SDG 11.6.1

Municipal solid waste management in the World's Cities

Methodology for City assessments

A Step by Step Guide

Draft for the ACCP Forum, Yokohama, Japan
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This Step by Step Guide is prepared as part of an initiative to establishing a methodology for the World's Cities to report on the SDG 11.6.1 indicator.

The initiative forms an integral part of the Wastewise Cities Campaign, which is benefitting from support and input from multiple agencies and experts in a truly global collaborative process.

The Guide has been prepared by UN-Habitat with support from a team of sector practitioners from Wasteaware, EAWAG and University of Leeds.

It has been prepared through an intensive process of methodological drafting, expert discussion and field testing, involving detailed survey in Nairobi and Mombasa in Kenya, and Victoria in the Seychelles.

UN-Habitat would like to express sincere thanks to all the institutions and experts who have been involved in this process, and especially to the City authorities for hosting and supporting the field testing.

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Acronyms

DDS	Designated Disposal Site
HH	Household
MSW	Municipal Solid Waste
NDDS	Non-Designated Disposal Site
PCGR	Per Capita Generation Rate
PPE	Potential Plastic Emissions
SDG	Sustainable Development Goal
WACS	Waste Amounts and Composition Survey

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Introduction

Understanding SDG 11.6.1

SDG 11.6 targets improved environmental performance of Cities. The SDG 11.6.1 indicator specifically looks at municipal solid waste (MSW) management.

Under SDG 11.6.1 two sub-indicators have been set:

a) Proportion of MSW collected out of total MSW generated
b) Proportion of MSW managed in controlled facilities out of total MSW generated
c) Quantity of potential plastic emissions into the environment

Together, these three sub-indicators characterise the performance of the MSW management system of a given city. In particular, 11.6.1(a) provides essential information for public health, 11.6.1(b) places the environmental performance of the MSW management system into the spotlight, and 11.6.1(c) identifies the potential plastic emissions to the environment.

Figure 1 summarizes the elements measured by the SDG 11.6.1. The first sub-indicator considers the amounts that fall under "Municipal Solid Waste collected" (1). The second sub-indicator considers the amounts going to "managed in controlled recovery facilities" and "managed in controlled disposal facilities" (2.1 + 2.2). Finally the potential plastic emissions (PPE) into the environment are estimated.

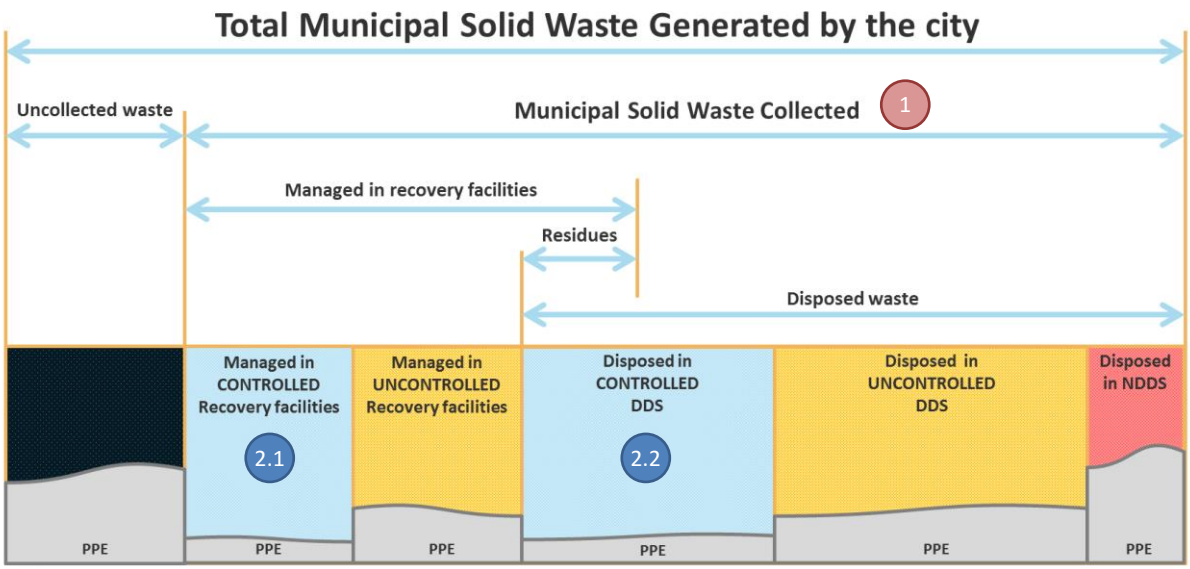
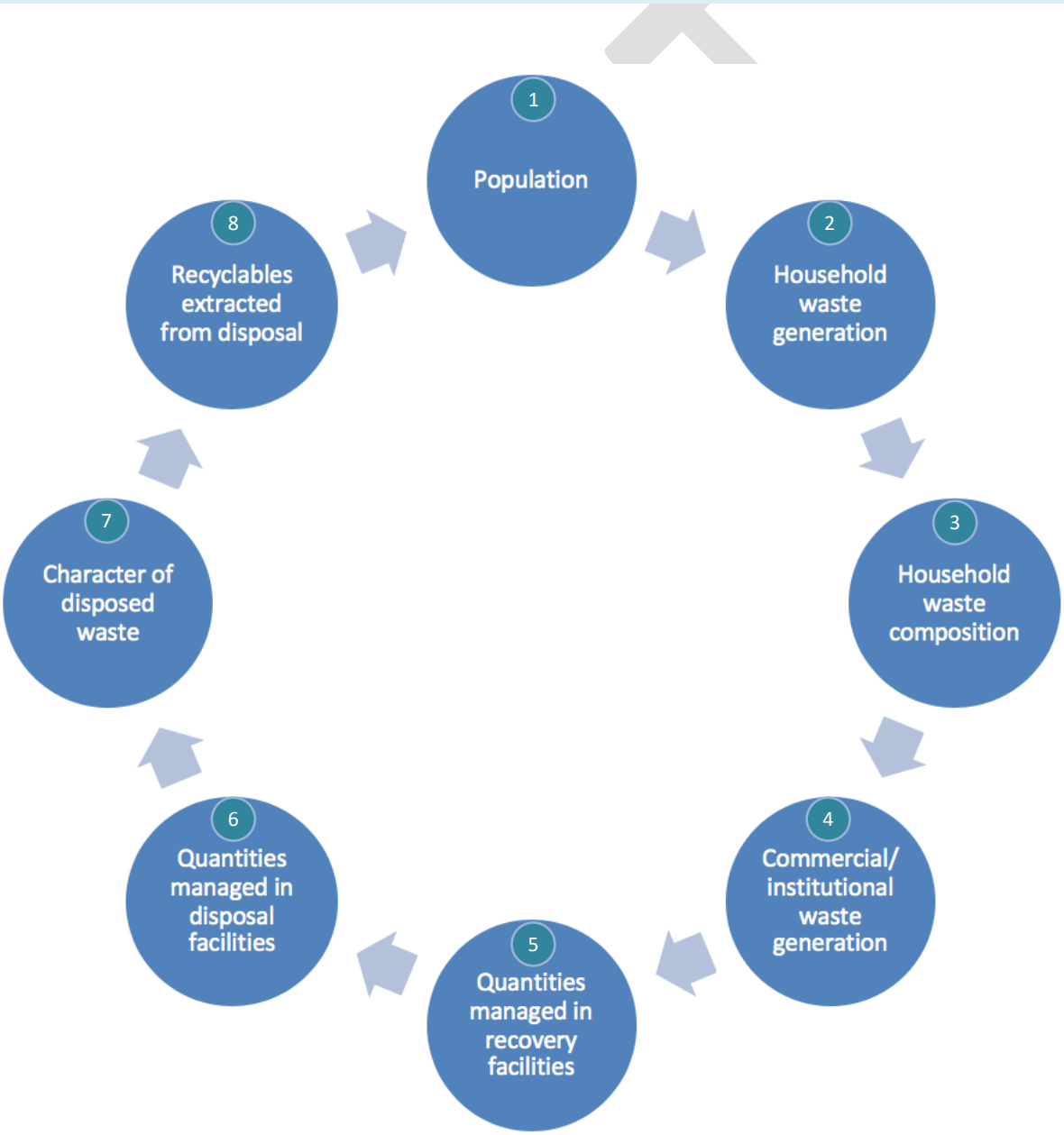


Figure 1: Concept model for SDG 11.6.1. DDS: Designated disposal site; NDDS: non designated disposal site; PPE: Potential Plastic Emissions.

Data collection points

The calculation of the three sub-indicators requires collection of information from 8 data points, including:

1) Population
2) Household waste generation
3) Characterisation of household waste
4) Commercial/institutional waste
5) Quantities managed in recovery facilities
6) Quantities managed in disposal facilities
7) Characterization of disposed waste
8) Recyclables extracted from disposal



System boundaries

For the monitoring of SDG 11.6.1, the boundary of "municipality" is recommended as the system boundary, the area where the City authority holds the responsibility for ensuring municipal solid waste management services are provided.

Where MSW collection, recovery or disposal services are being provided beyond the administrative boundaries of the city, the system boundary can be enlarged to encompass the contiguous waste management service area. Consequently, the system boundaries would represent the "serviced area" by the MSW management system. In this case, adjacent settlements will need to be included within the system boundaries of the assessment.

This might be common when inter-jurisdictional waste management services are provided, for example, in metropolitan areas.

Note:
If the final destinations of the municipal solid waste, i.e. disposal or recovery facilities, are outside of the municipal boundaries, we distinguish two scenarios:

- **a)** If these facilities receive waste from other municipalities and it is not possible to determine the amounts by origin, the system boundaries for the city assessment need to include all settlements that are sending waste to these facilities.
- **b)** If these facilities only receive waste from the municipality, or if the amounts being received at facilities can be distinguished by source of origin, it is not necessary to expand the system boundaries of the study.

Key concepts

Before diving into the methodological details of SDG 11.6.1 it is important to familiarise yourself with some of the key concepts. Further terminology and definitions are presented in Annex A.

Total Municipal Solid Waste Generated

Total MSW Generated by the City is the total municipal solid waste generated by the population and their economic activities within the defined system boundary.

Municipal Solid Waste Collected

MSW Collected refers to the amount of MSW generated that is moved from the point of generation such as specific addresses or designated collection points to facilities where the waste is recovered or disposed. The remaining share of MSW generated is considered "uncollected".

Where the collection services are split into primary and secondary collection elements both steps need to happen if we are to include the waste captured into the assessment. Where a primary collection service is provided, but the materials are **not** onwardly transported by a secondary collection service, then we do not count this as a 'controlled' collection service.

Collection services can be formal or informal. Waste is collected by operators providing a service to the waste generator, regardless of their legal status or form of organisation.

Collection service level can be categorized as shown in Table 1.

Table 1: Level of quality of collection service

SERVICE LEVEL	DEFINITION
1. None	• No collection service. • No organized service. • Waste is managed by the generators themselves.
2. Limited	• Collection point is further than 200m distance • Collected sporadically with limited frequency • Primary collection not reliably connected to the secondary collection system
3. Controlled	• Functioning door-to-door collection system or kerbside/community collection point within 200m distance • Service is provided at least once per week • Primary collection reliably connected to the secondary collection system
4. Improved	• Fulfils the criteria of controlled service • Compliant to set sanitation standards for health protection for workers • Compliant to prevent waste spillage from collection vehicles. • Effective monitoring and control
5. Full	• Fulfils the criteria of Improved service • SMART data management systems linked to monitoring and control

Municipal Solid Waste Managed in Controlled Facilities

MSW Managed in Controlled Facilities refers to municipal solid waste received by facilities with Level 3 control or above according to the ladder shown in Table 2. These facilities include recovery facilities (for energy and materials) and designated disposal sites (DDS).

The Ladder can be used as a checklist for assessing the Level of control of a particular recovery or disposal facility. Note that the emphasis is on operational controls rather than engineering/design control. A facility that is engineered and constructed to a high standard, but not operated in compliance with Level 3 (or above) standard is not regarded as a controlled facility.

Unmanaged waste

Unmanaged waste refers to waste that is not captured by the waste management system. It mainly consists of uncollected waste and waste that leaks out from the solid waste management system, regardless of the intention, as well as waste disposed in non-designated disposal facilities.

Potential Plastic Emissions (PPE)

PPE is the share of the plastic fraction of unmanaged waste that is released into the environment and has the potential to leak into water bodies. Field observations supported by a Waste Flow Diagram (WFD) is used to determine the amount of PPE.

Table 2: Levels of control for solid waste management facilities

Service level	Disposal sites	Energy Recovery (e.g. Incineration)	Material recovery (eg. Composting or other Recycling)
1: None	☐ No cover ☐ No leachate control ☐ No compaction ☐ No fencing ☐ Fire/smoke existence ☐ No equipment / limited equipment	☐ Uncontrolled burning ☐ No air / water pollution control functions	☐ Unregistered locations with no distinguishable boundaries ☐ No provisions made for worker health and safety ☐ No environmental pollution control
2: Limited	☐ No cover ☐ No leachate control ☐ Some compaction ☐ Some level of access control / fencing ☐ Some fire/smoke existence ☐ Some equipment for compaction ☐ Site staffed	N/A	☐ Unregistered facilities with distinguishable boundaries ☐ No provisions made for worker health and safety ☐ No environmental pollution control
3: Controlled	☐ Some use of cover ☐ Waste compacted ☐ Site fenced and control of access ☐ No fire/smoke existence ☐ Sufficient equipment for compaction ☐ Site staffed	☐ Emission controls to capture particulates ☐ Trained staff follow set operating procedures ☐ Equipment maintained ☐ Ash management carried out	☐ Registered facilities with marked boundaries ☐ Provisions made for worker health and safety ☐ Some environmental pollution control
4: Improved	☐ Waste periodically covered ☐ Waste compacted ☐ Leachate containment and treatment ☐ Site fenced and control of access ☐ Collection of landfill gas (depending on landfill technology) ☐ Site staffed	N/A	☐ Engineered facilities with effective process control ☐ Evidence of materials extracted being delivered into recycling or recovery markets. ☐ Pollution control compliant to environmental standards

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5: Full	☐ Waste daily covered ☐ Waste compacted ☐ Site fenced and full control of access ☐ Properly sited and designed functional sanitary landfill site ☐ Leachate treatment and containment (naturally consolidated clay on the site or constructed liner) ☐ Gas collection and flaring and/or utilization ☐ Site staffed ☐ Post closure plan	☐ Built to and operating in compliance with international best practice including e.g. EU or other similarly stringent stack and GHG emission criteria ☐ Emission controls is conducted compliant to environmental standards ☐ Fly ash managed as a hazardous waste using best appropriate technology. ☐ High energy conversion efficiency meeting European 'R1' or similar standard.	☐ Built to and in compliance with international best practice ☐ Nutrient value of biologically treated materials utilised (e.g. in agriculture/horticulture) ☐ Materials extracted with high purity and delivered into recycling markets

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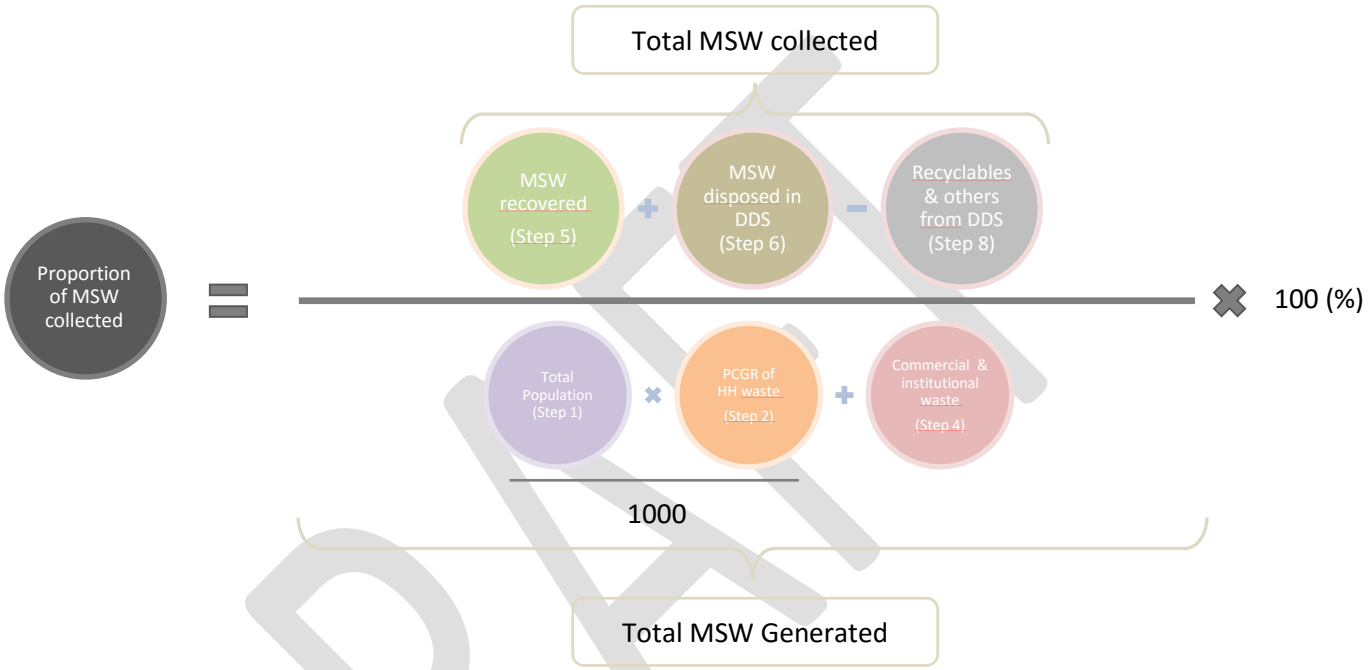
SDG 11.6.1 Sub-indicators

In this section we explain how the required data points relate to each SDG 11.6.1 sub-indicator.

Proportion of municipal solid waste collected

Equation 1 indicates all data points required to calculate this sub-indicator, as well as the step in which the methodology to calculate each item is explained.

Equation 1: Detailed formula for proportion of MSW collected



Where the units of measurement are:

- %: "Proportion of MSW collected"
- tonnes/day: "MSW recovered", "MSW disposed in DDS", "Recyclables from DDS", "Commercial waste", "Institutional waste" and "Waste from public spaces"
- number of people: "Total population"
- kg/cap/day: " per capita generation rate (PCGR) of HH waste"

The first sub-indicator of SDG 11.6.1 measures the total MSW collected in the city. In order to determine this figure one could think of interviewing the waste collection service providers. However, this will be more or less challenging depending on the size and complexity of the waste management system. Table 3 summarizes several challenges that you might encounter when assessing the collection system.

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Table 3: Challenges when measuring total MSW collected through collection service providers

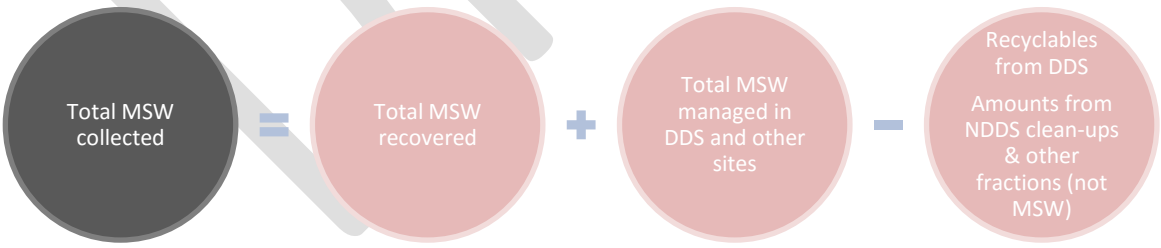
Collection service provider	Possible challenge	Explanation	Approach
Informal sector (recyclables)	High Number	Number of operators impossible to determine	In cities where the recovery sector is predominantly informal, the materials tend to concentrate in a few players. These players either recycle the materials or export them for recovery. Approach: Identify and interview only the "big" recovery facilities that concentrate each recyclable material.
	Fragmented Hierarchy	Value chain composed of many intermediary steps (i.e. middlemen) between the waste pickers and the last recycling company. Risk for double-counting if players along the same value chain are interviewed.	
Private collection service providers	Number	Number of players impossible to determine	Measure amounts at the final destination (e.g. DDS or recovery facilities)

Based on the challenges explained in Table 3, obtaining the collected amounts through collection service providers is in many cities impossible. Consequently, this guide measures the amounts of MSW collected at the final destinations:

1) Step 5: MSW managed in recovery facilities; and
2) Step 6: MSW managed in disposal facilities.

Equation 2 is used to calculate total waste collected. In order to avoid double counting, it is important to deduct a given number of items, as explained in Step 8.

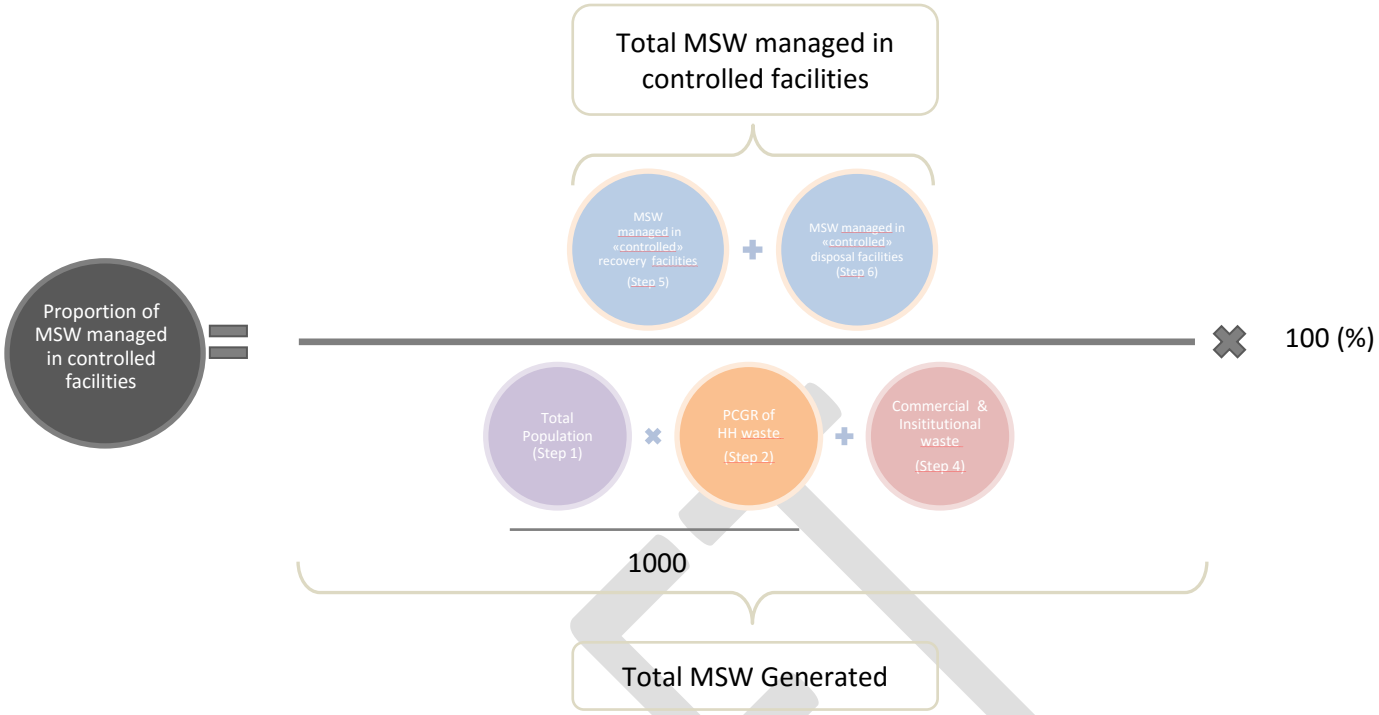
Equation 2



Proportion of MSW managed in controlled facilities

Equation 3 indicates all data points required to calculate this sub-indicator, as well as the step in which the methodology to calculate each item is explained.

Equation 3: Detailed formula for proportion of MSW managed in controlled facilities



Where the units of measurement are:

- %: "Proportion of MSW collected"
- tonnes/day: "MSW recovered", "MSW disposed in DDS", "Recyclables from DDS", "Commercial waste", "Institutional waste" and "Waste from public spaces"
- n° of people: "Total population"
- kg/cap/day: "per capita generation (PCGR) of HH waste"

Potential plastic emissions (PPE) into the environment

The detailed methodology to determine PPE-s is currently under development in collaboration with a GIZ-financed project, and will be presented in later versions of this Step by Step Guide.

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SDG 11.6.1 Step by Step

This section will guide you through the steps required to report the SDG 11.6.1 in its full extent. The steps are organized around the 8 data points:

Step 1	**Population**
Step 2	**Household waste generation rate**
Step 3	**Characterization of household waste**
Step 4	**Commercial and institutional waste generation**
Step 5	**Quantities managed in recovery facilities**
Step 6	**Quantities managed in disposal facilities**
Step 7	**Characterisation of disposed waste**
Step 8	**Recyclables extracted from designated disposal sites**

Additional steps are being formulated that have Strong linkages to other SDGs. These include an additional Step to identify the Access to Basic Services (related to SDG 1.4.1) and an additional Step to quantify potential plastic emissions to the environment (related to SDG 14.1.1). These methodologies are under development and will be included in later versions of this Step by Step Guide.

Getting started

Establish a working team

The assessment of SDG 11.6.1. requires a core team who brings the expertise and is familiar with the methodology.

- **Profile**: members of the expert team must have a good understanding of municipal solid waste management systems, both concepts and flows.
    - Having as a member of the team a responsible person for the waste management system of the city to be assessed is a very valuable asset.
- **Requirements:**
    - Language: Make sure that at least one person speaks the local language/dialect fluently.
    - Mobility: ideally most members should be based on the location where the assessment will be conducted.
    - Field visits: some of the members will have to conduct several field visits to waste management installations. Distance, accessibility and comfort of travel can greatly vary. Be ready for bumpy roads!
    - Social media: many stakeholders are much more responsive on the phone, or through quick messaging tools.
- **Workload**: the workload for the core team of experts is approximately 6 people-weeks[1].

[1] People-week: one people week implies having one person full time during one week. 6 people-week allows an array of combinations: i.e. 6 people working full time during a week, or 3 people working full time over 2 weeks, or 1 person working full time over 6 weeks, etc.

Identify key stakeholders and partnerships

Stakeholders in this context are those individuals and entities involved in the solid waste management system, either by providing a service, monitoring the service or by receiving the service.

A big part of the success of the assessment of this indicator depends on identifying and obtaining information from the key stakeholders. The goal is to obtain as much accurate quantitative data as possible on generated, collected, treated and disposed waste. Having a clear understanding of the MSW management system of the city to be assessed is a prerequisite. The following list gathers examples of possible stakeholders of interest:

1) **City waste management office and other departments**: Cities have statutory responsibilities for a wide range of SWM service provisions, including operation and maintenance. Different departments of the municipality besides the waste management department may be relevant and independent stakeholders, such as urban development authorities, environmental departments, public works departments or health and hygiene departments
2) **Public collection service providers**: often operated and supervised by the respective municipal department
3) **Formal private collection service providers**: often collection services are out-sourced to formal private companies which, in this case, are accountable to the municipality. Formal private collection companies may also be hired and paid directly by the waste generators (e.g. generators such as institutions, commercial units, industry).
4) **Informal collection service providers**: organizations or individuals providing the collection service. This also includes informal organizations or individuals picking or scavenging recyclables from waste or providing a service of collection and/or buying recyclables from waste generators.
5) **Community-based organisations (CBOs)**: e.g. organisations engaged in self-help activities or in providing services in and to communities
6) **Non-governmental organisations (NGOs)**: organisations that act as intermediaries between governments and local communities, and are sometimes involved in solid waste service provision
7) **National Ministries or departments of ministries**: are often involved in SWM management regulations
8) **Waste generators**: members of households, commercial units, institutions (schools, offices, etc.), industries, etc.
9) **Other**

Stakeholder identification and analysis is typically an iterative process where in interviews with stakeholders, information about other important stakeholders is obtained.

Setting up a collaboration with an important stakeholder can be very beneficial. The waste management department needs to take the leading role as they will facilitate many steps of the process (contacting operators, accessing waste generators, community based organizations, etc.). As we will see later, volunteers are needed for several tasks during the assessment. Such partnerships with local institutions or universities is very helpful to mobilize volunteers.

Prepare a work plan

Table 4 gives an indication of the workload and duration of each of the steps

Table 4: Material to prepare work plan for an average-city assessment

Step N°	Description	Minimum Duration	Tasks	Workload (n° people)
	Mobilise the data collection process	2 weeks	- Stakeholder identification - Set and train volunteers	1 -2
Step 1	**Population**	A few days	- Online search - Telephone calls	1
Steps 2 & 3	**Household waste generation and characterisation**	10 days	- WACS	Volunteers
Step 4	**Commercial and institutional waste generation**	10 days	- Premise/Institutions survey	Volunteers
Step 5	**Quantities managed in recovery facilities**	1 week	- Interviews - Observations - Data analysis	2 – 3 experts
Step 6	**Quantities managed in disposal facilities**	3 days	- Interviews - Observations - Data analysis	1 – 2 experts
Step 7	**Characterization of disposed waste**	1 day	- Interviews - Observations - Data analysis	Volunteers
Step 8	**Recyclables extracted from designated disposal sites**	1 -2 days	- Interviews - Observations - Data analysis	1 – 2 experts

Many of these steps can take place in parallel if the size of working group allows it.

Mobilize and train volunteers

Volunteers are needed to conduct three key activities:

1) household surveys and surveys to premises & institutions
2) waste generation and characterization assessments of households
3) the characterization exercise at the disposal site.

If you happen to be a city authority, mobilizing "hands" might not be an issue. However, if you are an external agent conducting the assessment you might wonder: "from where and how can I mobilise volunteers?".

That is why it is important to have partnerships with local key stakeholders. Before starting with such an assessment make sure you:

- Build a network of some key stakeholders of the city i.e. ministry of environment, municipal environmental office, universities, etc.
- Build their interest on the assessment and make them feel part of it.
- Mobilise the required number of volunteers through your local partners
    - The number of volunteers will depend on the sample size of households that will be surveyed. Considering a sample size of 90 households we would recommend mobilizing 20-30 volunteers.
- Once volunteers are identified, organize a small training. The purpose of this training is:

- Inform them about the purpose and relevance of the assessment
- Explain the steps required to conduct a Waste Amounts and Composition Survey (WACS).
  - Provide a list with how to classify the most common waste materials.
  - Ideally go through a dummy exercise with them
- Go through the Household and Premises surveys and make sure all questions are clear.
- Divide the volunteers into groups and assign different households to each group.

Note:
- "Volunteers" often need to be paid a small fee. Consider this when calculating the budget.
- A good idea to ensure the collaboration of most volunteers until the end, is deliver certificates at the end of the assessment stating that each volunteer has conducted a WACS

Estimate budget

Table 5 provides a list of the items required for the activities required for the assessment of SDG 11.6.1.

Table 5: Expenses for the SDG 11.6.1

Items	General	Collection	WACS
1. Salaries and per diems of expert group	X		
2. Remuneration of volunteers	X		
3. Transport expenses	X		
4. Printings costs (surveys, etc.)	X		
5. Liner bags (n° HH x 8 – vol: 60L)		X	
6. Identification tape (tag bags)		X	
7. Wheelbarrows[1]		X	
8. Pencils, pens, tape and marker		X	
9. Hanging Weighting scale (up to 60 kg)			X
10. Thick gloves			X
11. Shovel and rakes			X
12. Thick plastic sheet (at least 4 x 4)			X
13. Waste containers (60 L)			X
14. Chopping device			X
15. Brooms			X
16. Camera	X		

[1]Or any other carrier to transport the collected waste from the HH-s to the measurement site.

Step 1: Determine total population

Let's move now to the steps required to determine total population. In order to get this information, proceed with the following steps:

1) **Identify possible sources for this information**. gathers some of the common sources (see Table 6).

Table 6: Possible sources of information on population growth

Local literature	National literature	Globally available datasets
Municipal statistical bureau (latest census) Former SWM assessments (done by Universities, NGO's, consultancy companies, etc.)	National statistical bureau (latest census)	UNEP/UNSD Environmental Statistics What a Waste 2.0 by the World Bank (2018)

2) **Conduct an online search** to find already published and available reports which might contain this information.
3) **Conduct telephone interviews** with key stakeholders who might have this information (consider those in Table 6.
4) **Arrange and conduct face to face interviews** with local stakeholders who might have this information
5) **Iteratively conduct steps 2 to 4** based on the information found and contacts identified.
6) **Contrast the results** found with local experts. Figure 2 shows the possible outcomes for this step. The obtained figure should feed into Equation 1 and Equation 3 (denominator).

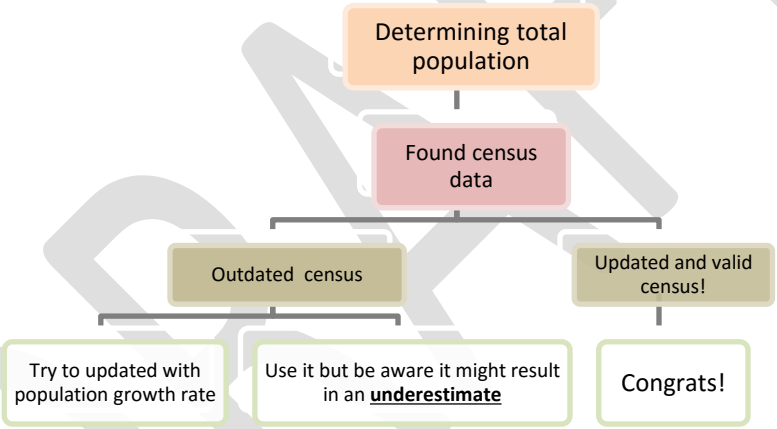

Figure 2: Outcome possibilities when determining total population.

Recommendations:

7) Use updated data: if available population data is older than 5 years, obtain population growth rate from similar sources as shown in
   - Table 6 and extrapolate to estimate the current population.
   - Including impact of income on per capita generation rate (PCGR):
     - PCGR varies according to certain socio-demographic and socio-economic variables. Typically higher income dwellers generate more waste per capita.
     - Using a default PCGR misses to consider this variability.

Whenever possible, calculate total MSW generated using population and PCGR figures stratified by income level or other stratification characteristic, such as household type.

Step 2 and 3: Household waste generation and characterisation

MSW generated in the city is a sum of MSW generated by the elements shown in Figure 3:

Figure 3: Elements that comprise total MSW generated. PCGR: Per capita generation rate.

Aspects to keep in mind:

- Quantifying total MSW generated is challenging
- Often based only on amounts disposed at the disposal site (underestimate)
- Per capita generation rates (PCGR) can be misleading. They could represent
    - a) per capita Household generation rates or
    - b) total MSW per capita generation rates.

  Make sure you always use b).

- Total population data in many cities is outdated or not measured

In the coming pages the steps required to plan and conduct a Waste Amounts and Composition Survey (WACS) are described. This is the methodology recommended for the assessment of the SDG 11.6.1.

The description details how to calculate household PCGR. Further information can be found in (UNEP, 2009; Waste Concern, 2010; Lenkiewicz, 2017) or in the open online course entitled "Municipal Solid Waste Management in Developing Countries" (see videos "Planning a waste generation and characterisation study" and "Conducting a waste generation and characterization study")[2].

For some potential users it might represent a resource intensive method (time, skills, labour, equipment, etc.). We are aware that mobilising such resources is often a challenge, however, we strongly encourage all future users of this methodology to give it a try. For those who cannot conduct the full assessment however, Annex D offers two simplified approaches.

Note:
Characterization data is required in order to calculate the potential plastic emissions (3rd sub-indicator of SDG 11.6.1). This indicator only looks at the plastic fraction and therefore data on plastic amounts are required.

[2] The course "*Municipal Solid Waste Management in Developing Countries*" is available for free on the learning platform Coursera. The videos of the course are also on YouTube. The links to both platforms are on our webpage www.eawag.ch/mooc

Steps to plan a WACS

1) **Sub-divide the city:** select representative neighbourhoods of high, middle and low income in your city. For each income level 3 neighbourhoods should be chosen.
2) **Calculate sample size:** From the areas selected, you will need to determine the number of households to survey to obtain a reliable result. Your chosen level of reliability is defined by the selected confidence level and margin of error (or confidence interval). Increasing the targeted confidence level or decreasing the margin of error will increase accuracy of your results but will also require an increased number of households that need to be sampled.

> Example:
>
> For instance, to achieve a confidence level of 95% and a margin of error of 5% for an income level with a population size of 10,000 households, at least 370 households would have to be sampled. Increasing the margin of error to 10% with the same confidence level will reduces the required sample size to 96. As a general rule, we recommend to aim at a confidence level of 95% and a margin of error of 5%. However, when resources and capacity to work are limited, higher margins of error can be justified and should be calculated and reported.

3) **Conduct a random selection:** Once the number of households to be surveyed in each income group has been determined, you must make sure to select these households in a random manner and avoid any bias in the selection. There are many methods to proceed with simple random selection.
    a. **Option A:** the most primitive would be the lottery method where each household in the income group is assigned a unique number and then the defined number of households are selected from this thoroughly mixed list so that each household has an equal chance of being selected as subject.
    b. **Option B:** another way would be to let a computer do a random selection from your list of all households in the selected neighbourhood.

4) **Select waste fractions:** choose the waste fractions you want to consider in the characterization exercise. We at least recommend the following categories:

Table 7: Fractions recommended for the characterization survey

Fractions	
1. Kitchen/canteen	7. Glass
2. Garden/park	8. Textile/shoes
3. Paper/card	9. Wood
4. Plastic-film	10. WEEE
5. Plastic-dense	11. HHW
6. Metals	12. Other

5) **Interview households:** Once households are selected, arrange a short interview with them to assess their willingness to collaborate in the survey. Explain the process and what is expected from

them. Make sure to have the sufficient number of households that are willing to participate in the survey. Record the number of members in the household.

a. **Important:** require that households do not sell or take out recyclables for rag pickers so that the genuine total waste generation in the household can be properly captured.

6) **Account for daily and seasonal variations:** To account for daily variations throughout the week, waste must be obtained daily and analysed for a minimum of eight consecutive days. If this is not possible, then waste should at least be collected for two consecutive days (see step "waste collection").

a. Where large seasonal variations can be expected (very distinct dry and wet seasons), repeat these audits two to four times throughout the year. Keep in mind that every time the audit is repeated, it is crucial to be consistent with your method. This means, maintaining the same sample size and the same calculation methods. This will allow comparison of results at a later stage.

7) **Prepare site for the audit (optional):** After having defined the sample size, you will have a rough idea of how much waste you will be dealing with on a daily basis during the surveying campaign. Accordingly, choose a site where you can store and manage all this waste. Ideally, this site should be flat and covered, have enough space, be accessible to vehicles, have access to water for drinking and washing purposes and offer protection from pests.

8) **Hire and train staff:** All staff should be trained properly on the aim of the waste audit, the main steps and the risks. Since sorting waste can be tedious and hazardous, the staff must be instructed to use personal protective equipment, avoid dehydration and take adequate breaks.

9) **Acquire necessary equipment**: Table 8shows the main items that are required for collection and for measuring the waste generation rate.

Table 8: Items required for a WACS per survey group

Items	Collection	WACS
1. Liner bags (n° HH x 8 – vol: 60L)	X	
2. Identification tape (tag bags)	X	
3. Wheelbarrows[1]	X	
4. Pencils, pens, tape and marker	X	
5. Hanging Weighting scale (up to 60 kg)		X
6. Thick gloves		X
7. Thick plastic sheet (at least 4 x 4)		X
8. Waste containers or bags (60 L) (as many as waste fractios)		X
9. Chopping device		X
10. Brooms		X
11. Camera	X	X

[1]Or any other carrier to transport the collected waste from the HH-s to the measurement site.

10) **Mark each liner bag** with the house number/name and a date. The bag will contain the waste generated in that household on the written date.

11) **Prepare and print spreadsheets**: prepare and print sheets that will be used to record all information

Steps to conduct waste amounts survey

1) **Organize staff:** Split your staff into different teams and distribute the selected neighborhoods. Make sure it is clear who is responsible for the survey in which neighborhood.

2) **Household Waste collection**: All HW generated in the surveyed households must be collected to calculate the average per capita generation rates. Ideally, you will have to collect waste every day for a minimum of eight consecutive days. HW waste amounts might be different depending on the day of the week (i.e. market days, holidays, religious breaks, etc.). If capacity, time or resources do not allow for a 8 day audit, the minimum length of an audit would be of 2 days (amounts collected on the first day would be discarded). We do however recommend to aim for a 8 day audit.
    a. **On day 1,** distribute 2 liner bags to each household.
    b. Ask them to store all the generated waste they have at home in one of these bags (day 1). This bag is then collected on day 2 and **is discarded**, as it may contain waste accumulated from this and previous days.
    c. **On day 2,** the surveyors collect the first bag (filled) and discard it.
    d. They provide an additional new liner bag for day 3.
    e. In the meantime, the household stores all the waste generated on day 2 in the second liner bag obtained in day 1.
    f. **Important:** do not collect the bag that is being used to store the waste generated on that same day!
    g. From **day 3 to 8**, repeat the same process as shown in Table 9.
    h. Label the bags with the following information: Household identifying number, date and time, number of people in the household, income level.

Table 9: Order for supplying, collecting and filling liner bags during a WACS

	Activity of surveyors		Activity of household
Day n°	Supply households with…	Collect from households liner bag n°…	Store waste in liner bag n°…
Day 1	Liner bags for Day 1 and Day 2	-	Day 1
Day 2	Liner bag for Day 3	Day 1	Day 2
Day 3	Liner bag for Day 4	Day 2	Day 3
Day 4	Liner bag for Day 5	Day 3	Day 4
Day 5	Liner bag for Day 6	Day 4	Day 5
Day 6	Liner bag for Day 7	Day 5	Day 6
Day 7	Liner bag for Day 8	Day 6	Day 7
Day 8	-	Day 7	Day 8
Day 9	-	Day 8	-

Note:

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If the surveyors do not have the capacity to collect waste every day, all liner bags for the 8 days can be distributed on day 1. Instruct households that all waste generated during one day should be deposited in the bag with marked with that date. Once the day is over, this bag should be closed and store.

Important:
Remind households not to sell or take out recyclables so that the genuine total waste generation in the household can be properly captured.

3) **Weigh the waste:** If a site has been allocated for the audit, use a convenient vehicle to collected the bags and transport them to this site before weighing each bag and recording the information in the data spreadsheet. Alternatively, the bags can also be weighed at the household at the moment of collection. Record the weights in the data spreadsheet. Be consistent with the unit you use (i.e. kg, g, etc.).

4) **Calculate average HW generation rate**: To calculate the average HW generation rate per capita per day:
    a. Consider all data points from one neighbourhood. If we assume that you sampled 50 households in this district and conducted an 8 day long audit, this will result in 7 data points for each household (one for each of the days of the week, and discarding the 1st day). This would amount to a total of 350 data points (50 household x 7 data points per household).
    b. The average of all these data points represents the *"average HW generation rate per household per day"* (kg/household/day) (note: the mass unit (kg) will depend on your choice).
    c. Now, go one step back, and observe again the 350 data points (weights of bags) and divide the weight of each waste bag, by the number of people living in the house where the waste was generated. This will result in 350 data points with the unit of kg/capita/day.
    d. The average of all these values will be the "*average HW generation rate per capita per day"* for the given neighbourhood.

Aggregate the data according to the different income groups. For this compile an average of all 3 or 5 selected neighbourhoods of that same income group. Multiply this average by the number of capita in the city within this income group. The result will be the total HW generated for this income group in the city. Do this for all income groups (see Table 10).

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Table 10: Summary of HH waste generation data per income level

Household income level	# of surveyed districts (N)	# of households per district[1] (HH)	# of households sampled (N x HH)	Average HW generation rate per HH day	Average HW generation rate per capita per day	Total population in the income group in the city	Total HW generated per income level
High income	5 or 3	10	50 or 30	g/day	g/person/day		t/day
Middle income	5 or 3	10	50 or 30	g/day	g/person/day	Refer to Step 2	t/day
Low income	5 or 3	10	50 or 30	g/day	g/person/day		t/day

[1]Will depend on your sample size

5) **Calculate total household waste generation:** When you have obtained the total HW generated per income group for each income group, sum all these results to obtain the total household waste generation of the city. This figure will fee into Equation 1 and Equation 3 (denominator).

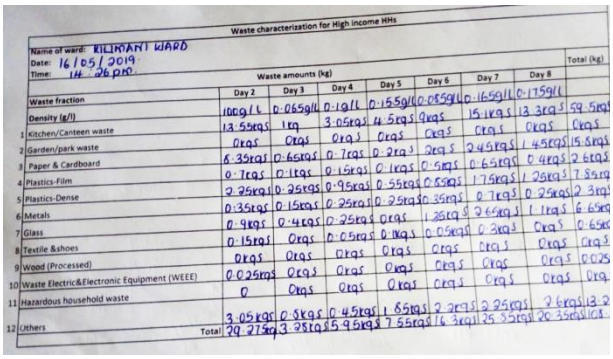
Steps to conduct waste characterization survey

After measuring amounts, it is time to measure what the waste is composed of. We refer to this as characterization survey. This activity is quite labour intensive. It is advisable to conduct the generation and characterization survey on the same day since the waste starts to degrade otherwise. However, if the resources are limited, one could combine all bags from the same neighbourhood collected in different days and combine them for this survey.

Let's now go through the steps required for such a study.

1) **Mix the waste:** empty all the bags collected from the same neighbourhood on the same day on to a flattened surface, not exposed to rain. Ideally this could be plastic sheet.
2) **Sort the waste:** bring the representative sample of 50kg to the sorting table.

   3.1 Prepare the labelled containers (as many containers as fractions) around the sorting table.
   3.2 Sort all the waste into the containers (see Figure 4 right).



Waste characterization for High income HHs

Name of ward: KILIMANI WARD
Date: 16/05/2019
Time: 14:26 PM

	Waste fraction	Waste amounts (kg) Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Total (kg)
	Density (g/l)	100g/L	0.065g/L	0.1g/L	0.155g/L	0.065g/L	0.165g/L	0.175g/L	
1	Kitchen/Canteen waste	13.5kgs	1kg	3.05kgs	4.5kgs	9kgs	15.1kgs	13.3kgs	59.5kgs
2	Garden/park waste	0kgs	0kgs	0kgs	0kgs	0kgs	0kgs	0kgs	0kgs
3	Paper & Cardboard	6.35kgs	0.65kgs	0.7kgs	0.2kgs	0kgs	2.45kgs	1.45kgs	15.5kgs
4	Plastics-Film	0.7kgs	0.1kgs	0.15kgs	0.1kgs	0.5kgs	0.65kgs	0.4kgs	2.6kgs
5	Plastics-Dense	2.25kgs	0.25kgs	0.95kgs	0.55kgs	0.55kgs	1.75kgs	1.25kgs	7.35kgs
6	Metals	0.35kgs	0.15kgs	0.25kgs	0.25kgs	0.35kgs	0.7kgs	0.25kgs	2.3kgs
7	Glass	0.9kgs	0.4kgs	0.25kgs	0kgs	1.35kgs	2.65kgs	1.1kgs	6.65kgs
8	Textile &shoes	0.15kgs	0kgs	0.05kgs	0.1kgs	0.05kgs	0.3kgs	0kgs	0.65kgs
9	Wood (Processed)	0kgs	0kgs	0kgs	0kgs	0kgs	0kgs	0kgs	0kgs
10	Waste Electric&Electronic Equipment (WEEE)	0.025kgs	0kgs	0kgs	0kgs	0kgs	0kgs	0kgs	0.025
11	Hazardous household waste	0	0kgs	0kgs	0kgs	0kgs	0kgs	0kgs	0kg
12	Others	3.05kgs	0.5kgs	0.45kgs	1.85kgs	2.2kgs	2.25kgs	2.6kgs	13.2
	Total	29.275kg	3.25kgs	5.95kgs	7.55kgs	16.3kgs	25.35kgs	20.35kgs	108

Figure 4: sorting collected waste (left), data sheet filled for one household (right)

3) **Weigh the waste fractions**:

   4.1 Weigh each fraction and record it on the datasheet.

Important:
Remember to subtract the weight of the empty container from your results!

4) **Calculate waste characterization:** Table 11 shows an example of amounts weighed for each fraction and day. With this information the percentage of each fraction over the total amount can be calculated as follows:
   5.1 Sum up the amounts of each waste fraction collected during the week (green numbers).
   5.2 Calculate the total amount (red number). Ideally it should be close to the total weight calculated before in the generation survey.
   5.3 Divide the amount of each fraction by the total amount and multiply it by 100 to obtain the percentage of each fraction (blue numbers).

Table 11: Example of compiled waste characterization data

Waste fraction	Amounts (kg)							Total (kg)	%
	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8		
Biowaste	*2.70*	*2.57*	*1.72*	*2.85*	*3.05*	*2.74*	*2.62*	18.24	38.5%
Paper & cardboard	*1.27*	*1.25*	*1.02*	*1.70*	*1.47*	*1.32*	*1.54*	9.58	20.2%
Plastic	*0.74*	*0.74*	*0.66*	*0.73*	*0.94*	*0.81*	*0.99*	5.60	11.8%
Textiles	*0.49*	*0.45*	*0.16*	*0.16*	*0.56*	*0.26*	*0.35*	2.42	5.1%
Metals	*0.14*	*0.31*	*0.24*	*0.27*	*0.33*	*0.17*	*0.35*	1.81	3.8%
Glass	*0.22*	*0.36*	*0.22*	*0.35*	*0.02*	*0.34*	*0.40*	1.91	4.0%
Other	*1.13*	*1.28*	*0.61*	*1.32*	*1.39*	*0.98*	*1.10*	7.81	16.5%
Total (sum)								**47**	100%

Step 4: Commercial and institutional waste generation

Household waste is only one part of the total MSW generated in a city. Commercial establishments (e.g. markets, restaurants, shops, hotels, etc.) and institutions (e.g. schools, administrative buildings, offices, etc.) also contribute considerably to the total amount of MSW generated. This amount of commercial waste in a city is typically between 20% and 30% of the total MSW generated. Two approaches can be followed in order to calculate this amount:

a) Run a similar WACS to the one explained in the coming section 0 for households, but choosing premises and institutions instead.
   - This approach yields more accurate results but it is more resource intensive
b) Conduct interviews to get approximate amounts of generated waste
   - This approach is less labour intensive but the results are less accurate

Steps to estimate total MSW generated from other sources

The below steps can be taken to estimate total MSW generation from other sources.

1) **Prepare a questionnaire template**
2) **Prepare the team who will conduct the questionnaires**
3) **Choose denominator unit:** household waste is normally calculated "per capita". However, this unit is not used for commercial and institutional waste. A different unit should be selected for the denominator. Table 12 provides some ideas for different generators:

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Table 12: Suggested units for aggregation of generations rates in premises and institutions

Generator	Unit	Comment
Hotel	# of beds,	If there is a shopping centre or restaurant, assess separately
Restaurant	# of tables/chairs; open for breakfast, lunch or dinner	
Schools	# of pupils	If there is a canteen, assess separately
Offices	# of employees; Square meters	If there is a canteen, assess separately
Markets	# of stalls; type of goods (vegetable market vs electronics market)	
Hospitals	# of beds	

4) **Identify premises to interview:** when distributing liner bags for households in selected districts, identify 2 hotels, 3 restaurants, 2 schools, 1 institution, 1 market and 1 hospital per ward/district. If a city has large shopping malls or institution, these should be visited separately too.
5) **Interview premises:** estimate how much waste is generated per day
6) **Identify the collection company** that services them.
7) **Interview collection companies** to obtain information on how much of waste is generated from the said premise.
8) **Aggregate the data** collected through the survey in the format shown in Table 13 according to the different sources of MSW generation.

Table 13: Summary table for commercial and institutional waste

Generation source		# of surveyed districts	# of premises visited per district	Total # of premises visited	Total # of sqm, beds, pupils, tables, etc.	Average MSW generation per day	Total MSW generated
Commercial	Hotel	5 or 3	2	10 or 6	unit	g/ unit/day	t/day
	Restaurants	5 or 3	3	15 or 9	unit	g/ unit/day	t/day
	Shopping malls	5 or 3	1	5 or 3	unit	g/ unit/day	t/day
Hospitals		5 or 3	1	5 or 3	unit	g/ m^2/day	t/day
Institutions		5 or 3	1	5 or 3	unit	g/ m^2/day	t/day
Markets		5 or 3	1	5 or 3	unit	g/ m^2/day	t/day
….		5 or 3	…	…	unit	g/m/day	t/day

9) **Extrapolate to the whole city.** After the data collected has been aggregated, use the census to estimate the total generation in the city. Multiply each generator type by the chosen denominator unit to obtain the total m^2, beds, pupils, etc. in the city. Then assign to each type the corresponding generation rate to obtain the total generated in the city.
10) **Sum total generation.** Sum all generated amounts to obtain the total generation of commercial premises and institutions in the city. This value will feed into Equation 1 and Equation 3 (denominator).

Step 5: Quantities managed in recovery facilities

Waste that is brought to facilities for its recovery is an important piece of information since it will help us calculate the total amount of MSW collected. The remaining fraction that is collected is represented

by the amounts going to disposal. There are countless types of recovery facilities. Figure 5 provides the classification followed in this guide.

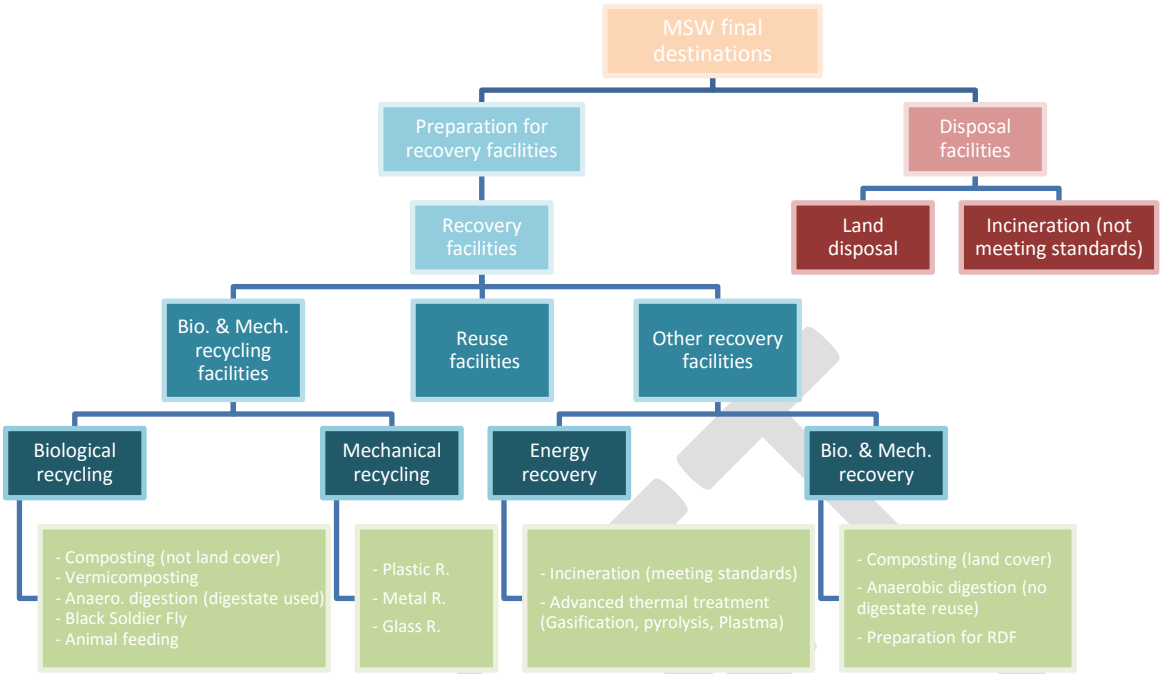

Figure 5: Classification of recovery and disposal facilities.

Steps to measure total MSW recovered

1) **Familiarize** with the collection system for recovery of your city. Figure 6 provides a possible set of steps.

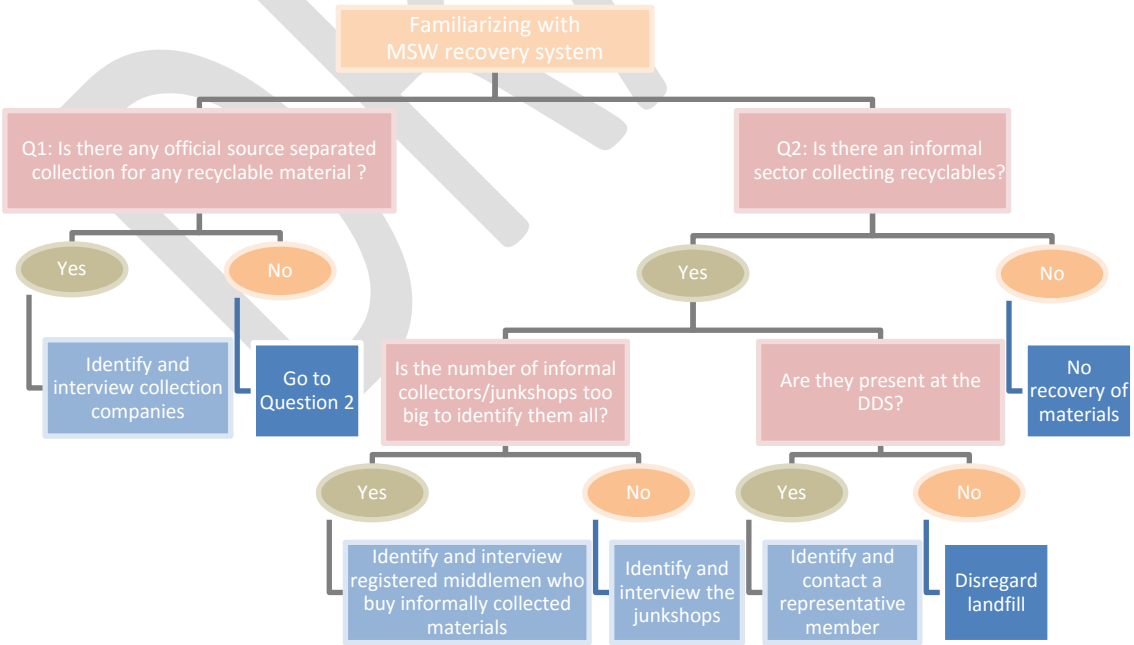

Figure 6: Process of mapping the recovery network in a city

2) **Obtain telephone numbers** of registered collectors and recovery facilities

3) **Telephone Interviews to identify actors.** This first round of interviews serves to continue expanding your understanding of the recovery sector. During the interview make sure you get information about aspects shown in Table 14 and that you identify and interview the biggest players for each material recovered. (i.e. plastics, glass, paper & cardboard, etc.).

Note:
Keep in mind that the list of actors you obtain might include actors collecting recyclable materials and actors collecting mixed waste without any recovery. Classify them into two groups: recovery sector, disposal sector. Questions 2 and 3 are only valid for collectors/facilities within the recovery sector.

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Table 14: Important aspects to be covered during the first round of telephone interviews

	Collectors for Recovery		Collectors for disposal	
Info. item	**Description**	**Remarks**	**Description**	**Remarks**
1. Amounts collected/ processed	Estimation of how much amount of materials they collect. In case the same company collects more than one material, get information for each material	- Let them say the time unit that best fits to them (per day, per week, per month…) - If more than one material are collected, ask the next questions for every material	Estimation of how much mixed waste they collect.	- Let them say the time unit that best fits to them (per day, per week, per month…)
2. Total share in local / national market	Often collection companies who are higher in the value chain hierarchy (i.e. those that concentrate the materials collected by numerous lower level collectors) are able to say what is their share over the total amount of materials collected in the city (and in the case of big players, even in the country).	- This is an important question. With the amounts of a material collected by a company and its share over the total collected amount in the city/country one can calculate the total amount collected of that material. - The city amounts are used to report SDG 11.6.1. - The country amounts can be used to report SDG 12.5.1 - This can be used to triangulate your data.	-	-
3. MSW vs Industrial	The amounts of some material fractions, such as metals, generated by industries outnumber those of MSW. However, all the material might be processed by the same companies. In such cases, it is important to separate amounts corresponding to MSW from those with other sources (in the case of metal: beverage containers, cans, etc. and not construction and demolition scrap metal).	- For SDG 12.5.1 it is interesting to also obtain amounts coming from industry.	Some collectors might collect different categories of MSW (commercial, institutional, tourist sector, etc.). If possible, obtain disaggregation per type.	- This information is only relevant if the number of collectors is small and all are interviewed
4. Origin	Note where they collect the material from or who sells them the material.	- Materials imported from a different city should not be accounted for SDG 11.6.1.	Note whether the mixed waste is collected only	- Amounts imported from a different city should not be

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	In big cities, the materials might be imported from elsewhere up-country or abroad. Also, often the materials are recovered from the disposal sites by waste pickers.	- Ask them to give an approximate % for how much of the material they process was originally collected by the informal sector. - Important: insist on one specific source: how much originates from the disposal sites?	within the system boundaries	accounted for SDG 11.6.1.
5. Destination	Note down where the waste/materials are brought to or sold to.	- This is an important question since it helps to identify bigger players in the recovery system (snowball effect).	Note down where the waste is brought to.	- This question is crucial to identify other disposal sites on top of the DDS as well as other facilities (WtE, etc.)
6. Other companies	Try to get the contact numbers of other important players (e.g. middlemen or recovery facilities) in the value chain of each material.	- The snowball effect is a common way of identifying important players	Try to get the contact numbers of other big mixed waste collectors	-
7. Rejects	Also ask them if they can provide numbers for their rejects	- This is a relevant aspect for the 3rd sub-indicator on PPE	-	-

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This first round of telephone interviews is very helpful to map the recovery sector of your city. You should already start having an idea of who are the important players in the recovery sector for each material type.

Important:
For each material fraction, identify the very last STAGE of the value chain that is located within the system boundaries of your case study. This could be a facility that prepares the materials for recovery or a recovery facility on its own.

4) **Arrange visits for face to face interviews** with the big players in the recovery sector. Make sure you visit at least one player per material.
5) **Evaluate the level of control of the site.** These visits should also be used to evaluate the level of control of the facility. Please, refer to Table 2, column about "Recovery facilities" for the evaluation.
6) **Interview the facility managers.** In this interview you should cover a similar set of aspects to the ones shown in Table 14. Put special emphasis on info items 1, 2 and 3 from Table 14. Get as much accurate data as possible. Other interesting aspects that could be covered are:
    a. **Challenges of the sector**
    b. **Buying and selling prices per unit mass of material**
7) **Calculate recovered amounts per material.** Based on the information obtained from the interviews, calculate the total amounts recovered for each material in the entire city. This number will feed into Equation 1 and Equation 2 to calculate the SDG 11.6.1 sub-indicator on collection.

Important:
When calculating SDG 11.6.1, do not consider imported amounts into the city and include exported amounts.
Note:
These amounts might be relevant however for 12.5.1

8) **Estimate the share of how much is recovered in controlled facilities.** The assessment based on Table 2 during the visits to the facilities should provide an indication of how much of the materials recovered, are recovered in facilities that stick at least to a "Basic" level of control. Sum those amounts to obtain the figure that will feed into Equation 3.

Note:
A recovered material often goes through several facilities which process the material to incrementally add its value. The level of control should be assessed only at the last facilities within the value chain, before the material leaves the system boundaries.

Step 6: Quantities managed in disposal facilities

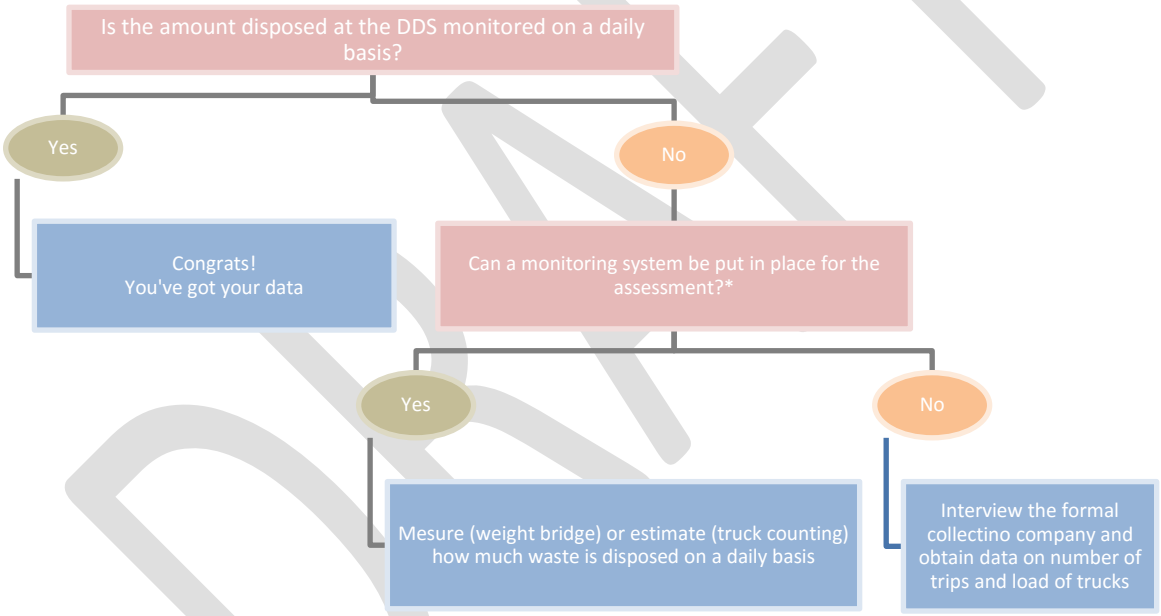
After obtaining information on amounts collected for recovery, the amounts going to DDS need to be determined. Waste that is brought to disposal facilities is an important piece of information since it will help us calculate the total amount of MSW collected.

Steps to measure total MSW disposed in DDS

1) **Identify all disposal sites.** The telephone interviews explained in Table 14 serve to map what are the main disposal sites used in the city of study. Most of the times, disposal facilities are not big in number.

Important:
On top of the official DDS of the city, waste collectors might be using other DDS from nearby regions to dispose their waste. If this is the case, those other DDS should also be visited even if they are outside of the system boundaries.

2) **Arrange visits for visit.** Often permits from the authorities are required in order to visit a disposal facility. Make sure you plan this in advance.
3) **Conduct interviews and visit the facility.** Obtain information on amounts disposed (per unit of time) of each disposal site. Depending on the available information, these information might be derived from three sources. The decision tree to follow is shown in Figure 7.



**There are two main monitoring system that can be organized for such assessment: a) rent and install a weighbridge, b) count trucks during a few days.*

Figure 7: Decision tree for quantitative data collection from DDS

4) **Evaluate the level of control of the site.** These visits should also be used to evaluate the level of control of the facility. Please, refer to Table 2, column about "Disposal sites" for the evaluation.
5) **Calculate total amounts of MSW brought to disposal.** Based on the information obtained from the interviews, calculate the total amounts disposed in DDS. This number will feed into Equation 1 and Equation 2 to calculate the SDG 11.6.1 sub-indicator on collection.
6) **Estimate the share of how much is disposed in controlled facilities.** The assessment based on Table 2 during the visits to the facilities should provide an indication of how much MSW is

disposed in facilities that stick at least to a "Basic" level of control. Sum those amounts to obtain the figure that will feed into Equation 3.

Step 7: Characterization disposed waste

The procedure explained here is almost the same as that explained in section 0. The only difference is the source of the waste. Therefore, for all those steps which are the same, we will refer the reader to section 0.

Steps to plan a characterization study

1) **Access to the landfill**. Evaluate which stakeholder issues the permits to visit the landfill and arrange such a permit.
2) **Contact the landfill manager** and explain the purpose and relevance of the activity.
3) **Arrange a date** to conduct he characterization study
4) **Prepare site for the audit (optional):** Choose a site where you can store and manage a sample of around 200 – 300 kg of waste. Ideally, this site should be flat and covered, have enough space, be accessible to vehicles, have access to water for drinking and washing purposes and offer protection from pests. Cover the surface with a thick plastic film, on top of which the waste will be thrown.
5) **Hire and train volunteers:** This exercise requires around 15 volunteers. All of them should be trained properly on the aim of the waste audit, the main steps and the risks. Since sorting waste can be tedious and hazardous, the staff must be instructed to use personal protective equipment (i.e. gloves and masks), avoid dehydration and take adequate breaks.
6) **Acquire necessary equipment**: Table 15 shows the main items that are required for collection and for measuring the waste generation rate.

Table 15: Items required for a WACS per survey group

Items	Number
1. Pencil and notebook	At least one person noting
2. Wheelbarrows[1]	2
3. Standing Weigh scale (up to 60 kg)	1
4. Thick gloves	As many as volunteers
5. Masks	As many as volunteers
6. Shovels	5
7. Thick plastic sheet (at least 4 x 4)	1
8. Waste containers or bags (60 L)	As many as waste fractios
9. Chopping device	2
10. Brooms	5
11. Camera	1

[1]Or any other carrier to transport the collected waste from the HH-s to the measurement site.

Steps to conduct Waste Characterization

1) **Prepare the sorting area**. Place a large tarpaulin onto a flat piece of ground, with easy access for trucks.
2) **Brief the survey team**. Gather together the survey team and explain the purpose of the characterisation, and how the work needs to proceed.
3) **Emphasise Health and Safety**. Give clear instructions that if any medical or other hazardous waste is spotted in the sample, the sorting must immediately stop. Health and Safety is the first priority.

4) **Choosing the trucks.** Check with the truck drivers (or the landfill manager) where was the waste they are transporting collected. Choose at least one truck for each income level.
5) **Discharge the waste.** Ask the truck driver to drive to your site and to deposit there at least 200 kg of MSW.
6) **Mix the waste:** make sure the waste discharged is well mixed
7) **Quartering technique: i**f your waste amounts to more than 150 – 200kg, you will have to take a representative sample of around 50 kg for analysis. The most commonly used technique for this is called "The Quartering Technique". You will do this by

   2.1 First mixing all the waste as thoroughly as possible. You can use your shovels for this.
   2.2 Then expand the waste on a flat hard surface so that it forms a flat layer.
   2.3 Divide the waste layer into four parts: ABCD (see Figure 8 left).
   2.4 From those four portions, discard two opposing quarters, say B and D.
   2.5 Combine the remaining two quarters.
   2.6 Repeat steps 1 to 4 until approximately 50 kg are left.

Figure 8: Quartering technique (left) and sorting (right)

8) **Sort the waste:** bring the representative sample of 50kg to the sorting site (i.e. table).

   5.1 Prepare the labelled containers (as many containers as fractions) around the sorting table.
   5.2 Sort all the waste into the containers (see Figure 8 right).

9) **Weigh the waste fractions**:
   6.1 Weigh each fraction and record it on the spread sheets.

Important:
Remember to subtract the weight of the empty container from your results!

10) **Calculate waste characterization:** Table 11 in section 0 shows an example of amounts weighed for each fraction and day. With this information the percentage of each fraction over the total amount can be calculated.

Step 8: Recyclables extracted from disposal facilities

Once the amounts arriving into recovery facilities and disposal sites are quantified, it is important to obtain an idea of the amounts that could be double counted.

1) **Avoid double counting and overestimations.** Table 16 details several aspects that should be considered when calculating amounts collected for disposal to avoid double counting.

Table 16: Aspects to consider to avoid double counting collected waste

Item	Possible challenge	Explanation	Approach
Extracted recyclables from DDS	Risk for double counting	Recyclables extracted from the DDS are accounted as amounts disposed in DDS and as amounts recovered.	Interview waste picker organizations at the DDS as well as recovery facilities to estimate amounts extracted from DDS.
Amounts coming from NDDS clean ups.	Risk for overestimation	If amounts accommodated in the DDS originate from NDDS clean-ups caused by primary collection dumping. These amounts should not be considered collected, unless they stick to criteria defined under the definition of Section "MSW collected" (see section *Key concepts*).	Check if the landfill operators distinguish the origin of the waste received. Try to quantify: - Amounts coming from NDDS clean ups in areas unserved with collection - Amounts corresponding to other waste fractions. E.g. construction and demolition waste, faecal sludge, healthcare waste, etc. If possible, deduct them from the amounts disposed in the DDS.
Other fractions on top of MSW	Risk for overestimation	If amounts accommodated in the DDS consist of other waste fractions on top of MSW (e.g. construction and demolition waste, faecal sludge, healthcare waste, etc.)	

2) **Sum total amounts double counted.** Based on the information obtained from the interviews, calculate the total amounts that are being double counted. This number will feed into Equation 1 and Equation 2 to calculate the SDG 11.6.1 sub-indicator on collection.

Estimate PPE into the environment

This methodology & section is being drafted in conjunction with a GIZ financed project and will be included in later versions of the Step by Step Guide.

Linkages to other SDGs

The surveys required to complete an SDG 11.6.1 assessment also provide primary data for reporting on other SDGs.

SDG 1.4.1 on access to basic services

The methodology for assessing 11.6.1 relies on primary data collection in City districts. A supplementary survey on 'access to services' can be easily integrated into the 11.6.1 field assessment in order to provide up-to-date information on householders experience of service.

During the field testing of the 11.6.1 indicator, interviews were conducted by the field team doing the WACS. This survey formed a natural part of the process, and also benefited the 11.6.1 process as it provided a well-structured introduction method for opening up communication and dialogue between the surveyors and the survey participants.

From interviews, the householders experience of the waste collection service can be gained. Understanding the viewpoint of the householder/customer of the service helps to determine more accurately the access to services.

It is important to note that having access to collection does not automatically imply that the waste is collected. Households could be served with primary collectors who later on dump the waste in the neighbourhood.

The percent of inhabitants with 'access to basic waste collection' is a parameter to be assessed through household surveys in cities where the collection service is not delivered to the entire population (e.g. low income districts). This aspect is very much linked to the collection service, however, it is meant to be reported under SDG 1.4.1. In order to measure this parameter household surveys are proposed (see Annex B).

These are the steps to determine access to a 'controlled' collection service:

1) **Identify and train the surveying team** who will conduct the household surveys. Make sure the team understands every question of the survey (Annex B).
2) **Stratify the city** based on income levels (same as when assessing waste generation)
3) **Select a random sample** of households in each income level (same as when assessing waste generation).
4) **Split** the surveying team and assign a number of households to each group.
5) **Conduct surveys** using the questions shown in Annex B to determine the provision of "basic or above", "limited" or "no" collection service.
6) **Prepare a summary sheet** with the results from the survey. See Annex C.
7) **Calculate** percent of the population with access to "basic" service using Equation 4 and based on Table 1.

Equation 4

$$\%Pop_{Ac.Col}^{>Basic} = \frac{\mathrm{Pop.}_{H.I.} \cdot \%Pop._{H.I.}^{>Basic} + \mathrm{Pop.}_{M.I.} \cdot \%Pop._{M.I.}^{>Basic} + \mathrm{Pop.}_{L.I.} \cdot \%Pop._{L.I.}^{>Basic}}{\text{Total Population}} \times 100\ (\%)$$

Where:

- $\%Pop_{Ac.Col}^{>Basic}$: Percent of population with access to basic collection service or above
- $\mathrm{Pop.}_{H.I.}$: Total high income population in the city.
- $\mathrm{Pop.}_{M.I.}$: Total high medium population in the city.
- $\mathrm{Pop.}_{L.I.}$: Total high low population in the city.
- $\%Pop._{H.I.}^{>Basic}$: % of high income population with at least basic collection service
- $\%Pop._{M.I.}^{>Basic}$: % of medium income population with at least basic collection service
- $\%Pop._{L.I.}^{>Basic}$: % of low income population with at least basic collection service

SDG 12.3.1 on food waste

The WACS provides primary data on the food waste generated by consumers. Whereas the food losses in the production system are a primary issue of concern for SDG 12.3.1, the waste generated by consumers is also of central importance.

SDG 12.4.2 on hazardous waste

The hazardous waste SDG is a national level indicator which relies on data reporting from inside countries. Whilst the hazardous component of municipal solid waste is generally small, understanding household hazardous waste is a useful adjunct to the 12.4.2 reporting.

SDG 12.5.1 on recycling

Also a national level indicator, data on the recycling performance of a country must be derived from Cities. Specific methodological issues on reporting of recycling rates are important to observe, however, understanding the MSW recycling/recovery rates is a central component of an 11.6.1 assessment. The assessments will contribute primary source data from the recycling value chain operators which can be used to update/verify national recycling rates.

SDG 14.1.1 on marine litter

Unmanaged waste from Cities is the major source of marine litter globally. Conducting an 11.6.1 assessment provides primary data on the sources of unmanaged waste, enabling the root causes of marine litter to be understood, and more importantly, addressed at source. A separate sub-indicator on potential plastic emissions to the environment has been included with the 11.6.1 methodology to help Cities understand and combat the sources of marine litter.

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Annex A: Understanding Terminology

Waste types

Waste refers to any substance or object generated as a result of human activity that is not a product (that is, a good or service resulting from a production process and intended for sale) for which the generator has no further use in a production, transformation or consumption activity and which, whether by choice or by legal requirement, is or is intended to be discarded. These substance or objects could lead to the possibility of resource recovery, recycling, reclamation, direct re-use or alternative uses, without or with only nominal remuneration.

Municipal Solid Waste (MSW) refers to wastes generated by households, and wastes of a similar nature generated by commercial premises, by institutions such as schools, hospitals, care homes and prisons, and from public spaces such as streets, markets, slaughter houses, public toilets, bus stops, parks, and gardens. The definition of MSW should follow the local definitions so it is important to annotate the local and national definition(s) of MSW.

MSW should however exclude construction and demolition waste and waste from municipal sewage network and treatment, as it is the case in other international data collections (e.g., UNSD/ United Nations Environment Program Questionnaire on Environment Statistics-Waste Section). Therefore, where possible data collected for this SDG indicator should allow for disaggregation by these categories which would allow for reporting for both the SDG and for other international reporting.

Most common sources of MSW are:

- ***Household waste:*** refers to waste generated by household units.
- ***Commercial waste*** refers to waste of a similar nature to household waste generated by hotels, restaurants, shops/shopping areas, markets/supermarkets, slaughter houses and offices.
- ***Institutional waste*** refers to waste of a similar nature to household waste generated by schools, hospitals, care homes, prisons and government offices.
- ***Waste from public places*** refers to waste of a similar nature to household waste discarded in public places such as streets, squares, parks and gardens, unused plots of land, public toilets and bus stops

Waste management systems

Municipal solid waste management (MSWM) is the set of activities carried out by formal and informal economic units, both public and private, and by households for the purpose of the prevention, collection, transportation, treatment and disposal of waste. Waste management includes activities (both formal and informal). Waste-related activities that are illegal and/or uncontrolled are referred to as “other waste-related activities”.

Municipal solid waste follows a sequence of steps throughout its life time. Waste is first generated, then collected and finally brought to either disposal or a recovery facility. MSWM can be undertaken by both *formal* and *informal* economic units.

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Integrated Solid Waste Management (ISWM) refers to the coordinated use of a set of waste management approaches and solutions, each of which has a functional role in an overall solid waste management system, and combine together as a recognisably coherent whole.

Formal waste management relates to waste management activities undertaken by units working within the context of the formal economy; that is, organizations or individuals registered as economic units with government authorities and assumed to generally abide by local laws and regulations related to wastes and their management. Units in any economic sector, public or private, can be involved in formal waste management. Household activities related to management of their own wastes (for example, separation of recyclable materials into different types in preparation for curbside collection) are also considered formal activities.

Formal waste management activities must be legal. It should be noted, however, that not all activities undertaken by organizations/individuals registered as formal economic units will necessarily be legal, as even formal organizations/individuals can break laws.

Informal waste management relates to waste management activities undertaken by organizations or (more likely) individuals working outside the context of the formal economy; that is, by organizations/individuals not formally registered as economic units with government authorities. Scheinberg et al. (2010) provide this more precise definition: "individuals or enterprises who are involved in private sector recycling and waste management activities which are not sponsored, financed, recognised, supported, organised or acknowledged by the formal solid waste authorities, or which operate in violation of or in competition with formal authorities."

By definition, informal waste management is not undertaken by units operating in the public sector, as these are always formal. It may, however, be undertaken by informal units operating in either the business sector or in the household sector.

Informal units are assumed to abide by local waste-related laws and regulations when it is in their interests to do so, but also to engage in illegal activities in some instances. Whether their activities are legal or illegal will depend on the laws and regulations in the jurisdiction in question. It may be the case, for example, that scavenging of wastes (for example, used beverage cans) from household recycling bins set out for collection is legal in one jurisdiction but prohibited in another.

In high income settings, service providers involved in the MSWM system are mostly well identified, have established contractual agreements and are accountable for their service. Most dominant are services provided by the public sector or formal private sector.

In low and middle income settings often service is provided by a mix of formal as well as informal sector. Informal sector services may provide a large part of the service. The formal sector can also be fragmented in public and several formal private sector providing services such as collection. A clear understanding of type of service provision and respective stakeholder is an important prerequisite to be able to assess this indicator.

Standard refers to an acknowledged measure of comparison of quantitative or qualitative value; a criterion against which to enforce and/or benchmark the performance of ISWM systems.

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Waste management activities

Waste prevention refers to measures taken before a substance, material or product has become waste and that reduce: the quantity of waste, the adverse impacts of the generated waste on the environment and human health; or the content of harmful substances in materials and products.

Collection and transport is defined as activities involving the gathering of waste, including its preliminary sorting and storage, and its transport to a facility or location where further waste management activities (for example, material recovery or disposal) will be carried out. Waste collection and transport may be carried out by units operating in both the formal and informal sectors and it may be legal or illegal.

The collection system may be divided into two subsequent steps, which are represented in Figure 9:

a) ***Primary collection service*** removes the waste from the generators. It is often conducted manually or with simple vehicles from areas of high population density, with difficult access roads often un-paved and narrow. Primary collection delivers waste to the so-called collection points or transfer stations.
b) ***Secondary collection service*** collects the waste from the transfer stations and transports it to the next waste management activity (e.g. treatment or disposal). Normally the vehicles are motorized and have big load capacities.

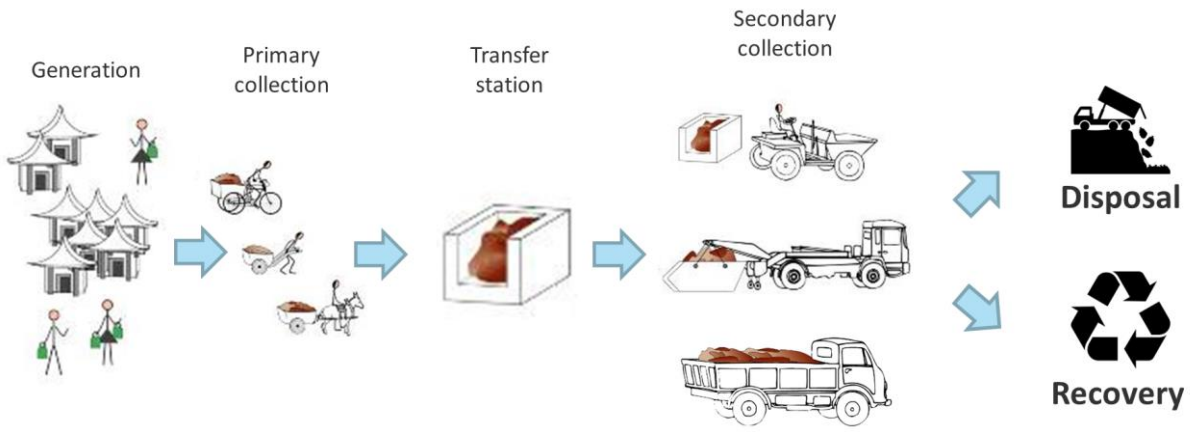

Figure 9: Simplified schematic of a MSWM system

Treatment refers to a method, technique or process that: a) Changes the physical, biological or chemical character or composition of a waste, b) Removes, separates, concentrates or recovers a hazardous component of a waste and/or, c) Destroys or reduces the toxicity of a waste.

Recovery refers to any operation the principle result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function; or waste being prepared to fulfil that function. Includes the use of waste as a substitute for virgin materials. Recycling and reuse are two examples of recovery.

Recycling refers to any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.

Disposal refers to any operation that is not recovery even where the operation has as a secondary consequence including the reclamation of substances or energy.

Designated disposal sites (DDS) refer to disposal sites which are regularly (i.e. daily) used by the public authorities and private collectors, regardless of their level of control and legality. DDS-s can be officially designated and thus, recognized by authorities, or non-officially designated but still used regularly.

Non designated disposal sites (NDDS): refer to disposal sites which are not recognized by the public authorities and are only used occasionally and for minor amounts. Public authorities may organize clean ups to remove the waste from these disposal sites.

For further information on the different elements of the SWM system please consult the available literature (UN-Habitat, 2010; UN Environment, 2015; Kaza eta al., 2018). Also, the following open online course entitled *"Municipal Solid Waste Management in Developing Countries*[3]*"* provides a valuable introduction.

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[3] The course *"Municipal Solid Waste Management in Developing Countries"* is available for free on the learning platform Coursera. The videos of the course are also on YouTube. Of special interest for this indicator are the chapters in Week 1. The links to both platforms are on our webpage www.eawag.ch/mooc

Annex B: Household survey – Collection

Preliminary data:

Date and time: _____ Name interviewer: _____ District: Income level: _____ Household n°: _

Mixed Household Waste Collection survey					Answers/Comments	Data Reliability
No.		**Item**	**Survey Question**	**Answers**	**Answers/Comments**	**Value**
1.1	1.11	Household practice	What do you do with your mixed waste?	It is collected by a collection service		
	1.12			I dispose it within my premise		
	1.13			I dispose it in a Non-Designated Disposal site on land		
	1.14			I dispose it in a Non-Designated Disposal site on a water body		
	1.15			I burn it		
	1.16			I give it go animals as feed		
	1.17			Don't know		
Notes		*Ask the respondent to give approximate percentages to the selected practices based on the amounts managed according to each practice*				
No.		**Item**	**Survey Question**	**Multiple choice**	**Answers/Comments**	**Value**
1.2	1.21	Type of collection service	What type of mixed waste collection service do you have?	Door to door		
	1.22			Summoned		
	1.23			Bring system		
Notes		*Answer the questions 1.2 to 1.7 only if you ticked 1.11 (it is collected by a collection service).* *- Door to door: waste is deposited in front of the house in bags or in containers. The collectors come and remove it from there.* *- Summoned: collection vehicles announce with some sort of sound when they are collecting waste and household dwellers come out to give their waste to the collectors* *- Bring system: waste generators bring their waste to a community container*				
No.		**Item**	**Survey Question**	**Multiple choice**	**Answers/Comments**	**Value**
1.3	1.31	Type of collection vehicle	What type of mixed waste collection vehicle is used to collect?	Primary collection		
	1.32			Secondary collection		
	1.33			Don't know		
Notes		*- Primary collection comprises small or medium vehicles, man power or motorized (e.g. hand-carts, donkey-carts, cycle-carts, motorized-carts).* *- Secondary collection comprises normally motorized and bigger vehicles.*				

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No.		Item	Survey Question	Multiple choice	Answers/Comments	Value
1.4	1.41	Frequency	What is the frequency of the mixed waste collection service?	Once every 3 days or more frequent		
	1.42			Once every 3 to 7 days		
	1.43			Once every 7 to 14 days		
	1.44			Once every 14 to 30 days		
	1.45			Less than every 30 days		
Notes						
No.		**Item**	**Survey Question**	**Multiple choice**	**Answers/Comments**	**Value**
1.5	1.51	Distance	How far is designated mixed waste container or collection point?	Closer than 200 m		
	1.52			Further than 200 m		
Notes		*Answer this question only if you receive a summoned (1.22) or bring system (1.23) collection service.*				
No.		**Item**	**Survey Question**	**Multiple choice**	**Answers/Comments**	**Value**
1.6	1.61	Effectiveness of collection	How much of the mixed waste deposited is left uncollected?	0%		
	1.62			< 25%		
	1.63			25% - 50%		
	1.64			> 50%		
Notes		*Answer this question only if you receive a bring system (1.23) collection service. Aim of question: understand how clean the collection points are left after collection service.*				
No.		**Item**	**Survey Question**	**Multiple choice**	**Answers/Comments**	**Value**
1.7	1.71	Destination of waste	Where is the mixed waste brought?	Recovery plant (i.e. compost)		
	1.72			Transfer station		
	1.73			Designated disposal site		
	1.74			Non designated disposal site		
	1.75			Don't know		
Notes		*Whenever the destinations have names, write them down in "answers/comments"*				
No.		**Item**	**Survey Question**	**Multiple choice**	**Answers/Comments**	**Value**
1.8	1.71	Waste burning	Who is responsible for burning the waste in your neighbourhood	Waste is never burnt		
	1.72			Every household burns		
	1.73			The street sweepers burn		
	1.74			The waste pickers burn		
	1.75			Don't know		
Notes		*Whenever the destinations have names, write them down in "answers/comments"*				
No.		**Item**	**Survey Question**	**Multiple choice**	**Answers/Comments**	**Value**
1.2	1.21	Source separation	Is there any waste fraction that you source separate?	Paper		
	1.22			Plastics		
	1.23			Glass		
	1.24			Metals		
	1.25			Other		
	1.26			Biowaste		
Notes		*Whenever possible, ask for approximate amounts per week (kg/week)*				

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Annex C: Example of summary of HH surveys.

					High Income			Middle income			Low income		
					Ward 1	Ward 2	Ward 3	Ward 1	Ward 2	Ward 3	Ward 1	Ward 2	Ward 3
1. Household waste practice													
No.		**Item**											
1.2		Source Separation		% of HH	10%	100%	83%	20%	10%	0%	0%	10%	0%
2. Service provider for MIXED WASTE					% of households			% of households			% of households		
No.		**Item**	**Survey Question**	**Answers**									
2.1	2.11	Household practice	What do you do with your waste?	Give to collection service	100%	50%	100%	100%	90%	100%	100%	90%	100%
	2.12			Bring myself to recycling center	0%	0%	0%	0%	0%	0%	0%	0%	0%
	2.13			Disposed/buried in household	0%	0%	50%	0%	0%	0%	0%	0%	0%
	2.14			Disposed elsewhere on land	0%	0%	0%	0%	10%	0%	0%	10%	11%
	2.15			Disposed elsewhere on water	0%	0%	0%	0%	0%	0%	0%	0%	0%
	2.16			Buried elsewhere	0%	0%	0%	0%	10%	0%	0%	0%	0%
	2.17			Burnt	0%	0%	0%	0%	0%	0%	10%	0%	0%
	2.18			Other	0%	50%	0%	0%	10%	0%	0%	0%	0%
No.		**Item**	**Survey Question**	**Multiple choice**									
2.2	2.21	Type of collection service	What type of mixed waste collection service do you have?	Door to door	100%	50%	83%	100%	80%	20%	80%	90%	100%
	2.22			Summoned	0%	0%	0%	0%	0%	80%	20%	0%	0%
	2.23			Bring system	0%	0%	0%	0%	10%	0%	0%	0%	0%
	2.24			No collection	0%	50%	0%	0%	0%	0%	0%	10%	0%
	2.25			Not answered	0%	0%	17%	0%	10%	0%	10%	0%	0%
No.		**Item**	**Survey Question**	**Multiple choice**									
2.3	2.31	Type of collection vehicle	What type of mixed waste collection vehicle is used to collect?	Primary collection	0%	0%	67%	0%	10%	20%	100%	90%	0%
	2.32			Secondary collection	100%	50%	0%	90%	90%	70%	0%	10%	33%
	2.33			Don't know	0%	0%	33%	0%	0%	0%	0%	0%	11%
	2.34			Not answered	0%	N/A	0%	0%	0%	10%	0%	0%	56%
No.		**Item**	**Survey Question**	**Multiple choice**									
2.4	2.41	Frequency	What is the frequency of the mixed waste collection service?	Once every 3 days or more frequent	0%	40%	33%	10%	10%	0%	0%	0%	0%
	2.42			Once every 3 to 7 days	100%	10%	17%	80%	80%	90%	90%	90%	22%
	2.43			Once every 7 to 14 days	0%	0%	50%	0%	0%	10%	0%	0%	0%
	2.44			Once every 14 to 30 days	0%	0%	0%	0%	0%	0%	0%	0%	0%
	2.45			Less than every 30 days	0%	0%	0%	0%	0%	0%	10%	10%	0%
	2.46			Not answered	0%	50%	0%	10%	10%	0%	10%	0%	78%
No.		**Item**	**Survey Question**	**Multiple choice**									
2.5	2.51	Distance	How far is collection point?	Closer than 200 m	100%	0%	83%	0%	70%	90%	30%	0%	0%
	2.52			Further than 200 m	0%	10%	0%	90%	0%	10%	0%	90%	0%
	2.53			Not answered	0%	90%	17%	10%	30%	0%	70%	0%	100%
No.		**Item**	**Survey Question**	**Multiple choice**									

2.6	2.61	Effectiveness of collection	How much of the mixed waste deposited is left uncollected?	0%	90%	0%	67%	100%	10%	70%	30%	10%	11%
	2.62			< 25%	0%	0%	17%	0%	70%	30%	10%	0%	0%
	2.63			25% - 50%	0%	0%	0%	0%	10%	0%	0%	0%	0%
	2.64			> 50%	0%	0%	17%	0%	0%	0%	0%	90%	0%
	2.65			Not answered	10%	100%	0%	0%	10%	0%	60%	0%	89%
No.		**Item**	**Survey Question**	**Multiple choice**									
2.7	2.71	Destination of waste	Where is the waste brought?	Recovery plant (i.e. compost)	0%	0%	50%	0%	0%	0%	0%	10%	0%
	2.72			Transfer station	0%	0%	0%	0%	0%	0%	80%	100%	0%
	2.73			DDS	100%	50%	0%	0%	70%	0%	0%	0%	22%
	2.74			NDDS	0%	0%	0%	0%	10%	20%	0%	0%	0%
	2.75			Other	0%	50%	0%	0%	0%	0%	0%	0%	0%
	2.76			Don't know	0%	0%	50%	90%	20%	60%	0%	0%	0%
	2.77			Not answered	0%	0%	0%	10%	0%	20%	20%	0%	78%
No.		**Item**	**Survey Question**	**Multiple choice**									
2.8	2.81	Payment	Mode of payment	To collector per month	40%	50%	83%	100%	70%	80%	90%	90%	0%
				To collector per week	0%	0%	0%	0%	10%	0%	10%	0%	0%
				Included in house	50%	0%	0%	0%	0%	10%	0%	0%	0%
				Not answered	10%	50%	17%	0%	20%	10%	0%	0%	100%
			Average salary/month	-	525	1120	646.7	330	362.5	356	100	200	-
No.		**Item**	**Survey Question**	**Multiple choice**									
2.9	2.91	Info on service provider	What is the legal status of the collector?	Formal company	90%	40%	67%	80%	50%	50%	100%	0%	0%
				Informal company	0%	0%	17%	10%	0%	10%	0%	100%	33%
	2.92			Not answered	10%	60%	17%	10%	50%	40%	0%	0%	67%

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Annex D: Simplified WACS

Figure 10 shows the three approaches to calculate PCGR. The preferred approach is explained in the guide. The user should only consider the approaches explained in this annex only if the recommended approach explained in the main document is impossible to conduct.

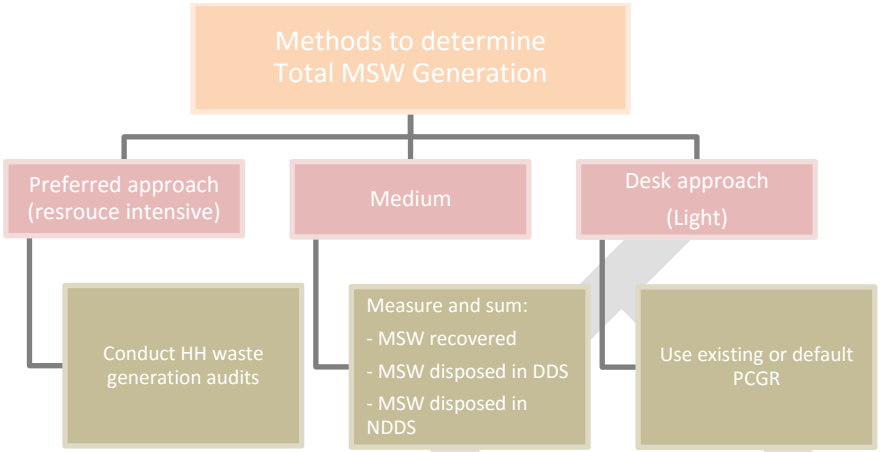

Figure 10: Three approaches to calculate total MSW generation.
PCGR: Per capita generation rate; DDS: Designated disposal site; NDDS: Non designated disposal site; HH: households

'Medium' methodology

This section describes the steps required to calculate the total waste generation based on local waste management quantitative data. It involves primary data collection in the form of interviews and questionnaires. The scoring obtained for the SDG 11.6.1 sub-indicators through this approach will be more accurate than that obtained through the 'light' approach, but not as accurate as the preferred approach.

This approach calculates the total generated waste by obtaining quantitative information for three elements (Equation 5).

Equation 5: DDS: Designated disposal site, NDDS: Non designated disposal site

Equation 6

$$\mathrm{MSW}_{NDDS} = \frac{\mathrm{MSW}_{collected}(\mathrm{t}/day)}{Population\ served\ with\ collection\ (\%)} - \mathrm{MSW}_{collected}(\mathrm{t}/day)$$

$$\mathrm{MSW}_{collected}(\mathrm{t}/day) = \mathrm{MSW}_{Recovered}\ (\mathrm{t}/day) + \mathrm{MWS}_{DDS}\ (\mathrm{t}/day)$$

Where:

- $\mathrm{MSW}_{collected}$: total MSW collected

- $\mathrm{MSW}_{Recovered}$: total MSW recovered
- MWS_{DDS}: total MSW disposed in designated disposal sites
- MSW_{NDDS}: total MSW disposed in non-designated disposal sites

Equation 7

$$\mathrm{MSW}_{NDDS} = Population\ unserved\ (N°) \cdot PCGR(kg/cap/day)$$

Table 17: Advantages and disadvantages for the method to calculate total MSW disposed in NDDS

	Advantages	Disadvantages
Equation 6	Is independent of PCGR. It avoids conducting waste generation surveys	Assumes an equal PCGR for all inhabitants The result is less accurate
Equation 7	It yields a more accurate number	It is more labour intensive if waste generation surveys are to be conducted

In this section the steps required to determine the following two data points are detailed:

a) Total unserved population (without waste collection service) or the reverse, i.e. total population with waste collection service)
b) PCGR of unserved population

Let's start with the steps required to determine a) total population without waste collection service. In order to get this information, proceed with the following steps:

Steps to determine unserved population

1) **Identify the criteria** that determine when a dweller has no collection service. Possible criteria are shown in Figure 11.

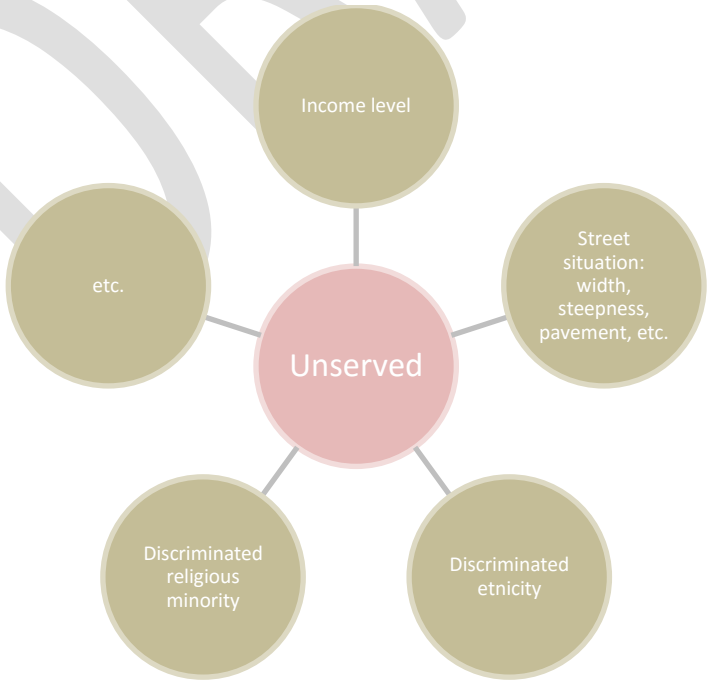

Figure 11: Criteria used to identify areas where waste is not collected.

Note:
Often these criteria correlate. In lower income neighbourhoods, streets are often not paved and tend to be are narrow. Also, poor people tend to settle in most unfavourable locations, i.e. steep slopes. Think of a slum.

2) **Conduct observations** and verify that the areas which are believed not to have collection service, are indeed unserved.
   2.1. Walk and visit in the pre-selected areas.
   2.2. Observe existence of active neighbourhood dumps
3) **Talk to the local waste generators.** Obtain information from the local households by either a) conducting unstructured interviews or b) by running a questionnaire to a given number of pre-selected households. A sample questionnaire is provided in Annex A. Similar questions could be used in unstructured interviews.
   3.1. Assess whether the households have "Access to Collection"
   3.2. Assess what is the destination of the collected waste
      i. ***Attention!*** Dwellers in these areas might have access to collection (e.g. in the form of primary collection) however, the waste is disposed in a nearby NDDS. Unless there is a clear coordination with a secondary collection service, this waste is not collected.
4) **Estimate unserved population.** Once the unserved areas are identified, estimate total population whose waste is not collected in the city.
   4.1. First obtain the updated total population data as explained in Step 2.
   4.2. Estimate the share of total population living in unserved areas. Check latest census data if available, or talk to local authorities.

Steps to determine PCGR of unserved population

Determining PCGR of unserved inhabitants involves at least conducting household waste generation surveys. This is the minimum requirement. If possible, waste generation surveys of premises in unserved areas should also be included.

The steps required to run household and premise waste generation surveys are detailed in Step 4.

Note:
If the unserved areas of the city host communities belonging to a different income level (or any other criteria which has an influence on the PCGR), waste generation surveys should be conducted for each category.

Once the PCGR (for each category, e.g. income level) is obtained, multiply it by the total population of each category to obtain the total MSW disposed in NDDS.

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Example:

In City A collection is provided only to high income neighbourhoods. Low and middle income areas are not provided with basic collection service and therefore their waste is disposed in neighbourhood dumps……..

Outcomes

- Compare the results for NDDS using Equation 6 and Equation 7. Assess how different they are and if so, assess if the difference is explainable.
- Double-counting: NDDSs such as neighbourhood dumps might be removed with a given frequency by the municipality in some cities. If the amounts removed are brought to the landfill and recorded, these amounts are being double-counted when Equation 5 is used and therefore the total generation might represent an overestimate.
    - **Recommendation:** discard the amounts accommodated in the DDS which originate from clean-ups conducted in NDDS.

'Light' methodology

This section describes the steps required to calculate total MSW generated based on pre-existing or default information. No additional primary data gathering is required.

Calculating total amount of MSW generated requires two important data points as shown in Equation 8:

Equation 8

It is required to find a pre-existing or default values for PCGR. In order to get this information, proceed with the following steps:

1) **Identify possible sources for this information.** Table 18 gathers some of the common sources.

Table 18: Possible sources of information on PRGR

Local literature	National literature	Globally available datasets
• MSWM plan of the city • Former SWM assessments (done by Universities, NGO's, consultancy companies, etc.)	• National, regional MSWM plans • MSWM of neighbouring city	• UNEP/UNSD Environmental Statistics • What a Waste 2.0 by World Bank (2018) • 'Wasteaware' ISWM Benchmark Indicators (WABI)[4]

[4] http://benchmark.wasteaware.org/reports

2) **Conduct an online search** to find already published and available reports which might contain this information.
3) **Conduct telephone interviews** with key stakeholders who might have this information (consider those in Table 18).
4) **Arrange and conduct face to face interviews** with local stakeholders who might have this information
5) **Iteratively conduct steps 2 to 4** based on the information found and contacts identified until you find checked all sources available.
6) **Contrast the results** found with local experts.

Outcomes

Figure 12 shows the possible outcomes for this step.

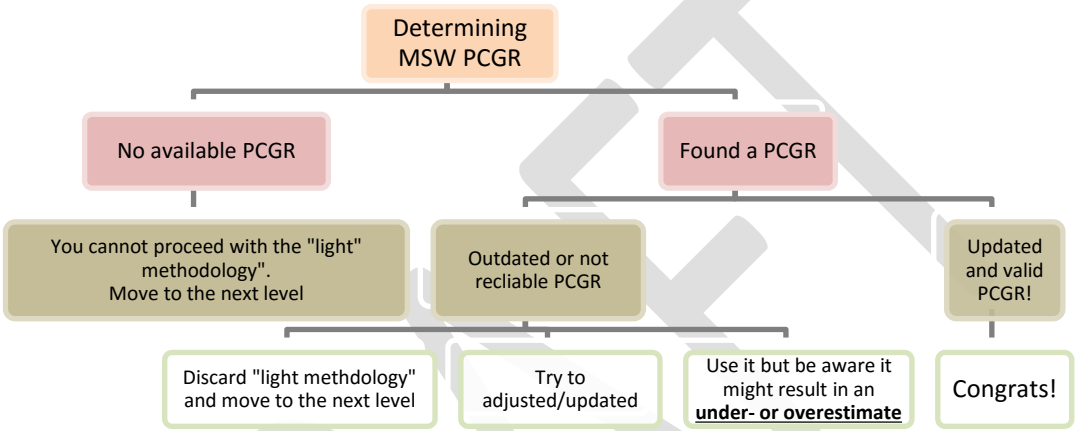

Figure 12: Outcome possibilities when determining MSW PCGR.

Recommendations:

- Use local data whenever possible, rather than over national and global datasets.
- Use updated data: if PCGR data is more than 5 years old, evaluate the economic development of the city over the given period of time.
    - Decrease or equal: use same number
    - Increase: using the same PCGR will yield an underestimate. Multiply by an increase-factor.
- Including impact of income on PCGR:
    - PCGR varies according to certain socio-demographic and socio-economic variables. Typically higher income dwellers generate more waste per capita.
    - Using a default PCGR misses to consider this variability.
    - Whenever possible, calculate total MSW generated using population and PCGR figures per each income level.

Compare the total MSW generated estimated with the amounts obtained for collection and managed in facilities. How big is the gap?

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