MODULE 5

SOLID WASTE MANAGEMENT IN CITIES

UN-HABITAT
FOR A BETTER URBAN FUTURE

SOLID WASTE MANAGEMENT IN CITIES

TARGET 11.6: *By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.*

Indicator 11.6.1: *Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated by cities.*

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SECTION 1:

INTRODUCTION

1.1 Background

Urban households and businesses produce substantial amounts of solid waste that must be collected regularly, recycled or treated and disposed properly in order to maintain healthy and sanitary living conditions. Many cities are increasingly facing solid waste management challenges due to rapid urbanization, lack of technical and financial capacity or low policy priority. As urbanization and population growth will continue, it is expected that municipal solid waste generation will double by 2025. Also, the higher the income level of a city, the greater the amount of the solid waste produced. Therefore the economic growth to be experienced in the developing and emerging countries will pose greater challenges in solid waste management to local governments in the next decades.

Adverse environmental impact of uncollected waste in a city is significant. Uncollected solid waste can end up in drains leading to the blockage of drainage systems e and cause unsanitary conditions that have a direct health impact on residents. Open burning of uncollected waste produces pollutants that are highly damaging locally and globally. Vectors such as mosquitos usually breed in blocked drainages and blocked drainages also contribute to flooding. In 2015, the Global Waste Management Outlook estimated that at least 2 billion people do not have access to regular waste collection . This is particularly worse in informal settlements. UN-Habitat's report on Solid Waste Management in World Cities Report published in 2010 estimated that only 5% of waste in squatter areas is regularly collected.

Even when solid waste is collected, it is not uncommon that recycling and treatment facilities or landfill sites are not operated in an environmental sound manner, especially when lacking a pollution control system. Particularly in developing countries lacking technical and financial capacity, open dumping or uncontrolled landfill is the common way of disposal. Leachate generated in dumping sites pollutes surface and groundwater. Frequent fire and explosions caused by the high temperature inside the accumulated waste is a source of air pollution. Composting and recycling facilities and incineration plants lacking pollution control systems are one of the largest pollution sources. Open dumpsites are major source of greenhouse gasses (GHG) emission in urban settings, and if the situation remains unchanged in conjunction with rapid urbanization, dumpsites will account for 8-10% of the global anthropogenic GHG emission by 2025.

Improper waste management accelerates poverty and social exclusion. In an open dump site, waste pickers or scavengers are regularly collecting recyclables without any protection measures. They are exposed to extreme health threats and it is estimated that 20% of these waste pickers are out-of-school. The frequent explosion or landslides in open dumpsites often kill these waste pickers working on the pile of waste. It is also not unusual that gangs or cartels are involved in these informal recycling activities or open dumpsites operations.

1.2 Rationale for Monitoring

A reliable estimate of the quantity of solid waste generation in the city is very important for proper solid waste planning and management. The way in which waste is produced and discarded gives us a key insight into how people live, and the quality of waste management services is a good indicator of a city's governance. An integrated solid waste management system is strongly connected to three dimensions: urban environmental health, the environment and resource management.

Moreover, a regular solid waste management strategy is a clear indicator of the effectiveness of a municipal administration. This provides a need for the city to develop and create or have in place a good waste governance structure. Good waste governance that is inclusive, financially sustainable and based on sound institutions is one of the key challenges of the 21st century, and one of the key responsibilities of a city government in many countries worldwide.

a) Monitoring and Reporting Process

DATA COLLECTION

National Statistical Offices (NSOs), in collaboration with relevant entities such as corresponding government ministries and municipal authorities, will be responsible.

CAPACITY DEVELOPMENT

UN-Habitat will lead the global responsibility of capacity building of National governments and statistical agencies for reporting purposes.

National governments/ national statistics agencies have the primary responsibility of reporting at national level with the support of UN-Habitat to densure uniform standards in analysis and reporting

DATA RELEASE

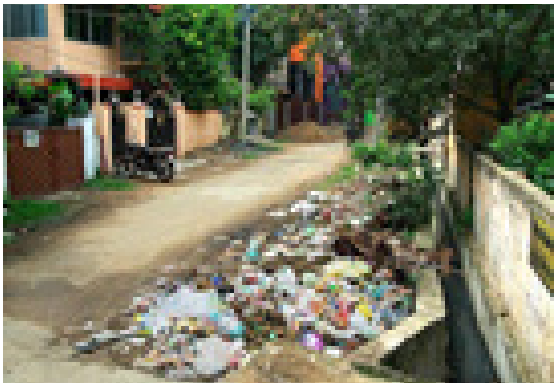
Global monitoring and reporting, led by UN-Habitat, will be conducted annually.

1.3 Concepts and Definitions

Municipal Solid Waste: This is waste generated by households, and waste of a similar nature generated by commercial and business establishments, industrial and agricultural premises, institutions such as schools and hospitals, public spaces such as parks and streets and construction sites. Generally, it is non-hazardous waste composed of food waste, garden waste, paper and cardboard, wood, textiles, nappies (disposable diapers), rubber and leather, plastics, metal, glass, and refuse such as ash, dirt and dust.

Regularly Collected Municipal Solid Waste: This waste is routinely collected from specific addresses or designated collection points. Waste collection is conducted directly by municipal authorities or private contractors licensed/commissioned by municipal authorities with a regular schedule of the day of the week and time of collection. In some cases, private waste collection companies have contracts with clients individual to provide collection services.

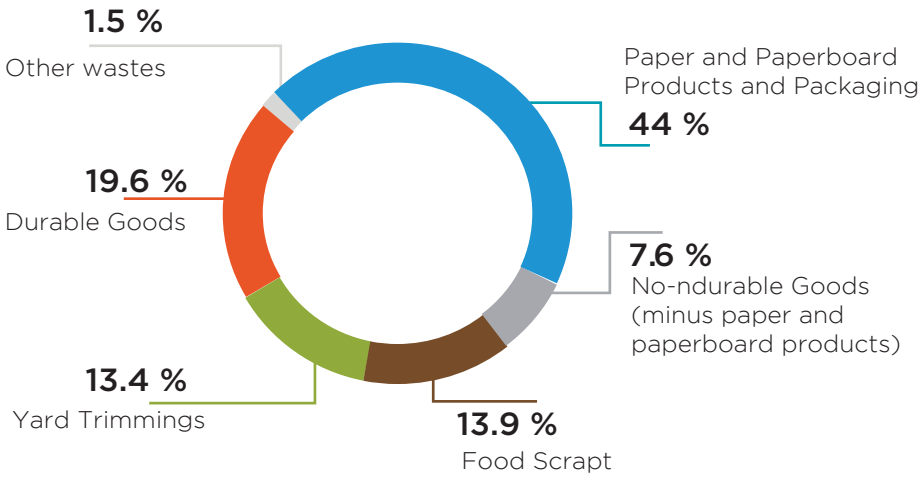
Uncollected Municipal Solid Waste: This refers to waste that is generated in a city but which remains uncollected due to lack of collection services. In many cities, informal settlements areas do not have access to this basic service. The amount of uncollected waste can be estimated by waste generation per capita in the city multiplied by the population that does not have access to the solid waste collection service.



Total Municipal Solid Waste Generated by the City: This is the sum of municipal solid waste, or the sum of regularly collected municipal solid waste and uncollected municipal solid waste.

Municipal Solid Waste with Adequate Final Treatment and Disposal: refers to the total municipal solid waste destined for treatment or disposal facilities that at least reached an intermediate level of control. The level of adequacy for a particular facility can be assessed using the qualitative criteria including 1) degree of control over waste reception and general site management; 2) degree of control over waste treatment and disposal and 3) degree of monitoring and verification of environmental control. A score of at least 10 on each criterion is the threshold required to be considered as 'adequate final treatment and disposal'.

Total U.S Municipal Solid Waste Generation by Category



Source: United States Environmental Protection Agency, Municipal Solid Waste Generation, Recycling and Disposal in the United States. Facts and Figure for 2010. Adjusted to combine containers with packaging and paper and paperboard

SECTION 2:

HOW TO COMPUTE THE INDICATOR

Data Sources

Possible data sources for this indicator include:

- Municipal records
- Service providers
- Community profiles
- Household surveys
- Scorecards from waste management experts in the city

Method of computation

Currently, the data for this indicator is mainly collected using two tools:

- Municipal records of solid waste generation and adequate final treatment and disposal
- Household surveys for daily waste generation in household and other premises (e.g. restaurants, hotels, hospitals, schools, etc.).

Evaluation Criteria

The total municipal solid waste generated by the city can be estimated by multiplying the municipal solid waste generation per capita by the population of the city. When the municipal solid waste generation per capita is not available, household surveys for daily waste generation in households and other premises (e.g. restaurants, hotels, hospitals, schools, etc.) should be conducted. Since the waste generation can differ according to the seasons, the survey should be conducted at least two times a year to estimate the municipal solid waste generation per capita.

Municipal solid waste regularly collected with adequate final treatment and disposal is estimated through qualitative judgement of the degree of environmental control of facilities where the city's municipal waste is collected and transported. The judgement of environmental control can be conducted in line with the criteria below. It is also important to deduct residue amount from treatment facilities to avoid double count.

Table 1: Criteria to be used in evaluating waste collection mechanisms and disposal.

<table>
<tr><td rowspan="2">[1] Degree of control over waste reception and handling at each site. This criterion should be applied to all treatment and disposal sites, whatever the specific process being used.</td><td colspan="2">Factors affecting the assessment include:
• Vehicular access to the site (high level of control: hard surfaced access roads of adequate width and load-bearing capacity, kept clean and free of mud)
• Traffic management (high level of control: any queues for site access kept short in time and contained within the site; little impact of traffic on neighbours).
• Site security (high level of control: site fenced; no unauthorised site access; gates locked when site closed).
• Waste reception and record keeping (high level of control: reception office; staffed during all opening hours; all vehicles logged and loads checked; weighbridge installed and all weights logged). Note that the procedures for monitoring the records thus collected are assessed under (3).
• Waste unloading (high level of control: waste directed to a designated area; unloading supervised by site staff).
• Control over nuisance (high level of control: successful control of windblown litter, flies, vermin, birds and of 'mud' leaving the site on vehicle tyres)
• Control of fires (high level of control: no routine burning of wastes; no 'wild' fires; active fire prevention and emergency response systems in place in case of accidental fire)</td></tr>
<tr><td>a. No control
b. Low level of control
c. Medium level of control
d. Medium/High level of control
e. High level of control</td><td>0 is scored
5
10
15
20</td></tr>
</table>

(2) Degree of control over both the waste treatment and disposal process in use at each site and over any potential emissions. This criterion covers both the presence of the necessary technologies, and the operating procedures for their proper use.	The nature of controls required will depend on both the process employed and on the potential emissions. As an example, the table below provides guidance on how the general principles can be applied to land disposal and thermal treatment (using the specific example of mass-burn incineration). For biological treatment, the detail will vary with the type of process (e.g. windrow composting, in-vessel composting, anaerobic digestion). However, in all cases a 'high level' of control would imply a high degree of control over: the incoming waste (to avoid hazardous waste or contrary materials); processing temperature to ensure pathogen destruction; retention time in the process; mixing in the process (including turning of windrows); atmospheric emissions including odours and bio aerosols; and leachate collection and treatment. Similar principles can be applied to other facilities, including mechanical-biological treatment (MBT) plants, advanced thermal treatment and new technologies for valorisation of organic waste in developing countries. In each case, the user may use the following scoring tables as a 'best judgment' guideline for scoring. Where a fuel is being made from waste to be burnt elsewhere, then the assessment should include the process and emission controls at the user facilities.

(3) Degree of monitoring and verification of environmental controls (Includes the existence and regular implementation of: robust environmental permitting/ licensing procedures; regular record keeping, monitoring and verification carried out by the facility itself; and monitoring, inspection and verification by an independent regulatory body)	The environmental monitoring programme and process control record keeping required will be specific to the type of facility. • All sites must comply with the federal/national/local environmental legislation, have conducted an Environmental Impact Assessment (EIA) where necessary, have obtained the most recent permit/ license and kept it up-to-date. • Permitting processes should be supportive of initiatives that improve environmental performance of the system. A lower score should be assigned if permitting processes for improved facilities have been unduly long and complex, while existing facilities continued to operate with much lower levels of (or no) environmental control. • For all sites it should include incoming waste volumes, weights and categories; at least occasional monitoring of waste composition and relevant properties; control of 'nuisance' (including windblown litter, flies, vermin, birds and 'mud' leaving the site on vehicle tyres); and control of odour, site fires, and emission of potential greenhouse gases (particularly methane and nitrous oxides, as well as carbon dioxide). • For all land disposal: ground and surface water. • For engineered and sanitary landfills: leachate and landfill gas management. • For thermal treatment: moisture content and calorific value of incoming wastes; temperature, residence time, emissions to air (including those of nitrogen oxides (NO), sulphur dioxide (SO2), hydrogen chloride (HCl), heavy metals and dioxins), effluent treatment and disposal, and the quantities and management methods of both fly ash and bottom ash. • For biological treatment: input waste controls (to protect both the process and the product quality); process control (temperature, residence time, mixing); product quality control; emissions controls; and greenhouse gas controls (particularly methane and nitrous oxides).

	Level of Control:	Score given
	a. No compliance	0 is scored
	b. Low compliance	5
	c. Medium Compliance	10
	d. Medium/High compliance	15
	e. High compliance	20

Table 2: Score card for treatment and disposal facilities

	Level of Control	Score	Land Disposal	Thermal Treatment
a.	None	0	Uncontrolled dumping – no controls	Uncontrolled burning lacking most 'control' functions
b.	Low (Semi-controlled facility)	5	Site staffed; waste placed in designated area; some site equipment	Site staffed; some containment and management of combustion process; basic operating procedures to control nuisance
c.	Medium (Controlled facility)	10	Waste compacted using site equipment; waste covered (at least irregularly)	Emission controls to capture particulates; trained staff follow set operating procedures; equipment properly maintained; ash properly managed
d.	Medium/high (Engineered facility)	15	Engineered landfill site: use daily cover material; some level of leachate containment and treatment; collection of landfill gas	High levels of engineering and process control over residence time, turbulence and temperature; emission controls to capture acid gases and capture dioxins; active management of fly ash.
e.	High (State-of-the-art facility)	20	Fully functional sanitary landfill site: properly sited and designed; leachate containment (naturally consolidated clay on the site or constructed liner); leachate & gas collection; gas flaring and/or utilization; final cover; post closure plan	Built to and operating in compliance with international best practice including eg. EU or other similarly stringent stack and GHG emission criteria Fly ash managed as a hazardous waste using best appropriate technology.

All the treatment and disposal facilities that receive municipal solid waste of the city are checked against the criteria above and scored. Facilities that are scored above 10 for all the criteria are accounted as facilities that can deliver 'adequate treatment and disposal'. Therefore the amount of municipal solid waste received by the facilities that has capacity of delivering 'adequate treatment and disposal' is accounted as the amount of municipal solid waste regularly collected with adequate final treatment and disposal.

Survey Sheet Example for Recycling and Treatment Facilities

Treatment facility name	Degree of control score	Process employed	Type of waste	Amount of solid waste received	Amount of sewage sludge	Amount of residue	Where residue is exported
	(1)			(t)	(t)	(t)	
	(2)						
	(3)						
	(1)			(t)	(t)	(t)	
	(2)						
	(3)						

Survey Sheet Example for Disposal Facilities

Landfill sites name	Landfill type	Operation start year	Degree of control score	Amount of MSW received	Amount of sewage sludge received
			(1)	(t)	(t)
			(2)		
			(3)		
			(1)	(t)	(t)
			(2)		
			(3)		

Example of Usage (Scenario 1: Where Municipal Records on Solid waste generated and collected are available)

Municipal solid waste Generated in City X	13000 kg
Municipal solid waste regularly collected with adequate final treatment and disposal in City X	7500 kg

The general formula is

$$X = \left[\frac{\text{Municipal solid waste regularly collected with adequate final treatment and disposal}}{\text{Total municipal solid waste generated by the city}} \right] \times 100$$

$$x = \frac{7500Kg}{13500Kg} x100$$

$$x = 57.7\%$$

57.7% of solid waste in City X is regularly collected and adequately treated and disposed.

GENERAL LIMITATIONS

1. In majority of the countries, solid waste collection and management data are currently incomplete or not available.
2. Countries have varying policies that define appropriate waste management, with different levels of treatment and data collection.
3. Cities and countries that have more advanced systems do not report other aspects of waste management such as recycling that could be disaggregated by different components.
4. The data on total municipal solid waste generation is globally available although the precision of data is disputable.

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FREQUENTLY ASKED QUESTIONS

1. What is solid waste management?

Solid waste management is the collection, transportation and disposal of waste materials

2. What are the common methods of waste disposal?

The commonly practiced technologies for solid waste management can be grouped under three major categories, i.e., bioprocessing, thermal processing and sanitary landfill. The bio-processing method includes aerobic and anaerobic composting. Thermal methods are incineration and pyrolysis. Sanitary landfill is generally used to dispose of the final rejects coming out of the biological and thermal waste processing units.

3. How do I practice waste management at home?

- Keep separate containers for dry and wet waste in the kitchen.
- Keep two bags for dry waste collection- paper and plastic, for the rest of the household waste.
- Keep plastic from the kitchen clean and dry and drop into the dry waste bin. Keep glass / plastic containers rinsed of food matter.
- Keep a paper bag for throwing sanitary waste.

4. What are the first few steps to initiate a waste management programme in your apartment complex?

- Form a group with like-minded people.
- Explain waste segregation to your family / neighbors in your apartment building.
- Get the staff in the apartment building to also understand its importance.
- Get separate storage drums for storing dry and wet waste.
- Have the dry waste picked up by the dry waste collection centre or your local scrap dealer.

5. What are the different types of waste?

5.1 Wet waste

Wet waste consists of kitchen waste - including vegetable and fruit peels and pieces, tea leaves, coffee grounds, eggshells, bones and entrails, fish scales, as well as cooked food (both veg and non-veg).

5.2 Dry Waste

Paper, plastics, metal, glass, rubber, thermocol, styrofoam, fabric, leather, rexine, wood – anything that can be kept for an extended period without decomposing is classified as dry waste.

5.3 Hazardous waste

Household hazardous waste or HHW include three sub-categories – E-waste; toxic substances such as paints, cleaning agents, solvents, insecticides and their containers, other chemicals; and biomedical waste.

5.4 E-waste

E-waste or electronic waste consists of batteries, computer parts, wires, electrical equipment of any kind, electrical and electronic toys, remotes, watches, cell phones, bulbs, tube lights and CFLs (Compact Fluorescent Lamps).

5.5 Biomedical waste

This includes used menstrual cloth, sanitary napkins, disposable diapers, bandages and any material that is contaminated with blood or other body fluids.

Metal

Paper

Glass

Organic

Batteries

Plastic

Light Bulbs

E-waste

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