling price must be very low, which does not cover the cost of the composting operation. The financial support of the municipalities is inevitable and can be justified by the "avoided costs" for the municipality. Two types of avoided costs can be considered, namely (i) the savings generated by the absence of collection and transport, and (ii) the savings generated by ...

the absence of landfills (operation and depreciation cost of the storage facility). The calculations made by the ORVA2D Program in Lomé demonstrate that, starting from 5,000 tons processed per year, the savings for the municipal budget are higher than the deficit of the composting platform. With the increase in the quantities processed, mechanisation is possible in certain stages of the process to reduce the cost of composting and the deficit to be covered.

In addition to these avoided costs, there are two other positive externalities of composting: (i) the reduction of greenhouse gases (GHGs) emitted by organic waste when composted instead of being landfilled, which may be converted into carbon credits, and (ii) the social impact of creating jobs for a segment of the population that is generally poor. Composting plants provide more jobs than landfill sites.

Conclusion

The cost of waste management has a tendency to increase in all countries because, on the one hand, volumes expand, while on the other, the uncontrolled waste disposal sites are gradually replaced by regulated landfills.

This new financial cost of landfilling, combined with the difficulty of finding available sites in urban areas once a landfill becomes saturated, leads to reconsidering waste recovery procedures. To the extent that a recycling or composting system saves transportation and landfill costs, does it necessarily have to be profitable? Are there financial mechanisms capable of remedying this budget imbalance?

In a collective work addressing the new models of resource management in urban areas, Lorrain compares the avoided costs to the depreciation costs that were progressively introduced into local public finances in the 19th century and allowed, after a few decades, to establish a techno-economic model of functional and sustainable local public services (Lorrain *et al.,* 2018). The argument of "avoided costs" appears as a new approach towards considering waste management costs, making it possible to reconsider the financial aspects of the recovery procedures.

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