



**DEVELOPING INTEGRATED
SOLID WASTE
MANAGEMENT PLAN**
TRAINING MANUAL

***Volume 2:
Assessment of Current Waste
Management System and
Gaps therein***

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Developing Integrated Solid Waste Management Plan Training Manual

Volume 2

Assessment of Current Waste Management System and Gaps therein

Compiled by



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Preface

Rapid increase in volume and types of solid and hazardous waste as a result of continuous economic growth, urbanization and industrialization, is becoming a burgeoning problem for national and local governments to ensure effective and sustainable management of waste. It is estimated that in 2006 the total amount of **municipal solid waste (MSW)** generated globally reached 2.02 billion tones, representing a 7% annual increase since 2003 (Global Waste Management Market Report 2007). It is further estimated that between 2007 and 2011, global generation of municipal waste will rise by 37.3%, equivalent to roughly 8% increase per year. Based on incomplete reports from its participants, The Basel Convention estimated that about 318 and 338 million tons of **hazardous and other waste** were generated in 2000 and 2001 respectively. **Healthcare waste** is classified as a sub-category of hazardous wastes in many countries. As per WHO estimations, the total health-care waste per person per year in most low-income countries, is anywhere from 0.5 kg to 3 kg. There is no estimate about *global industrial wastes generation*. The US EPA estimates that, American industrial facilities generate and dispose off approximately 7.6 billion tons of non-hazardous industrial solid waste each year. The EU estimated that its 25 member states produce 700 million tons of **agricultural waste** annually. **Waste Electrical and Electronic Equipment (WEEE) or E-waste** is also one of the fastest growing waste streams and it equals to 1% of total solid waste on an average in developing countries. It is expected to grow to 2% by 2010.

Although considerable efforts are being made by many Governments and other entities in tackling waste-related problems, there are still major gaps to be filled in this area. The World Bank estimates that in developing countries, it is common for municipalities to spend 20-50 percent of their available budget on solid waste management (open dumping with open burning is the norm), even though 30-60 percent of all the urban solid wastes remain uncollected and less than 50 percent of the population is served. . In low-income countries, collection alone drains up 80-90 percent of municipal solid waste management budget. In mid-income countries, collection costs 50-80 percent of total budget. In high-income countries, collection only accounts for less than 10 percent of the budget, which allows large funds to be allocated to waste treatment facilities. Upfront community participation in these advanced countries reduces the collection cost and facilitates waste recycling and recovery.

Hence, developing countries face uphill challenges to properly manage their waste with most efforts being made to reduce the final volumes and to generate sufficient funds for waste management. If most of the waste could be diverted for material and resource recovery, then a substantial reduction in final volumes of waste could be achieved and the recovered material and resources could be utilized to generate revenue to fund waste management. This forms the premise for **Integrated Solid Waste Management (ISWM) system based on 3R (reduce, reuse and recycle) principle**. ISWM system has been pilot tested in a few locations (Wuxi, PR China; Pune, India; Maseru, Lesotho) and has been well received by local authorities. It has been shown that with appropriate segregation and recycling system significant quantity of waste can be diverted from landfills and converted into resource.

Developing and implementing ISWM requires comprehensive data on present and anticipated waste situations, supportive policy frameworks, knowledge and capacity to develop plans/systems, proper use of environmentally sound technologies, and appropriate financial instruments to support its implementation.

Many national governments, therefore, have approached UNEP, [as reflected in the decision taken by the UNEP Governing Council/Global Ministerial Environment Forum during its 25th Session in February 2009 (UNEP/GC.25/CW/L.3)] to get further support for their national and local efforts in implementation of the Integrated Solid Waste Management (ISWM) programme.

In response to this decision and in line with the Bali Strategic Plan for Capacity Building and Technology Transfer, UNEP has developed a programme on integrated solid waste management. This programme includes support for capacity building and technology transfer for ISWM through a number of actions:

1. Guidelines to develop ISWM System: The four sets of guidelines on ISWM covering waste characterization and quantification, assessment of current waste management system, target setting and identification of stakeholders' issues of concern for ISWM, and how to develop ISWM Plan.
2. Pilot projects on ISWM and emerging waste streams including E-waste, waste agricultural biomass, waste plastics and so on
3. Regional and sub-regional training for policy makers and experts on ISWM and emerging waste streams
4. Interactive advisory support on ISWM and emerging waste streams

This document is the *second* of the four sets of the guidelines on ISWM. It focuses on collection and analysis of information to generate baseline on current waste management system with identification of gaps therein. This second step is important to develop ISWM Plan to avoid re-inventing the wheel and to prioritize the actions.

This document can also be of interest to other interested parties/organisations that aim at supporting decision-makers. They may be:

- consultants working on urban services, recycling, or waste management;
- representatives or staff of other local stakeholders including community groups, NGOs, and the private sector;
- entrepreneurs wishing to expand or strengthen their solid waste portfolios;
- academicians and scholars in urban environmental management;
- the press, especially when seeking background materials;
- donors interested in supporting future waste management activities;
- local experts interested in using or replicating the results;

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ACRONYMS

| | |
|-----------------|---|
| AHP | Analytical Hierarchy Process |
| ASL | Automated Side Loaders |
| APC | Air Pollution Control |
| BEI CHP & RS | The bei cellulose hydrolysis process and reactor system |
| BMT | Biological and Mechanical Treatment |
| BMW | Bio-Medical Waste |
| BOT | Build-operate-transfer |
| C&D | Construction and Demolition |
| CDM | Clean Development Mechanism |
| CD-ROM | Compact Disc Read-Only Memory |
| CIWMB | California Integrated Waste Management Board |
| C.L | Confidence Level |
| CO ₂ | Carbon Dioxide |
| CRT | Cathode Ray Tube |
| CRV | California Redemption Value |
| CV | Calorific Value |
| DEPA | Danish Environmental Projection Agency |
| DKK | Danish Krone |
| DPSIR | Driving force - Pressure - State - Impact - Response |
| DTIE | Division of Technology, Industry and Economics |
| EIA | Environmental Impact Assessment |
| EMC | Environmental Management Centre |
| EnRA | Environmental Risk Assessment |
| EPA | United States Environmental Protection Agency |
| EPR | Extended Producer Responsibility |
| ESTs | Environmentally Sound Technologies |
| E-Waste | Electronic Waste |
| EWC | European Waste Catalogue |
| FOB | Free on Board |
| GDP | Gross Domestic Product |
| GHG | Greenhouse Gas |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| HCl | Hydrogen Chloride |
| HDPE | High Density Polyethylene |
| HW | Hazardous Waste |
| IETC | International Environmental Technology Centre |
| ISWM | Integrated Solid Waste Management |
| ISWMP | Integrated Solid Waste Management Plan |
| IT | Information Technology |
| IWPM | Integrated Waste Management Plan |
| KPIs | Key Performance Indicators |
| LPB | Liquid Paper Board |
| LR | Landfill Rate |
| LWAC | Landfill Waste Acceptance Criteria |
| MB | Megabytes |

| | |
|-------|--|
| MBT | Mechanical and Biological Treatment |
| MC | Moisture Content |
| MCDM | Multi Criteria Decision Making |
| MEAs | Multilateral Environmental Agreements |
| MF | Multi Family residence |
| MRF | Materials Recovery Facility |
| MSW | Municipal Solid Waste |
| MSWM | Municipal Solid Waste Management |
| NGOs | Non-governmental Organizations |
| NIMBY | Not-in-my-backyard |
| O&M | Operations and Maintenance |
| ODS | Ozone Depleting Substances |
| OECD | Organisation for Economic Co-operation and Development |
| PAYT | Pay as You Throw |
| PE | Polyethylene |
| PET | Polyethylene Terephthalate |
| PIC | Project Implementation Committee |
| PMC | Pune Municipal Corporation |
| PP | Polypropylene |
| PPE | Personal Protective Equipment |
| PRC | People's Republic of China |
| PS | Polystyrene |
| PS | Private Sector |
| PSP | Private Sector Participation |
| PVC | Polyvinyl Chloride |
| RAM | Random Access Memory |
| RDF | Refuse Derived Fuel |
| RPPC | Rigid Plastic Packaging Containers |
| SAT | Sustainability Assessment of Technologies |
| SF | Single Family residence |
| SP | Strategic Planning |
| SWAP | Solid Waste Analysis Protocol |
| SWM | Solid Waste Management |
| SWOT | Strengths, Weaknesses, Opportunities and Threats |
| 3R | Reduce, Reuse and Recycle |
| UNEP | United Nations Environment Programme |
| USD | The United States Dollar |
| WCV | Waste Collection Vehicle |
| WGF | Waste Generation Factors |
| WND | Wuxi New District, People's Republic of China |
| WTE | Waste-to-Energy |
| WWTP | Wastewater Treatment Plant |

1. Integrated Solid Waste Management (ISWM)

1.1. Overview

These guidelines are written to collect and assess the information on solid waste management (SWM) practices including regulations and economic tools, institutions and resources, coverage of the services and technology, and role of various stakeholders.

The goal of data collection on solid waste (quantification and characterization of various waste streams) and existing management systems (collection, transportation, treatment, disposal, recycling and recovery) is to develop an integrated solid waste management plan.

This chapter discusses the concept of ISWM with respect to three perspectives, viz.: *lifecycle, waste generation and waste management.*

1.1.1 Lifecycle-based Integrated Solid Waste Management

The first concept of ISWM is based on lifecycle assessment of a product from its production and consumption point of view (*Figure 1.1*). The reduction in consumption, and utilization of discarded products within the production system as a substitute for new resources, can lead to reduced end-of-cycle waste generation; thus, less efforts and resources would be required for the final disposal of the waste.

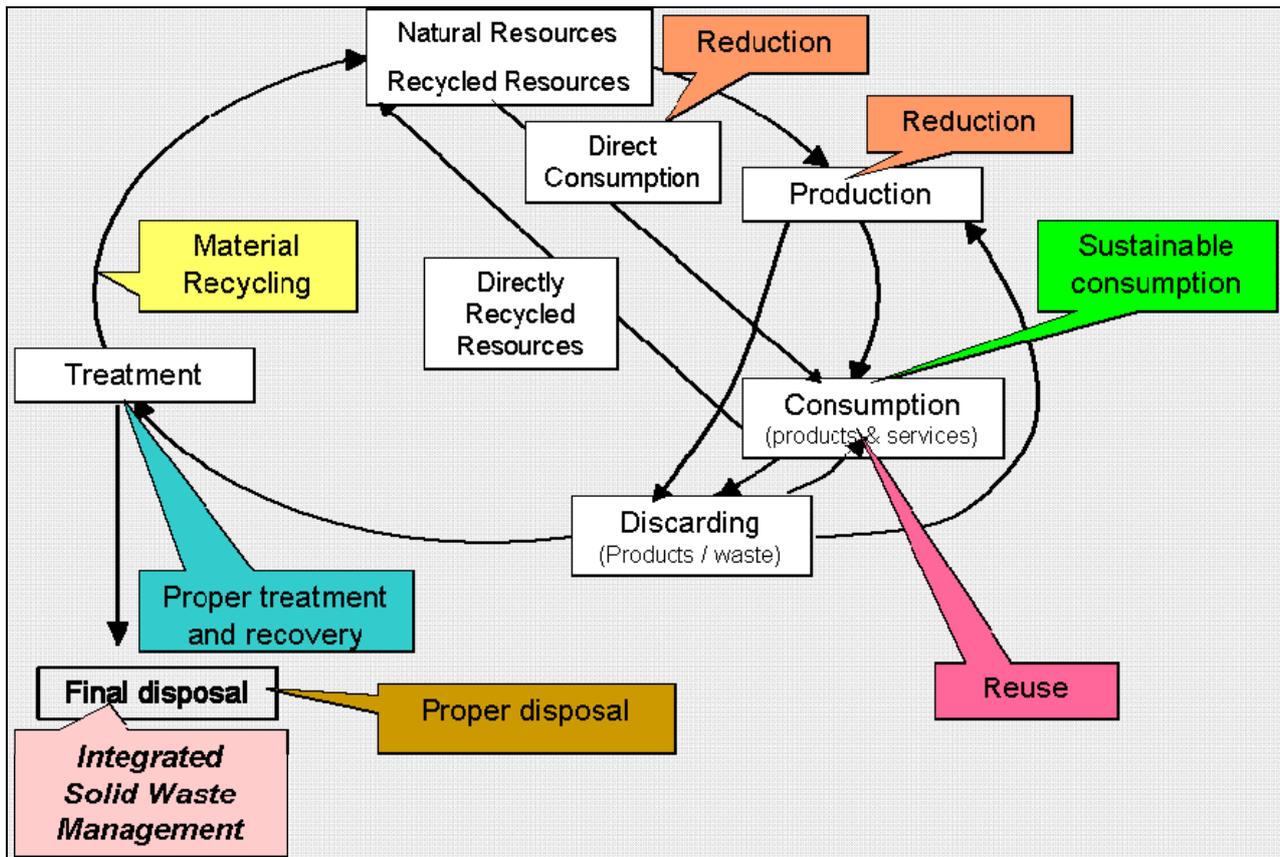


Figure 1.1: Lifecycle-based ISWM

1.1.2 Generation-based Integrated Solid Waste Management

The second concept of ISWM is based on its generation from different sources including domestic, commercial, industrial and agriculture. This waste could be further classified as hazardous and non-hazardous waste (*Figure 1.2*). The former has to be segregated at source and treated for disposal in accordance with the strict regulations. 3R approach (reduce, reuse and recycle) is applicable both at source as well as at the different levels of solid waste management chain including collection, transportation, treatment and disposal.

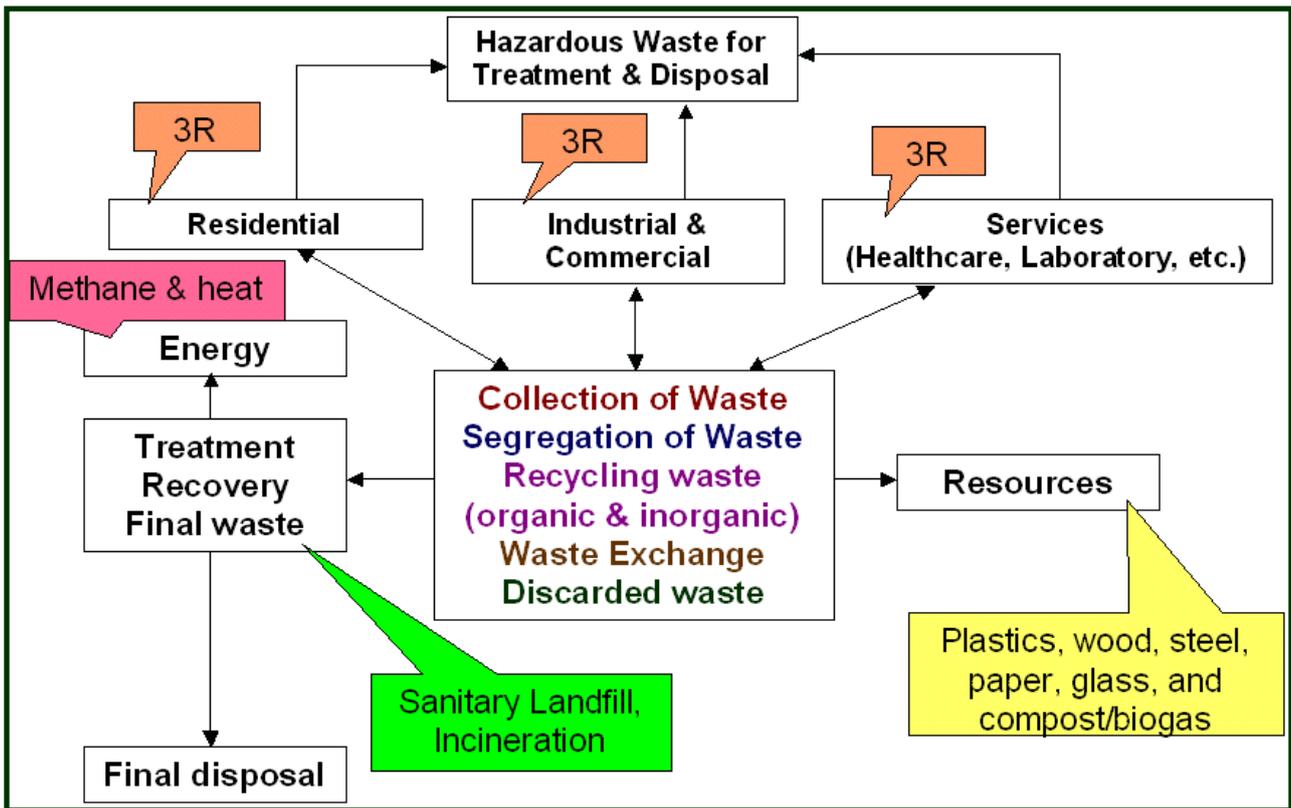


Figure 1.2: Generation-based ISWM

1.1.3 Management-based Integrated Solid Waste Management

The third concept of ISWM is based on its management (*Figure 1.3*) which includes regulations and laws, institutions, financial mechanisms, technology and infrastructure, and role of various stakeholders in the solid waste management chain.

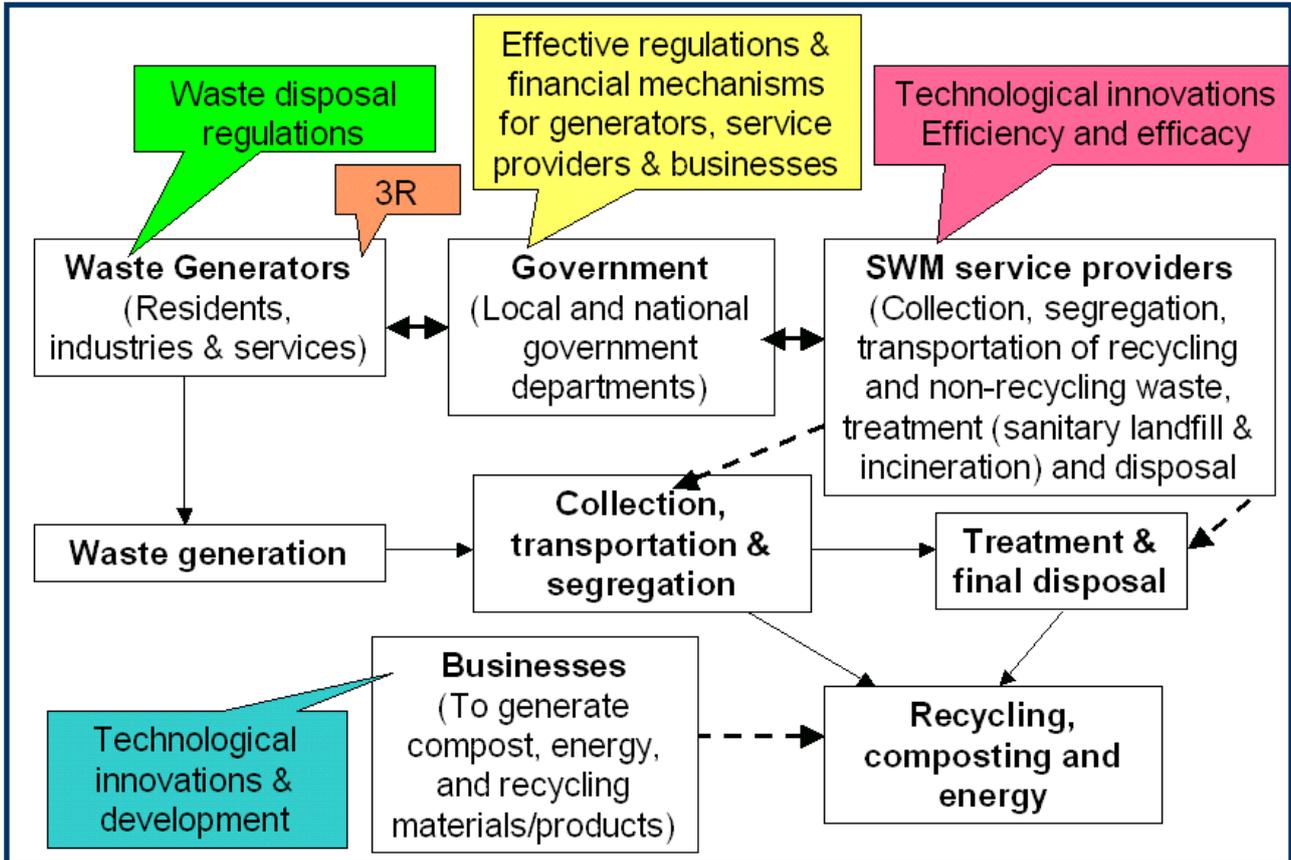


Figure 1.3: Management-based ISWM

1.2. Organization of Guidelines

This is the second set of guidelines that focuses on the assessment of solid waste management systems. The first set, which is available separately, focuses on the quantification and characterization of solid waste streams from different sources.

The assessment of the management systems may follow the following roadmap:

- **Coverage:** In case of SWM, before starting to assess the management systems, it is important to define them. There may be more than one management systems to address solid waste from different sources and/or different types of solid wastes. SWM systems include regulations and laws, institutions, financial mechanisms, technology and infrastructure and stakeholder participation in solid waste management chain (*Chapter 2*)
- **Assessment of individual management systems:** If there is more than one management system to handle solid waste, either from different generators or different types of solid waste (hazardous and non-hazardous), then the individual systems should be analyzed separately and the data so obtained could be compared to see their similarities and differences. For general purpose, the guidelines classify solid waste management in three systems, viz.: municipal solid waste, industrial solid waste, and hazardous solid waste. However, there might be fewer or more systems available in a particular city or country. To analyze solid waste management systems, the data and information is required to be collected on the following aspects:
 - **Policies** (*Chapter 3*)
 - **Institutions** (*Chapter 4*)
 - **Financing mechanisms** (*Chapter 5*)
 - **Technology** (*Chapter 6*)
 - **Stakeholder participation** (*Chapter 7*)

2. Assessment of Solid Waste Management (SWM)

Solid waste management may vary from country to country and city to city. In most countries, the local governments are responsible for municipal solid waste management; however the other two viz.: industrial and hazardous solid waste is the responsibility of the national government. In some places, the local governments with different departments, manages all the three kinds of wastes individually. If there is only one institution or department, responsible for all types of SWM, then it may be considered as a *single management system*. However, if there is more than one institution responsible for different types of solid waste or waste generated by different sources, then it is considered as *separate management systems*. Therefore, *it is recommended to collect the data and information separately, for different types of systems even if there is some overlapping in terms of regulations and laws, financial mechanisms, technology and infrastructure and stakeholder participation (Figure 2.1).*

It may also be noted that management systems may be evolved over a period of time depending on the variations in solid waste, political and administrative systems, socioeconomic situation, and geo-climatic conditions. *Hence, it is useful to capture the evolving process with respect to laws, institutions, financial mechanisms, technology and infrastructure and stakeholder participation.*

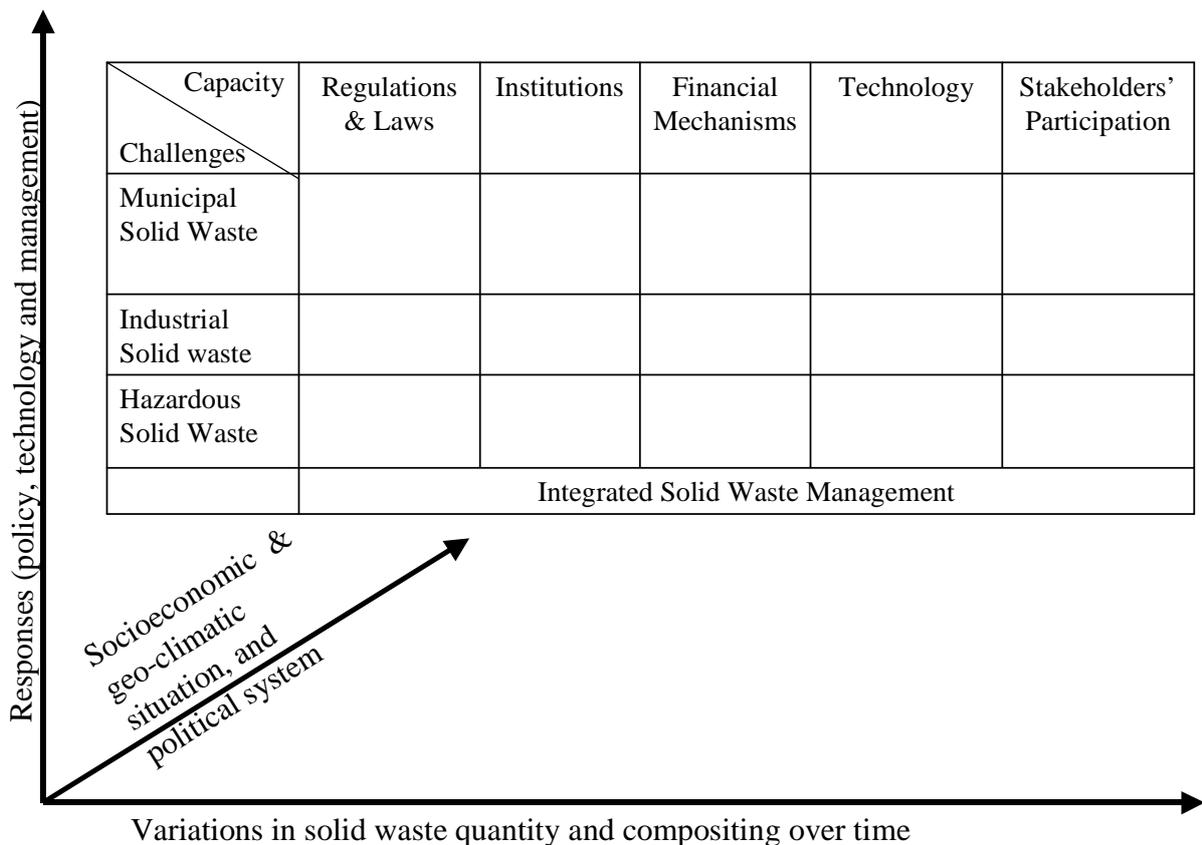


Figure 2.1: Solid Waste Management System

2.1. Importance of Data Collection and Analysis

Development of Integrated Solid Waste Management (ISWM) Plan demands the assessment of current solid waste management systems apart from their quantification and characterization which would further be useful for:

- Analyzing the availability, enforcement and impact of regulations and economic tools;
- Assessing the institutional framework, resources and jurisdictions for current institutions;
- Analyzing the efficiency and effectiveness of collection, treatment and disposal system including technologies;
- Understanding the role of different stakeholders at different levels of solid waste management chain; and
- Identifying the challenges and opportunities to improve SWM

2.2. Flowchart for Data Collection and Analysis

It may be helpful to create a flowchart for data collection and analysis for all the stages of SWM (Figure 2.2) to avoid duplication of efforts and to assign a clear role to the team members who are responsible for the same.

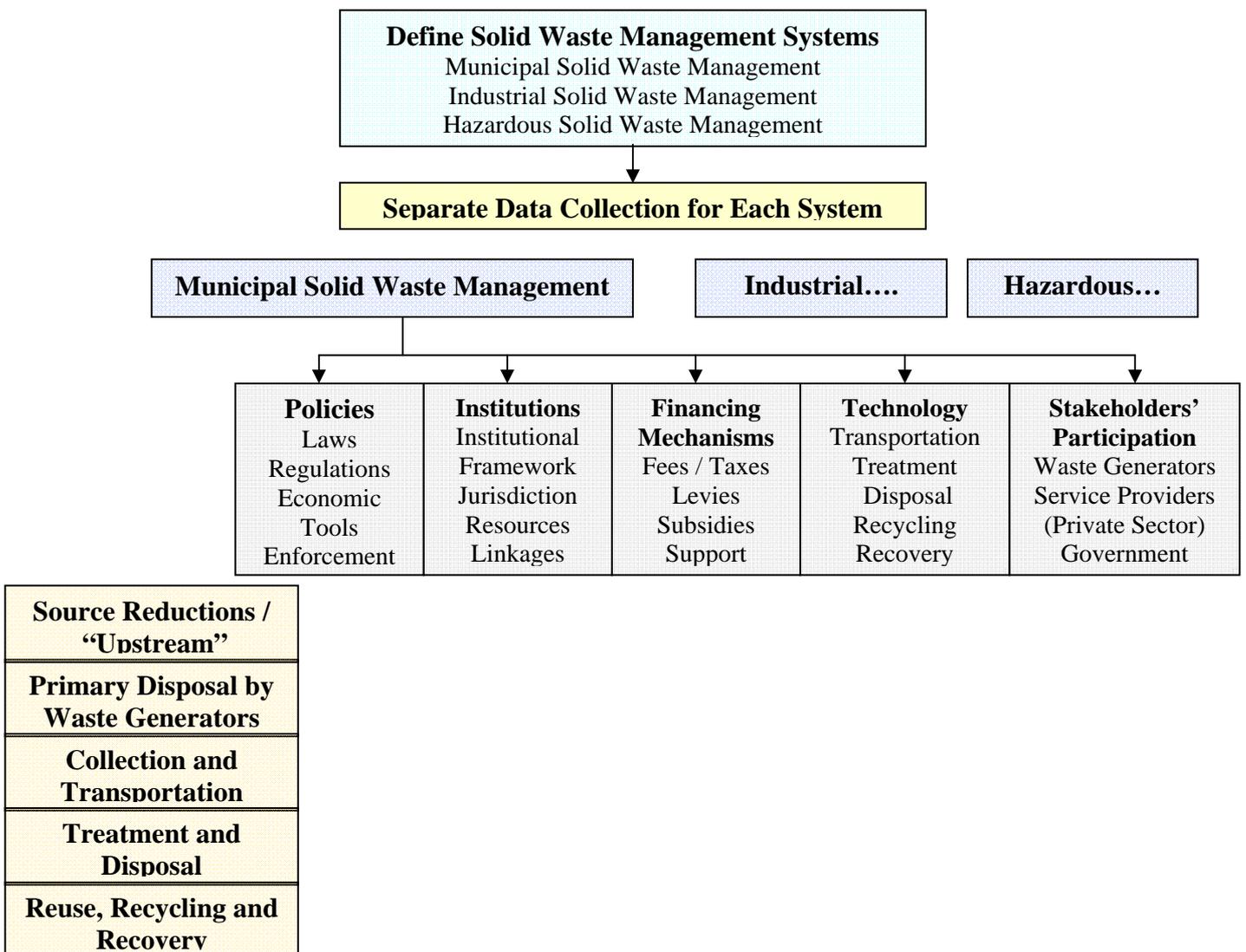


Figure 2.2: Flowchart for Data Collection & Analysis

3. Policies

A wide range of policies could be available at international, national, and local level. At international level, various multilateral and bilateral treaties and agreements, including Basel Convention, are available. National policies may have more than one perspective: they may help to improve SWM with respect to local conditions and/or they may assist to comply with international treaties and agreements. Furthermore, local policies could have an importance as in many countries, SWM is a local issue dealt by local governments. *The aim of these guidelines is to collect existing national and local policies.*

Policies are translated into regulatory and economic instruments for their implementation. The former, also known as command and control, specify the standards or limits to be followed and the latter, also known as market-based instruments, provide incentives and disincentives. There may also be some voluntary instruments agreed by the stakeholders. *Regulatory, economic and voluntary instruments may be available either in general or for every stage of solid waste management chain¹.*

3.1. Data Collection

3.1.1 Laws and Acts

Firstly, the laws and acts pertaining to SWM should be collected. There could be direct laws or acts addressing either overall SWM or a particular aspect of its chain, say, recycling and recovery. Environmental protection laws and acts usually cover SWM at national and local level along with a possibility of other laws, such as provision of public services, covering all or some aspects of it. The policies addressing various economic sectors, such as industries and agriculture, and also the specific laws for healthcare facilities, construction and demolition activities may, directly or indirectly, contain specific clauses on SWM. Laws or acts on SWM may or may not cover hazardous waste management. In that case, some of the separate laws and acts addressing hazardous waste management could be:

- I. Environmental Protection Law/Act
- II. Hazardous Waste Management Law/Act
- III. Recycling or Resource Recovery Law/Act
- IV. Clean Air Act – Incineration, Landfill gases
- V. Public Services Act – Solid Waste Management

3.1.2 Regulations

Secondly, information on all the relevant regulations should be collected which may include various standards covering every stage of existing solid waste management chain. The standards may also be available for technology and infrastructure, for example construction and operation of landfills and incinerators. Some examples of regulations or standards could be:

- I. Regulations on production and consumption – upstream measures
- II. Regulations on segregation of recyclable and non-recyclable waste
- III. Regulations on electronics waste

¹ Including waste minimization (source reduction), segregation at source, storage and collection, transportation, treatment, disposal, and recycling and recovery.

- IV. Regulations pertaining to extended producer's responsibility
- V. Regulations on handling of hazardous waste
- VI. Regulations on collection and transportation of industrial waste
- VII. Regulations on construction and operation of landfills
- VIII. Regulations on construction and operation of incinerators
- IX. Regulations on construction and operation of composting plant

3.1.3 Economic Instruments

Thirdly, the information should be collected on all the relevant economic instruments addressing one or more aspects of solid waste management chain. Financial disincentives (in the form of charges, levy, fine and penalty for waste generators) and Economic incentives (such as subsidies or payback for recycling) could be common economic instruments. Some examples could be:

- I. Levy on use of fresh resources in industrial production
- II. Subsidies for recycling in industrial production
- III. Volume-based solid waste fee on non-recyclable waste
- IV. Penalties on hazardous waste
- V. Subsidies for resource recovery, including power-generation at landfill

3.1.4 Enforcement

Enforcement becomes the most crucial aspect of policies for SWM as they could only make a difference if these are properly enforced at all levels. Therefore, an assessment of the level of enforcement is vital. But it can become a challenging task as the criteria or benchmarks to ascertain the level of enforcement may not be available and the opinion on the enforcement levels may differ within the different stakeholders². Hence, the opinions from all the major stakeholders should be sought to get a comparatively appropriate assessment.

3.2. Datasheet:

Based on the collected information on laws, regulations, economic instruments and enforcement, a data sheet should be prepared as shown in Table 3.1* with the relevant documents annexed.

² such as government, waste generators or handlers, regulators, service providers, community, etc

Table 3.1: Policies for Solid Waste Management

| | Laws / Acts | Regulations / Standards | Economic Instruments | Enforcement |
|--|--------------------|--------------------------------|-----------------------------|--------------------|
| Overall (General) | | | | |
| Source Reduction (Production & Consumption) | | | | |
| Segregation of Waste (at source) | | | | |
| Primary Storage & Collection | | | | |
| Transportation & Transfer Stations | | | | |
| Treatment | | | | |
| Landfills | | | | |
| Incinerators | | | | |
| Recycling | | | | |
| Resource Recovery | | | | |
| Hazardous Waste (Industrial) | | | | |
| Hazardous Waste (Healthcare facilities) | | | | |
| Hazardous Waste (Others) | | | | |
| Construction & Demolition | | | | |

* This table can be modified in accordance with the availability of data. If there is more information available, then new columns and rows can be added accordingly

4. Institutions

Traditionally solid waste management was the responsibility of local governments. However, with the increasing rate of solid waste from diversified, unconventional sources (like industries and laboratories respectively), and awareness and regulations (for recycling and recovery, hazardous waste management and source reduction by intervening at production and consumption level), various institutions got involved into one or more aspects of solid waste management chain. This transition from public to private institutions for undertaking various public utilities and services demanded governments to establish strong regulatory institutions to make sure that the service providers deliver effective and efficient services. There may be more than one institution involved at the same level or for the same type of activity, for example, informal and formal sector for recycling or public and private sector for collection and transportation of municipal waste.

We need to collect detailed information on all the institutions, currently responsible at any level of the solid waste management chain to identify their role or mandate, institutional framework, human resources and sources for financing their activities. The collected data may be tabulated in two levels. At first, the name of the institutions may be provided as per Table 4.1* followed by a separate sheet, containing abovementioned information regarding each institution.

Table 4.1: List of Institutions involved in Solid Waste Management Chain

| Type of Service | Regulator | Service Provider | | |
|--|-----------|---------------------|------------------|----------------|
| | | National Government | Local Government | Private Sector |
| Municipal Solid Waste Management | | | | |
| 1. Collection | | | | |
| 2. Transportation | | | | |
| 3. Treatment | | | | |
| 4. Disposal | | | | |
| 5. Recycling | | | | |
| | | | | |
| Industrial Solid Waste Management | | | | |

*This table can be modified in accordance with the length and breath of the available information.

5. Financing Mechanisms

In many countries, SWM being a local issue, all the financial activities like its annual budget, subsidies from national government, and international cooperation were taken care by the local governments. However, the demands for huge investments, to bring improvements in many aspects of the solid waste management chain, started rising with a rapid increase in waste generation rates and awareness for effective and efficient SWM practices to protect public health and environment. This further paved way for a transition for which the governments started adopting various financing modes and some of the widely practiced ones are as follows:

1. **User charges:** In many countries, user charges are being introduced. They are still low for municipal sectors but for commercial and industrial sector, the charges could be high to meet the costs in accordance with the polluter's pay principle. However, these charges also motivate waste generators to reduce the waste. Volume-based charges for municipal waste are quite common in some countries.
2. **Penalty, fine and levy:** This form of direct income is also becoming an important financing tool for governments to finance SWM. The terminology and rate of the penalty/fine/levy may vary from country to country.
3. **Environmental Bonds:** In some countries, these bonds are floated by local governments as a major source to arrange funds for environmental infrastructure and services including SWM and other developmental activities.
4. **Environmental Fund:** Some countries set a revolving fund to assist local governments in meeting their financing needs for environmental infrastructure and services. This fund is financed through various modes including national bonds, annual budget, loans from international financing institutions and international cooperation.
5. **Direct Loans:** Local governments may take direct loans either from domestic or international financing institutions.
6. **International Cooperation:** There is an increasing trend of a direct multilateral and bilateral cooperation with local governments. International agencies are providing support to local governments to improve the local environment. Various bilateral initiatives, including sister cities, are also helping local governments to seek assistance for financing their development projects including SWM.
7. **National subsidies:** This is still a major source for many local governments to finance environmental infrastructure and services.
8. **Annual budget:** Local governments allocate substantial portion of their development budget to finance SWM. This is usually cross-subsidized from the profit-making avenues of local governments.
9. **Private Sector Participation (PSP):** There is an increasing trend of private sector participation in solid waste management chain. The activities under SWM (collection, transportation, treatment, disposal, recycling and recovery) can be easily separated from each other enabling various organisations to involve in one or more aspects of the chain. There are quite a few established forms of PSP based on the level of investment and ownership as shown in Figure 5.1. In many countries, the primary collection system, also known as door-to-door collection, has been under community-based private sector where households pay monthly fee to the service provider. Infrastructure, such as landfills and incinerators, are being awarded to private companies on BOT (build-operate-transfer) basis. Franchise is another common way for PSP, where the private sector has the right to collect waste within the agreed location and sell recyclable waste.

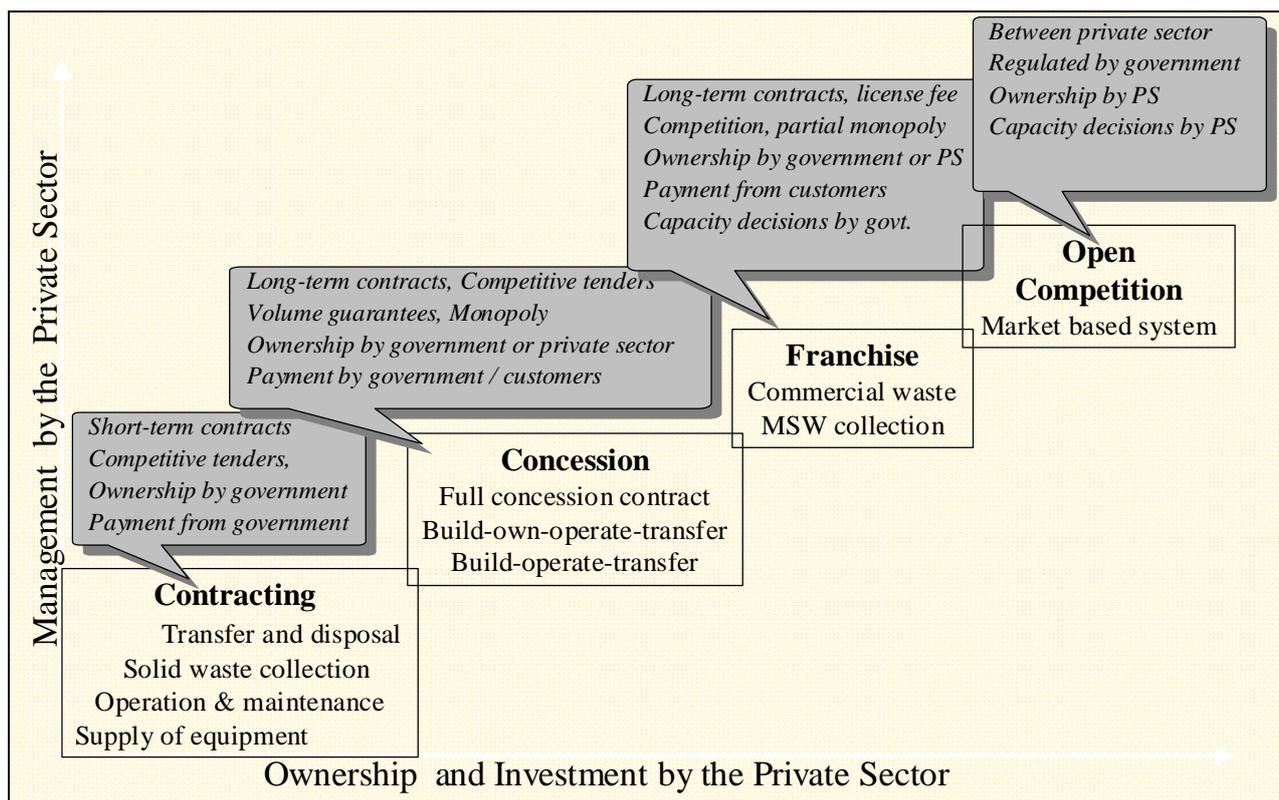


Figure 5.1: Management and Ownerships in Various Forms of Private Sector Participation

5.1. Datasheet:

The information should be collected on the financing mechanisms for all the activities under solid waste management chain as shown in Table 5.1*. There may be more than one organization and financing mechanism involved for one activity.

Table 5.1: Financial Mechanisms for Solid Waste Management Chain

| Type of Service | Organization | Financing Mode | | |
|--|--------------|----------------|--|---|
| | | Direct Revenue | Local Government/ National Government/ International Cooperation | Private Sector (Mention Type of PSP) |
| Municipal Solid Waste Management | | | | |
| 1. Collection | | | | |
| 2. Transportation | | | | |
| 3. Treatment | | | | |
| 4. Disposal | | | | |
| 5. Recycling | | | | |
| Industrial Solid Waste Management | | | | |

* This Table can be modified in accordance with the available information.

6. Technology

Solid waste management chain requires intensive use of environmentally sound technology (ESTs) for its activities which could be as simple as containers for primary collection to as complicated as incinerators for disposal of hazardous waste. The possible technological interventions within SWM chain are as follows:

1. **Primary collection and transfer stations:** This may include the waste collection bins for segregated municipal waste and special containers for hazardous waste. Material, construction, labeling and storage of the collection containers are important. Similarly construction and location of transfer station is also crucial to avoid adverse effects due to odour, breeding of vectors such as flies and mosquitoes, and entry of birds or cats and dogs. The transfer stations should be located and constructed in such a way that it is convenient for small carts to unload solid waste and for bigger vehicles to collect and transport that waste.
2. **Transportation:** This covers all types of vehicles under operation to transport solid waste from its generation point to the transfer station; and from there to the treatment and disposal site. All the vehicles in operation should be listed out including manually driven small carts, mechanically driven sophisticated transportation vehicles and special vehicles for special wastes - hazardous, bulky and recyclable wastes.
3. **Treatment:** This includes separation of different types of waste, hence, the technology equipped at this level may enable separation of various types of materials for recovery and recycling, equipment for shredding and treatment of final disposable waste. In some countries, incineration is covered at this level and ash from it is sent to landfill for final disposal. Incineration is a high-tech process – the negative impacts of which could be worse for both public health as well as the environment.
4. **Final Disposal:** Though sanitary landfill is the most common technology around the world, the conventional and environmentally unfriendly methods including open-burning, open-dumping and non-sanitary landfill can still be evidenced. However, in most countries these are officially banned allowing only sanitary landfill for final disposal. Sanitary landfills can be operated with fully aerobic, semi-aerobic and anaerobic methods. The technologies may also vary in accordance with the type of final disposable waste, for example, some landfills may be used for co-disposal of special wastes. The landfills for hazardous wastes could be more complicated and are known as “secure landfill.” The location of landfill is also an important factor considering the transportation costs and its impacts on the urban environment.
5. **Recycling and Recovery:** This includes various types of activities like recycling of reusable materials (e.g., plastic and glass containers), recycling of materials for industrial production (e.g., paper and iron), converting waste into energy (e.g., burning tires in cement kiln to produce heat), and converting waste into a resource (e.g., composting and landfill gas). Hence technology can determine the level and sophistication of recycling and recovery activities.

6.1. Datasheet:

The information on the technology is required for all the activities within solid waste management chain. First of all, an overview of current technologies could be provided as per Table 6.1*. Thereafter, separate sheets may be attached with this table on the details of each technology including transportation vehicles, landfill, and recycling and recovery processes.

Table 6.1: Technology for Solid Waste Management

| Type of Service | Technology | | |
|--|------------|--------|--------------------|
| | Type | Number | Important Features |
| Municipal Solid Waste Management | | | |
| 1. Collection | | | |
| 2. Transportation | | | |
| 3. Treatment | | | |
| 4. Disposal | | | |
| 5. Recycling | | | |
| | | | |
| Industrial Solid Waste Management | | | |
| | | | |
| Waste Management at Healthcare Facilities | | | |
| | | | |

* This Table can be modified in accordance with the available technology/equipment.

7. Stakeholder Participation

Stakeholder participation is becoming an essential part of SWM. Major stakeholders include waste generators, regulators, service providers such as organizations involved in waste collection and disposal, and organizations involved in recycling and recovery. Each stakeholder has a specific, clear and active role to improve the efficacy and efficiency of SWM by active participation and continuous interaction. Waste generators - traditionally considered as passive partners - have a major responsibility to reduce, segregate, and properly discard the waste as per the regulations. A close cooperation would be required between waste generators and waste collectors to increase the coverage and effectiveness of the waste collection system, proper disposal of waste, and recycling and recovery of materials. Furthermore, with rapid changes in quantity and composition of solid waste, regulatory organizations or governments have to be in continuous dialogue with the stakeholders to introduce appropriate regulations which can help bring the required improvements in SWM system.

7.1. Datasheet:

The information on stakeholder participation would be required at two levels. Firstly, to motivate stakeholders to participate with the help of materials, campaigns, meetings, and other political and social interactions and secondly on the ways and means for stakeholder participation, for example, stakeholder representation in decision-making bodies such as a regulatory body and monitoring committee. Stakeholder participation in the decisions to set the level and type of service, such as door-to-door collection or location of transfer station, could also indicate the level of participation. Table 7.1 may be helpful in obtaining and filling in this information.

Table 7.1: Process and Level of Stakeholder Participation in SWM

| Type of Service | Major Stakeholders | Measures to Improve Stakeholder Participation* | Level of Stakeholder Participation** |
|--|--------------------|--|--------------------------------------|
| | | | |
| Municipal Solid Waste Management | | | |
| | | | |
| Industrial Solid Waste Management | | | |
| | | | |
| Waste Management at Healthcare Facilities | | | |
| | | | |

* Measures may include awareness raising materials and campaigns, meetings, etc.

** Level of participation may be indicated by the role of stakeholders in SWM chain

About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

- > sustainable consumption and production,
- > the efficient use of renewable energy,
- > adequate management of chemicals,
- > the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:

- > **The International Environmental Technology Centre** - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
- > **Production and Consumption** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
- > **Chemicals** (Geneva), which catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
- > **Energy** (Paris), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
- > **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
- > **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

*UNEP DTIE activities focus on raising awareness,
improving the transfer of knowledge and information,
fostering technological cooperation and partnerships, and
implementing international conventions and agreements.*

For more information,
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This book is the second volume in the series of training manuals on developing Integrated Solid Waste Management (ISWM) plan. This manual aims to build the capacity of practitioners and policy makers for assessing the current waste management system and practices covering all the stages of waste management chain viz.: primary generation and disposal, collection and transportation, sorting and material recovery for recycling, treatment and resource recovery, and final disposal.

The objective of the manual is to facilitate identification of important aspects of waste management system and gaps therein with reference to regulations, institutional arrangements, financial mechanisms, technology and infrastructure, and roles and responsibilities of various stakeholders in the current system. The manual provides a methodology to conduct studies leading to collection and analysis of the information.