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Financial Aspects of the Solid Waste Management

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ABSTRACT

The article dwells on financial aspects of the municipal solid waste management. The *aim* of the article is to consider common factors of solid waste financing in developed and developing countries, to determine the structure of total costs of municipal solid waste services, to consider complications that appear in relation to capital costs and operation and management costs, to compare costs of municipal solid waste technologies, to find out how do cities obtain investment funding for solid waste management projects, how local governments obtain operational and maintenance funding, as well as to make comparison of waste management user fees by income level and by region. The following important costs consideration has been made. Capital costs and operation costs are normally financed differently. Capital costs are rather not difficult to benchmark. Quite often some important operation costs are not duly calculated or even overlooked. It is difficult to determine total cost of a service, especially in low-income countries. It is challenging task for a city in a developing country to get investment funds for municipal solid waste management projects for several reasons: municipal financing is highly limited in the context of growing volumes of waste; struggling cities can't just apply for loans because they are not considered creditworthy by international stock markets; accessibility of donor financing for municipal solid waste management is extremely low if to compare to other sectors; donor financing is often restricted to emerging economies; economic downturns limit private funding available for solid waste management.

Keywords: waste; capital costs; operation and maintenance cost; total cost; policy drivers; funding; cost of technologies; user fees

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INTRODUCTION

The actuality of the research is determined by the fact that waste management financing is a serious concern for cities. Providing municipal solid waste management services is a large part of expenses for municipalities. The quality of waste management services is largely dependent on the amount and sources of funding necessary for different stages of waste management system: sorting, collection, transportation, treatment and disposal, landfilling.

Investment costs (capital expenditures, CapEx) and operation and maintenance costs (O&M costs; operational expenses, OpEx) are normally financed differently. Cost recovery is important in order to avoid dependence on subsidization from private, national or external sources. Thus, a reliable cost-recovery system must be designed. The cost for the full range of waste services (from collection to final disposal) can't be completely recovered only from user fees. To keep the whole system floating government subsidies or external budgetary support are required.

Thus, the *purpose* of the study is to consider solid waste management financing as a whole system. In particular, the article aims to solve the following *tasks:* to consider common factors of solid waste financing in developed and developing countries; to determine the structure of total cost of municipal solid waste services; to consider complications that appear in relation to capital costs and operation and management costs; to make service-wise comparisons of various costs involved; to find out how cities obtain investment funding for solid waste management projects; and to determine how local governments obtain operational and maintenance funding.

There is a large body of *literature* on waste management issues. However, studies of waste management financing are still rather uncommon and not systematized. The information is scattered across articles and mostly country reports. Driving factors, charging methods and options of financing of solid waste management are considered in the following studies [1–5], in publications of the Asian

Development Bank [6, 7],[1] ISWA publications [8],[2] International Finance Corporation of the World Bank group [9, 10],[3] World Bank publications [11].[4] The in-depth literature review of economic and ecological efficiency of different waste treatment policies is carried out in the following studies [12, 13], systematic literature review and recommendations for different countries are given in the following studies [14–16].

Methodology. The research incorporates the assessment of the current situation in determining cost of solid waste management services. The author provides a comparative analysis between CapEx and OpEx, investigates methods of collection data on these types of costs and sources of its financing. Research findings might be useful for researchers and decision-makers.

PRINCIPLES OF THE MUNICIPAL SOLID WASTE MANAGEMENT

Are people willing to pay for both waste collection as well as waste disposal services? There are some basic *principles* that are true for solid waste financing in developed and developing countries:

- People are more willing to pay for waste collection than waste disposal because collection is more visible than disposal. Therefore, disposal is driven by environmental legislation and policies rather than demand for services.
- Recycling and treatment are also driven by the market value of materials. Higher-value materials like metal and paper tend to have better recycling rates in most places. Policy drivers are required for achieving higher waste diversion rates.
- The cost of inaction is greater than the cost of doing nothing.

What are the common *factors* of solid waste financing in developed and developing countries? How are the market and policy related to solid waste management? Here is a look at the market and policy drivers along the solid waste management chain (*Fig. 1*).

Collection is driven by demand for services and by policy. Policy, here, is driven by the need to protect or improve public health.

Treatment and recovery are driven by the market as well as by policy. There is value in recovering materials as well as in recovering energy from waste, factors that drive the market to participate in materials and energy recovery. Treatment is also driven by policy in terms of valuing and protecting the environment.

Disposal differs from both collection and treatment in that it is almost solely policy driven so as to protect the environment. Noticeably, users are less striving to pay for disposal than they are for collection and recovery.

DETERMINING COST OF SOLID WASTE MANAGEMENT SERVICES

How do local governments determine costs involved for introducing solid waste services? Financial revenues and financial costs are registered (or have to be registered) by accountants. Total costs are generally divided into investment costs and operation and maintenance costs (*Fig. 2*).

It is important in waste management to make a difference between operation costs and direct investment costs. It is difficult to determine the total cost of a service, especially in low-income countries, for several reasons. First, there may be no separate budget for municipal solid waste management. Second, money comes from various sources such as grants, loans, taxes, and fees. Third, costs are borne by multiple parties, making it difficult to keep track of the expenditure. For instance, the total estimated global capital expenditures and operational expenses for waste management is US $ 375 billion from 2010 to 2025.

Investment Costs (CapEx)

Numerous programs and projects focus on upgrading waste management infrastructure, which usually leads to a better understanding of investment costs. CapEx are costs related to evolving and building a project, including:

- preparation of a project, in particular planning, site selection, technical justification, permission, consultation, public involvement;

[1] Web-site of the Asian Development Bank. URL: https://www.adb.org/search0?keywords=waste%20financing (accessed on 30.05.2023).

[2] Web-site of the International Solid Waste Association. URL: https://www.iswa.org/wmw/?v=925ab312a51a (accessed on 30.05.2023).

[3] Web-site of International Finance Corporation. World Bank Group. URL: https://www.ifc.org/wps/wcm/connect/ifc_ext_design/ifc+search/search/ifc+search?q=waste+&tab=1&count=1896& (accessed on 30.05.2023).

[4] Web-site of the World Bank group. URL: https://elibrary.worldbank.org/wb-working-papers (accessed on 04.06.2023).

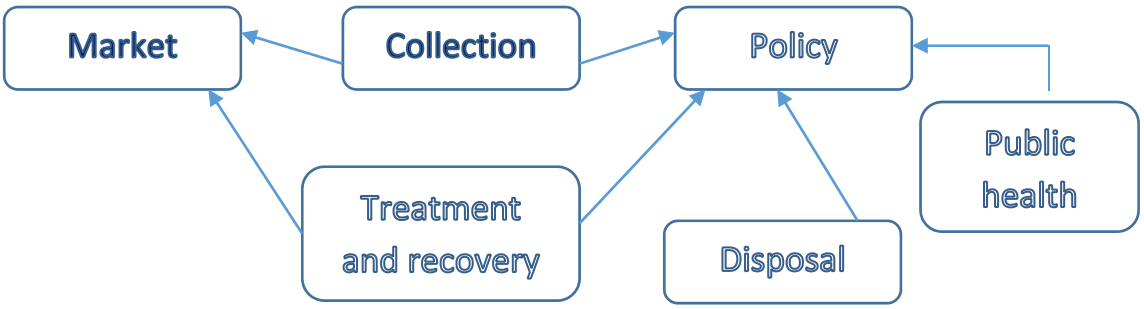

Fig. 1. **Policy Drivers Along the Municipal Solid Waste Management Chain**
Source: Author's development.

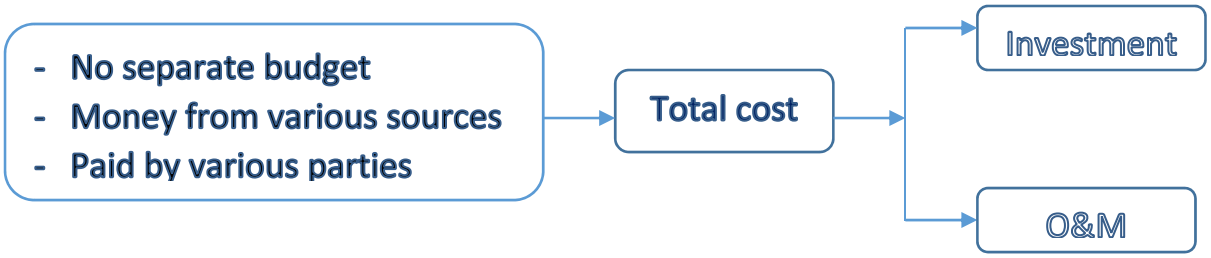

Fig. 2. **Total Cost of Municipal Solid Waste Services**
Source: Author's development.

- detailed projection;
- cost of land, particularly in the case of landfill sites;
- rigging, installations and construction.

In fact, CapEx is rather not difficult to benchmark, because facilities and technology suppliers are aware of the price of products they deliver. The costs of containers, garbage trucks, sorting lines, or landfill lines are evaluated on the base of price offers from facilities and technology suppliers, under the technical requirements. Mandatory foundation and building works are evaluated by respective professionals (engineers) on the base of cost standards for a specific country, in which investments are adopted.

Nevertheless, in practice, numerous difficulties may appear:

- it is not easy to obtain accurate and trustworthy data on CapEx for alternative types of disposal facilities and treatment plants;
- additionally, commercial confidentiality restrains the availability of data for public;
- waste is not homogeneous, so implementation of especially adapted technologies is inevitable;
- locally produced component costs differ between sites and countries;
- environmental standards are different;
- some new technologies, being rather appropriate, lack experience at large-scale work under diverse local conditions.

To sum up, it is very difficult for a city in a developing country to get investment funds for municipal solid waste management projects. Investments in solid waste management infrastructure in developing countries are 0.1% of total investments. Why are the investments in solid waste management infrastructure quite low in developing countries? We found out some *reasons*. First, municipal financing has become highly limited in the context of growing volumes of waste. Second, struggling cities can't just apply for loans. In fact, the World Bank reports that in developing countries, only 4% out of the top 500 cities are creditable in international stock markets, and therefore eligible for financing. Third, accessibility of donor financing for municipal solid waste management is extremely low if compared to other sectors. Forth, donor financing is often restricted to emerging economies. Finally, economic downturns limit private funding available for solid waste management.

Operations and Maintenance Costs (OpEx)

The key components of operation and maintenance costs are expenditures for energy, fuel, labor, maintenance and repair, monitoring, control of emissions, collection of fees, administration and management, and public communication. However, some important OpEx are *not duly calculated or even overlooked*. For example, payment for services of environmental auditors, customer care costs, awareness-raising campaign costs, investment in capacity building and worker training, and, in case of participation of private sector service providers, the customer's costs with regard to tenders, negotiation of contracts, insurance, control, and inspection. Additionally, operators are usually subject to the value added tax (VAT), even though tax exemptions may apply in some cases. Dividend taxes and income taxes are usually relevant for private commercial service providers but are not relevant for public ones. It may be that some waste management costs appear because of legislative requirements.

Completely *new costs* may appear. Among them the cost of implementing "user pays" systems; costs connected with new policy preferences (for example, implementing pollution prevention and re-use principles in the waste management agenda); and the after-care costs of landfills that don't receive waste any longer.

OpEx are registered in the accounting of municipalities and are employed to evaluate annual budgets. However, there is often a lack of data on OpEx of solid waste management services. It still persists a riddle why comparative analysis, for example, for landfilling costs or collection costs, is so complicated even in municipalities with similar circumstances. This is partially because of differences in the accounting. Municipalities usually assign only a portion of the OpEx to the waste management activities. For instance, in a municipal department, waste management services may be combined with other public services. Thus, cost allocation for a particular service, such as solid waste management services, is uncommon practice. Quite common for developing countries is that the sanitary department used to monitor waste management, but garbage collection vehicles used to be under control of the mechanics' department or by the staff of different "zones" within a municipality, while the costs are registered by each department "zone" separately. Different methods used to aggregate the costs complicate the things.

Among other restrictions are rather common lack of information and unwillingness to share data on costs and revenues. When it comes to sharing information on organizational data, technical data, or even investments costs of inventories, equipment and facilities, the staff of municipalities are usually very helpful. However, when it concerns operation costs, this type of cost is usually treated as "confidential" and is not available. Hence, tracing the information across municipalities is very uneasy, both in terms of obtaining and comparing the available data.[5]

To sum up, OpEx can be direct or hidden. *Direct costs* are those that can be directly traced to a project or product. These costs include salaries, fuel, utilities, maintenance and repair, replacement, feedstock, disposal of rejects, additives. *Hidden costs* can't be directly accountable to a project. These costs include overhead, marketing, taxes, insurance, monitoring and reporting, environmental auditing, emergency preparedness, training and capacity building, customer care, administration, revenue collection.

In some cases, where the municipality contracts out waste management services, the *municipality acts as a "client"* of the operator of the service. In this case, the hidden costs may be borne by the operator of the service and not the local government (*Fig. 3*).

Municipality as "client" costs include tendering, contract negotiation, monitoring service performance, insurance, administration fines, controlling and managing, revenue collection.

WASTE MANAGEMENT FUNDING

Waste management financing is a serious concern for cities. Cost recovery is important in order to avoid dependence on subsidization from private, national or external sources. CapEx and OpEx are normally financed differently [11].

Obtaining Operation and Maintenance Funding

We have studied different sources of information [19, 20] and found out that it is virtually

[5] There have been attempts to collect primary data based on templates that would facilitate collection of comparable data, including applied research work [17]. The information on cost has been consolidated in the waste report, which aims to collate various data on waste from around the world [18].

Fig. 3. **Operations and Maintenance Costs**

Source: Author's development.

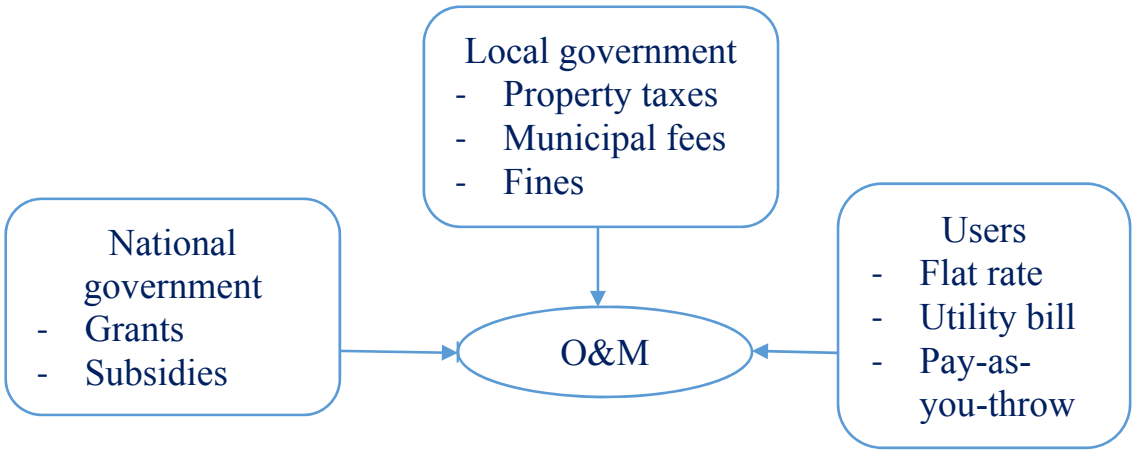

Fig. 4. **Obtaining O&M Funding**

Source: Author's development.

impossible to find donors to meet operational and maintenance costs. How crucial is OpEx funding for a solid waste management projects? Operating costs can often make up to 60–70% of total costs on waste management. This is very crucial for the success of a solid waste management project. It is important to plan the source of OpEx at the start of a solid waste management project to ensure its sustainability.

Funding for operation and maintenance can be obtained from national governments, local governments, and users of the service (*Fig. 4*).

In order to achieve long-term sustainability operational costs usually require a reliable *cost-recovery system*. A standard user fee (charges for service delivery) is a starting point for municipalities. In order to provide price availability for low-income users and to stimulate reduced waste generation user fees can be variable or fixed. To make them effective, affordability and willingness to pay must match user fees rates. Additional elements of a cost-recovery system that may be implemented in cities are waste-to-energy generation, selling compost and recycled materials, deposit-refund system for water bottles and aluminum cans, license taxes for transfer stations operators and operators of final disposal sites, consumer taxes on batteries, plastic bags and disposables.

There are averages across regions in the *Table 1*.

Table 1 shows that user fees vary greatly across regions of the world. We may see that in the Europe, Central Asia, Latin America and Caribbean user fees are the highest while in Sub-Saharan Africa and South Asia are the lowest.

If to compare user fees by income level of residents, we may see that it also varies greatly. In higher-income countries residents pay significantly greater fees for waste management services in comparison with lower-income countries. *Table 2* compares user fees for waste management services by income level.

Table 2 shows that in high income countries annual commercial fees are the highest and constitute US $ 314. In some middle- and high- income countries for each business commercial fees are flat. It makes them easier to collect and administer. In low-income countries commercial fees tend to be charged less often. However, data is very scarce and might be unreliable.

Essential remark is that for many countries the cost for the full range of waste services (from collection to final disposal) can't be completely recovered only from

Table 1

Waste Management User Fees by Region

Region	Average user fee in selected cities (US $/year, as reported in data)
Europe and Central Asia	83
East Asia and Pacific	46
South Asia	34
Middle East and North Africa	55
Sub-Saharan Africa	10–40*
Latin America and Caribbean	80

Source: Author's development.

Note: * Based on World Bank estimates.

Table 2

Waste Management User Fees by Income Level

Income group	Average fees, US $ per year	
	Household	Commercial
Low income	37	155
Lower-middle income	47	173
Upper-middle income	52	235
High income	168	314

Source: Author's development.

user fees. To keep the whole system afloat government subsidies or external budgetary support are required. Available sources provide the following actual data: annual transfers/subsidies, typically received by local governments, vary from US $ 4 to US $ 10 per capita [18]. The average annual value of a transfer/subsidy received from central government is US $ 8 per capita. National or regional governments may be donors of these funds.

Obtaining Investment Funding

Most cities, even in high-income countries, don't necessarily have the funds to invest in large projects. Then, how do cities get investment costs for solid waste management projects?

Since equipment and infrastructure investment are associated with high costs, national governments, partnership with private sector, or international donor, can typically do investment-funding organizations. Admittedly, local governments globally make at least 50% of investment in waste services, while 10–25% are made by private sector (dependent on the waste service provided), and 20% are national government subsidies [11].

Cities can raise capital for the solid waste management projects through a combination of sources (*Fig. 5*).

Funding can be in the form of grants, which do not have to be paid back, or loans, which have to be paid back with the interest.

Local government. Municipalities can also raise funds locally through revenues, taxes, or fees. Funding can also be raised through the issuance of bonds. Green bonds are a financial tool used to attract investors for climate-resilient and low-carbon infrastructure. A multilateral development bank, a financial institution, or a city can issue a green bond.

National government. National governments are usually an important source of funding for capital expenditures through grants.

Cities across the globe, especially in developing countries, usually have difficulties financing the waste management sector. Therefore, any grant or public financing are always desirable. Financing by local government assumes that a single city must increase the funds from local income sources. These sources usually consist of local fees (like parking fees), fines and taxes (like property taxes). Some cities are wealthier than others, so they may manage their funds more effectively, and can earn revenues by public-private partnership schemes or by renting out their assets.

Donors. Donor financing comes without interest payments, but often municipalities have to meet certain requirements to access these funds. The risks of donor financing are that consideration is not always given to local waste characteristics or local conditions. As a result, operations costs tend to increase significantly, resulting in the failure of the project.

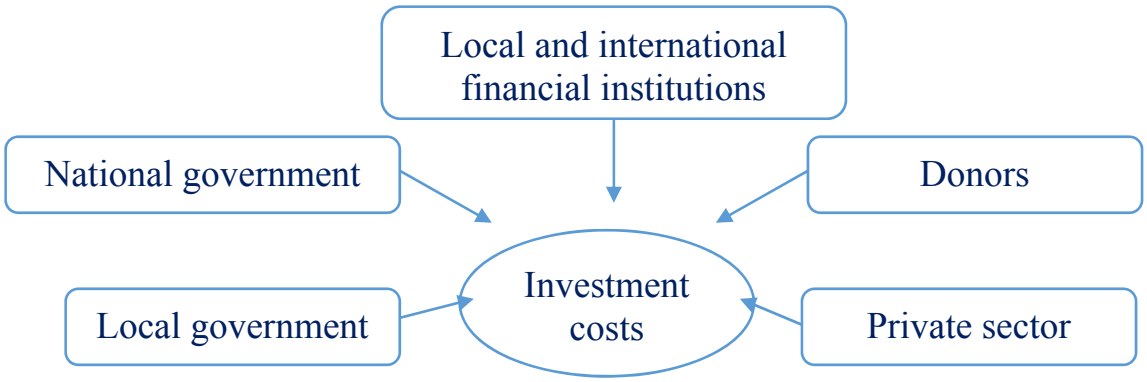

Fig. 5. **Obtaining Investment Funding**
Source: Author's development.

Private sector. Private sector entities invest only when it is possible to make a profit and recover their investment costs.

Public-private partnership in waste management systems is usually considered a means to achieve financial investment, technical expertise and efficiency [21]. Private businesses are able to participate in all stages of a waste management value chain: waste collection from households and commercial institutions, street cleaning, construction of transfer stations and disposal sites, its operation, education of people on the importance of waste reduction and separation at a source. Cost-recovery of private operators is made through the provision of their services. So municipalities with advanced waste management system guarantee that private operators are stably provided with the possibility to ern their incomes from user and tipping fees, the sale of recyclables, or are paid directly from the locality [22]. Conductive environments for private sector are characterized by rather easy and transparent procurement procedures, low political and other types of risk, a stable and robust legal system to stimulate paying and increase user compliance with regulations (like waste separation at a source, littering, etc.).

Local and international financial institutions. Often municipalities, particularly in developing economies, have competing priorities and lack the financial resources necessary for solid waste. In this case, they can obtain loans from international financial organizations (like very active in the waste management field the Inter-American Development Bank, the Asian Development Bank, the World Bank), or local banks. Generally, international lending institutions offer loans at lower interest rates than commercial banks.

A recent study for the ISWA has recorded the contribution of international financial organizations to the financing of solid waste management programs in developing countries. Namely, the greatest amounts (70%) of the donor support have been provided as lending from development banks. The total amount of this financial aid between 2013 and 2022 compiles US $ 2.8 billion. For some middle-income countries, access to capital has been provided in order to develop their municipal solid waste management infrastructure, especially engineering landfills and waste collection. Interestingly, the allocation of loans for solid waste management has been highly uneven. The top-10 recipients of finances for the development of the solid waste management sector are middle-income countries. These countries accepted fat about 2/3 of the grants and loans over US $ 4 million.[6] In general, low-income countries accepted essentially less financial aid: just 10 countries of Sub-Saharan Africa got transfers in the form of loans and grants that compiled more than US $ 4 million (or less than 5% of the total financial aid). The uneven allocation of financial funds is, perhaps, because middle-income countries have better opportunities for accessing and absorbing financial aid for waste management sector development. Nonetheless, this issue has to be investigated more profoundly so as to guarantee that development funds are targeted properly.

DISCUSSION AND CONCLUSION

On balance, studying the issue of costs, we have found the following facts:

[6] In descending order, these are the PRC, India, Morocco, Turkey, Azerbaijan, Vietnam, Venezuela, Ukraine, Tunisia and Argentina.

• Waste management policy is driven by the need to protect or improve public health.

• People are more willing to pay for waste collection than waste disposal because collection is more visible than disposal. Thus, collection is driven by the demand for services and by policy. Recycling and treatment are driven by the market value of materials and by policy. Disposal is solely driven by environmental legislation and policies.

• Total costs are divided into investment costs (CapEx) and operation and maintenance costs (OpEx). In general, CapEx includes project preparation, detailed design, land costs, equipment, construction costs. OpEx includes costs for energy, fuel, labor, maintenance and repair, monitoring, control of emissions, collection of fees, administration and management, and public communication. OpEx accounts for 60–70% of the total costs in well-developed waste management systems.

• CapEx are rather not difficult to benchmark. The lack of data on OpEx is very common. Quite often some important OpEx are not duly calculated or even overlooked. Differences in accountancy between municipalities, different methods used to aggregate data on OpEx and unwillingness to share data complicate the things. It is important to understand OpEx because it influences investments in cost-efficient technologies and improvements in the system as a whole.

• To compare OpEx, we may apply the standardized methodology of collection activity-based cost data. This methodology assumes collection only of the costs exclusively related to a particular waste management activity. To increase data collection, it is recommended to develop the interactive web-based interface.

• It is difficult to determine the total cost of a service, especially in low-income countries, because (a) there may be no separate budget for municipal solid waste management; (b) money comes from various sources (grants, loans, taxes, and fees); (c) costs are borne by multiple parties, making it difficult to keep track of the expenditure.

• It is very difficult for a city in a developing country to get investment funds for municipal solid waste management projects for several reasons: (a) municipal financing is highly limited in the context of growing volumes of waste; (b) struggling cities can't just apply for loans because they are not considered creditworthy by international stock markets; (c) accessibility of donor financing for municipal solid waste management is extremely low if compared to other sectors; (d) donor financing is often restricted to emerging economies; (e) economic downturns limit private funding available for solid waste management.

• CapEx and OpEx are normally financed differently. It is virtually impossible to find donors to meet OpEx. Funding for OpEx can be obtained from national governments, local governments, and users of the service. To ensure sustainability of a solid waste management project (a) OpEx must be planned at the start, (b) a reliable cost-recovery system must be designed.

• Funding CapEx can typically be done by national governments (20%), local governments (at least 50%), partnership with private sector (10–25%), or international donor organizations. Funding CapEx can be in the form of subsidies, grants, loans, taxes, fines, fees, revenues from different activities, and public-private partnership schemes.

• The greatest amount (70%) of the donor support is been provided as lending from development banks. The allocation of loans for solid waste management has been highly uneven across countries. The top-10 recipients of finances for the development of the solid waste management sector are middle-income countries.

• On balance, local government revenues and national government grants can be used as a source of both CapEx and OpEx. Users of the service are a source of OpEx whereas loans from development banks and bilateral donor agencies are sources of CapEx.

Here are some important considerations to keep in mind regarding municipal solid waste management costs. Often, there are many opportunities to reduce costs if operations are optimized. The largest cost efficiencies often come from: (a) staff productivity (reducing overstaffing); (b) cost accounting (recording actual solid waste

management expenditures instead of items such as snow removal, beautification, etc.); (c) fuel efficiency (driving trucks that are full). High cost-efficiency potentials are found in collection and transportation, whereas disposal is typically underfunded. Optimization is extremely important, as many cities are reaching or exceeding affordability benchmarks while at the same time having little or no room to increase tariffs.

Thus, why should we pay for solid waste management services? The economic costs of improper municipal solid waste management to society are essentially higher than the financial costs for waste management programs.

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