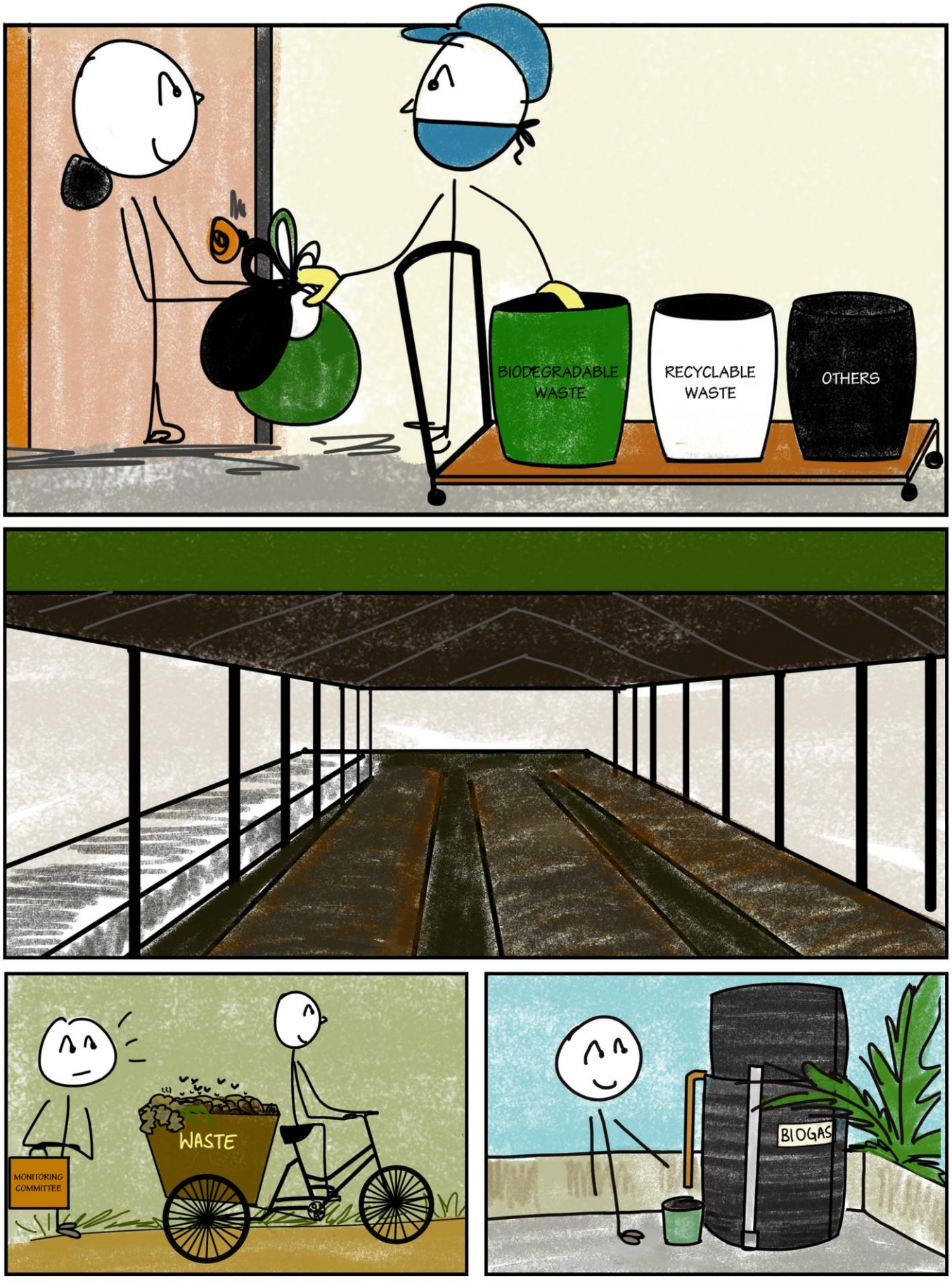
Municipal Solid Waste Management in Tamil Nadu

A Guidebook for Urban Local Bodies



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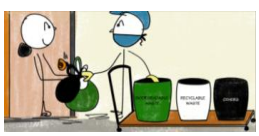
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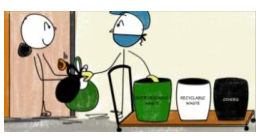


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Foreword

With a vision to facilitate a bottom-up approach to urban planning, the 74th Constitutional Amendment in 1992 mandated the devolution of select rights and responsibilities to Urban Local Bodies (ULBs) – the third tier of government. A number of schemes and initiatives, by both state and central governments, have been launched since then to fulfil the objective of creating empowered and financially sustainable ULBs. The Jawaharlal Nehru Urban Renewal Mission, (JNNURM) a reform linked investment scheme, is one such initiative introduced by the Ministry of Urban Development in 2005. With an outlay of INR 66,000 crore spread across a seven year period, it remains among the most far-reaching initiative undertaken by the government to empower ULBs.

Despite this increased emphasis on empowering ULBs to deliver efficient, sustainable and affordable urban services, the status of urban infrastructure and service delivery in Indian cities remains far from satisfactory. Water supply is grossly inadequate; only 64% of the urban population is covered by individual water supply connections, with the duration of water supply ranging from 1 to 6 hours for a majority of the households. Due to inefficiencies in distribution, 50% of water production is non revenue water, which poses a serious threat to the financial viability of water utilities. The level of water recycling and reuse is extremely low: only 21% of the waste water generated is treated and over 94% of the cities/towns in India do not have even a partial sewerage network. With respect to solid waste, although waste collection coverage ranges from 70% to 90% in major metropolitan cities, less than 30% of the waste is segregated and scientific disposal is almost never practiced.

The High Powered Expert Committee on Indian Urban Infrastructure and Services identified the lack of capacity among ULBs to design, implement and govern projects as being a critical contributor to the persistence in the infrastructure and service delivery gaps.

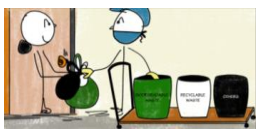
This recognition has created a renewed focus, among governments and within policy circles, on the need for targeted capacity building interventions at the ULB level. Several initiatives such as the creation of regional capacity building hubs and promotion of centres of excellence/innovation in urban policy are being designed and implemented by state and central governments alike to empower ULBS to respond to the rising demands of urban infrastructure creation and service delivery.

This guidebook seeks to contribute to the larger ongoing process of building capacities among ULBs and provides a set of simple tools and guidelines to enable ULBs to deliver their functions more effectively. In specific, it seeks to provide municipal representatives, specifically the commissioners, with a set of actionable strategies to improve service delivery and enhance participatory decision making.



S. Narayan, IAS (Retd.)

President, Athena Infonomics



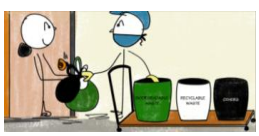
Preface

This guidebook is the outcome of an ongoing engagement with the British High Commission that seeks to explore the potential of Public Private Partnerships to fulfil the investment and innovation gaps in the delivery of critical urban services and empower Urban Local Bodies to deliver their responsibilities more effectively. A number of surveys and workshops were held across the country as a part of the engagement to understand existing gaps in urban service delivery and identify suitable policy responses.

The insights generated from the primary surveys, stakeholder interviews and secondary research have been consolidated and presented here in the form of a set of tools and processes to enable municipal representatives to make effective decisions on different aspects of urban service delivery starting from estimating demand to identifying the mode of procurement, managing stakeholder expectations, engaging community representatives and monitoring project outcomes.

These tools and processes have been customized for four project states namely Karnataka, Andhra Pradesh, Madhya Pradesh and Tamil Nadu, with a focus on urban water supply in the first two and municipal solid waste management in the other two states.

This guidebook focuses on informing and empowering ULBs in the state of Tamil Nadu to improve the effectiveness of service delivery in the Municipal Solid Waste Management (MSWM) sector. The information presented here was developed over a period of six months and in two phases. In the first, a number of interviews and discussions were held with senior state government representatives, ULB functionaries, citizen groups, private concessionaires and academics on challenges and concerns in MSWM within the state. The information generated from this process was analysed, key areas of concern in the state were identified and a set of policy and operational responses were developed in the form of a set of guidelines. These guidelines were presented to diverse stakeholder groups, at a workshop in Chennai in the second stage and were further deliberated upon. The rich discussions and suggestions emanating from the workshops were then incorporated into the final framework, which is presented here.



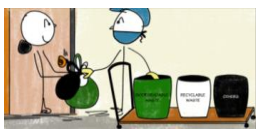
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This guidebook would not have been possible without the cooperation of experts and practitioners in the MSWM Sector of India. Their willingness to share their experiences has helped us ground this book in practical insights.

In particular we would like to thank Mr. Chandrakant B. Kamble, Commissioner of Municipal Administration, and Mr. Ajay Yadav Joint Commissioner of Municipal Administration, Government of Tamil Nadu for being a pillar of support and helping us organize and delivering the Capacity Building Workshop titled 'Strengthening Participatory Approaches in Municipal Solid Waste Management', held in Chennai on 5th November, 2012. We are also grateful to Mr. D. Karthikeyan, Commissioner, Corporation of Chennai, for his valuable inputs on various aspects of MSWM. We thank all the municipal commissioners and engineers for attending the workshop and providing their insights and feedback on the structure and content of the guidebook.

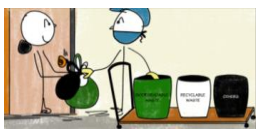
We owe a special thanks to our advisor Dr. Ashwin Mahalingam, Professor, IIT Madras for having guided us in developing the idea. We are also grateful to Dr S Narayan, our President and Mentor, Ms. Revathy Ashok, CEO and Founder, Iris Consulting and Mr. M.G. Devasahayam (IAS Retd.) for their constant advice and support throughout the assignment and in making this Guide Book possible.

We would also like to extend a special thanks to the British High Commission for their support for carrying out this study. In particular we thank Ms. Aarti Kapoor, Programme Manager, BHC, New Delhi for her continuous encouragement and support during the project.



List of abbreviations

AC	Alternative Current
AM	Alandur Municipality
ASCI	Administrative Staff College of India
ARTI	Appropriate Rural Technology Institute
C&T	Collection &Transportation
BARC	Bhabha Atomic Research Centre
BOO	Build Own Operate
BOT	Build Operate Transfer
BOOT	Build Own Operate Transfer
BPL	Below Poverty Line
CapEx	Capital Expenditure
CBO	Community Based Organization
CLO	Compost Like Output
Cm/sec	Centimetre per Second
CMA	Commissionerate of Municipal Administration
CMCDM	Chennai Metropolitan City Development Mission
CO_2	Carbon Dioxide
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health & Environmental Engineering Organisation
DB	Design and Build
DBFOT	Design Build Finance Operate Transfer
EMU	Eluru Municipal Corporation
EPC	Engineering Procurement Construction
ESCI	Engineering Staff College of India
FGD	Focus Group Discussion
GOI	Government of India
GMC	Guwahati Municipal Corporation
GWMS	Guwahati Waste Management Society
HDPE	High Density Polyethylene
HH	Household
IEC	Information Education Communication
INR	Indian National Rupee
IUDM	Integrated Urban Development Mission
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
Kcal	Kilo Calorie
Kg	Kilogram
L	Litre
LPG	Liquefied Petroleum Gas
MTD	Metric Tonnes per Day
M	Metre



M^2	Meter Square
M^3	Cubic Meter
MAWS	Municipal Administration and Water Supply Department
MBT	Mechanical Biological Treatment
MJ/m3	Mega Joule per Cubic Metre
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
MW	Mega Watt
OpEx	Operational Expenditure
O&M	Operations and Management/Maintenance
PMC	Pune Municipal Corporation
PPM	Parts per Million
PPP	Public Private Partnership
PUA	Pune Urban Agglomeration
RDF	Refuse Derived Fuel
RWA	Resident Welfare Association
SHG	Self Help Group
SLB	Service Level Benchmark
SWaCH	Solid Waste Collection & Handling
TA	Transaction Advisory
TNIDB	Tamil Nadu Infrastructure Development Board
TNPCB	Tamil Nadu Pollution Control Board
TNUDF	Tamil Nadu Urban Development Fund
TNUIFSL	Tamil Nadu Urban Infrastructure Financial Services Limited
TUFIDCO	Tamil Nadu Urban Finance & Infrastructure Development Corporation
TWG	Total Waste Generated
TWV	Total Waste Volume
ULB	Urban Local Body
VfM	Value for Money
WTE	Waste-to-Energy
WtP	Willingness to Pay
YASHADA	Yashwantrao Chavan Academy of Development Administration
6R	Reduce, Reuse, Recycle, Recover, Return Nutrients to Soil, & Residual Management



Glossary

Accountability	The obligation of an agency to account for its activities, accept responsibility and disclose results in a transparent manner.
Annual Maintenance Contracts	An agreement between two or more agencies outlining the terms and conditions of quality control and functioning of infrastructure assets
BOT Annuity	Build - Operate - Transfer - Annuity A type of public private partnership model in which the private player builds and operates the infrastructure assets as agreed upon and mentioned in the concession agreement. The private player also finances a minimal amount of the project cost. In return to the services provided, the contracting authority pays an annual lump sum amount. These cash flows determine the number of years required for the private player to recover its investments. Upon completion of the project, the assets are transferred to the contracting agency.
BOT Toll	Build - Operate - Transfer - Toll A type of public private partnership in which the roles of the private player and contracting agency are the same as that of BOT Annuity. The difference between the two models is that the private player recovers its investment via generating revenue from user charges collected. These user charges are regulated over the time period of the project by a regulatory body.
Revenue Collection Efficiency	Current annual revenue collected, expressed as a percent of the potential operational revenue
Commercial Establishments	Non-residential consumers/ customers such as hotels, schools, hospitals, etc.
Comparative Advantage	Ability of the agency/body to produce a set of outcomes at a lower marginal or opportunity cost than the other
Contract	An agreement in which two or more parties voluntarily enter into a legal obligation with certain terms and conditions
Cost Recovery	Annual operations revenue collected as a percent of total annual operations expenditure
Customer Service Centre	A customer service unit within the ULB that is responsible for managing relations with all the customers for solid waste management services. It receives complaints and applications for services from the customers via a certain media, such as online forms, telephonic registrations, kiosks, etc. and ensures that reliable services are provided.
DBFOT	Design - Build - Finance - Operate - Transfer A type of public private partnership model similar to a BOT. Here the private



	player is vested with an additional responsibility of design.
EPC Contract	Engineering - Procurement - Construction Contract A type of a public procurement in which the public sector contracts out the construction works to a private engineering firm and pays a fee upon completion
Focus Group Discussion	An activity that gathers together a group of people from similar backgrounds or experiences to discuss a specific topic of interest which is guided by a moderator
Financial Proposal	Proposal consisting of the financial features of the project along with the bid, as submitted by the party that has cleared the technical round in a competitive bidding mechanism
Financial Viability	Ability of an ULB or any other operating agency to generate sufficient income annually so as to meet its annual operating expenditures
Flat Tariff/ Uniform Tariff	A type of tariff where a single fixed fee is charged to all users/ beneficiaries in return for a service
Households	A type of customer which is domestic/residential in nature
IEC	Information - Education - Communication Strategies or tools used by an agency to interact with the community to inform, create awareness and educate them about the project
Implementing Body/ Agency	An agency/ a body that is implementing a project. Generally refers to an urban local body that may either self-implement the project or contract it to another party
Management Contract	An agreement between two parties (in this case, between the implementing agency and the private player) where the government is responsible for policy regulation and monitoring and the private operator is mandated to operate and manage the MSW to provide services as agreed upon and mentioned in the contract
OpEx	Operational Expenditure Total annual cost incurred by the ULB for operating and maintaining the SWM infrastructure like collection & transportation vehicles, compost yards, waste to energy plants, etc. These include salaries to staff, costs incurred on power, chemicals, etc.
Participatory Urban Appraisal	Appraisal of urban projects through participatory approaches, i.e., through consultations with the community
Performance - based Management Contract	A Management Contract where payments to the private operator are linked to achievements or performances, with (not always) an application of penalties and bonuses
PPP	Public Private Partnership



	Government of India defines Public Private Partnership as '*An arrangement between a government / statutory entity / government owned entity on one side and a private sector entity on the other, for the provision of public assets and/or public services, through investments being made and/or management being undertaken by the private sector entity, for a specified period of time, where there is well defined allocation of risk between the private sector and the public entity and the private entity receives performance linked payments that conform (or are benchmarked) to specified and pre-determined performance standards, measurable by the public entity or its representative*'[ii]
Procurement	Process of acquisition of assets and services by an agency
Public Procurement	Process in which the acquisition of goods and services remains with the public sector/government
Redressal of Customer Complaints	Total number of MSWM related complaints that are redressed within 24 hours of receipt of complaint, as a percentage of total number of complaints received in the given time period
Sampling Strategies	Process of selection of a subset from a set of total population
SPV	Special Purpose Vehicle A subsidiary company with an asset/liability structure and legal status that makes its obligations secure even if the parent company goes bankrupt
Stakeholders	All the project affected people comprising the implementing agency, financier, private concessionaire, consumers, rehabilitated/ resettled citizens
Sustainable Livelihoods Approach	An approach that addresses and identifies the complexities of poverty, the inter linkages in the factors affecting it and creates action plans to overcome it
Technical Proposal	A proposal consisting of the details of project scope, approach and methodology and the work plan for performing the activities
Transect Walks	Here, a transect walk refers to a systematic walk along a defined path (transect) across the community/project area together with the local people to explore issues related to waste collection/disposal points by observation and interactions
Work Plan	A plan that details the list of activities to be performed, provides timelines for the same and allocates responsibilities along with the estimated person days



Objectives | Target Audience | Structure

Objectives

This guidebook has been created with the objective to:

- Provide Urban Local Bodies (ULBs) with a set of guidelines to effectively identify, implement and execute projects in Municipal Solid Waste Management (MSWM)
- Strengthen participatory approaches by engaging citizen representatives at different stages of project implementation and governance
- Acquaint ULBs with a few best practices in the delivery of MSWM

Target Audience

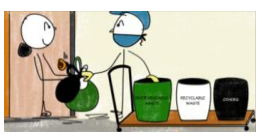
The guidebook is designed to serve as a reference manual to ULB representatives (commissioners, executive engineers, planners) responsible for implementing MSWM projects in Tamil Nadu

Structure

The structure of this guidebook follows the steps associated with identifying and executing projects in the MSWM sector, namely:

- Project Identification
- Project Procurement
- Project Monitoring

Only functions that are of relevance to ULBs at these stages have been covered.



Section I: Overview of MSWM in Tamil Nadu

- Introduction
- Institutional Framework
- Key Challenges
- Key Initiatives

This section discusses the status of Municipal Solid Waste Management (MSWM); presents the institutional framework and role of ULBs in MSWM project cycle; highlights key issues faced by ULBs and other stakeholders; and captures recent policy, financial and technological initiatives taken by the Government of Tamil Nadu to empower ULBs.



I.1 Introduction



A well managed system of solid waste is a city's calling card as it is the first thing that hits the public eye. Tamil Nadu being among the most urbanized states in the country has made conscious efforts to improve the status of solid waste management in the state and empower local bodies to conceive, design, implement and manage SWM projects. In fact, Tamil Nadu has been among the first few statesto have adopted public private partnerships (PPPs) and has encouraged community participation in the sector to the improve management of MSW.

Despite the rising emphasis on creating efficient solid waste management mechanisms a quick appraisal of the system of management and disposal of solid waste in the state leaves much to be desired. Most of the cities and towns in the states are not MSW rules compliant and continue to face a number of challenges across the MSW value chain



The inability of ULBs to manage solid waste in a sustainable and efficient manner, partly traces back to the absence of adeqaute capacities among ULBs to conceptualize, implement and montior SWM models efficiently.

This guidebook seeks to provide an overview of the various tools and methods that will enable ULBS to make informed decisions, adopt suitable models and monitor projects outcomes.

Section Ibegins by providing the readers with an overview of the MSW sector in the state.In Section II, III & IV, various aspects related to project identification, project procurement and project monitoring have been discussed, respectively.



I.2 Institutional Framework

Roles

Exhibit 1 below presents the roles of the central, state and local governments when it comes to the management of MSW. Exhibit 2 maps the role of various institutional bodies in the management of MSW in Tamil Nadu.

Exhibit 1: Roles of Central, State and Local Government in MSWM in Tamil Nadu

Government	Role
Centre	▪ Through the formulation of MSW (Management & Handling) Rules 2000 and the Modal Municipal Law and National Municipal Accounting Manual, the centre has set in place a set of directives to guide the delivery of MSWM services in India ▪ The Ministry of Urban Development, through JNNURM, provides financial support for MSWM projects, based upon the state/local government's ability to undertake specific reforms like property tax reforms, shift to double entry accounting system, etc.
State	▪ Municipal Administration and Water Supply (MAWS) Department is the apex body for water and sanitation in the state and plays an active role in state assisted projects and projects that cover more than one ULB ▪ The state is responsible for approval of transfer of land from state to ULBs (for all projects) and from ULBs to the private concessionaire (for PPP projects) ▪ The state government provides advisory support on technical matters relating to appropriate waste minimisation and disposal strategies ▪ It also regulates creation of staff position (technical, non-technical) in the ULBs
Urban Local Bodies	▪ ULBs plan, implement and operate MSWM projects ▪ ULBs decide the method of waste collection ▪ ULBs are free to decide the method of waste processing ▪ ULBs are responsible for identification of the land required for waste disposal and informing the same to the state



Exhibit 2: Role of Institutional Bodies in MSW Management in Tamil Nadu

INSTITUTIONAL BODIES	PL	F	TA	PI	LA	AP	A	IM	DC	M	PG
Tender Inviting Committee	○	○	○	○	○	○	●	○	○	○	○
TNIDB	●	○	○	●	○	●	○	○	○	●	○
Municipal Administration & Water Supply	●	○	○	●	●	○	●	○	○	○	○
Tamil Nadu PPP Cell	○	○	○	○	○	●	○	○	○	○	○
State Steering Committee*	○	○	○	●	○	●	○	○	○	○	○
Central Sanctioning & Monitoring Committee	○	○	○	○	○	●	○	○	○	○	○
State Level Nodal Agency* - TUFIDCO	○	○	○	○	○	●	○	○	○	○	○
TNUIFSL	○	●	●	○	○	○	○	○	○	●	○
CMA	○	●	○	○	○	○	○	○	○	●	○
MOUD*	●	●	○	○	○	●	○	○	○	○	○
Dept. of Environment / TNPCB	○	○	○	○	○	○	○	○	○	●	○

● Role

PL: Planning; F: Finance; TA: Transaction Advisory; PI: Project Identification; LA: Land Acquisition; AP: Approval; A: Award; IM: Implementation; DC: Design & Construction; M: Monitoring; PG: Post Award Governance;



Role of ULB in MSWM Project Cycle

In this section, the list of activities conventionally performed by ULBs at every stage of the MSWM project value chain, i.e., project identification, project approval, financial arrangement, project procurement, project monitoring and post award governance is presented. In essence, the primary responsibility of delivering efficient and sustainable management of solid waste rests with the ULBs. The state government assists ULBs whenever approached onmatters pertaining to finance, technical and policy support. Exhibit 3 below presents the various steps involved in conceptualizing, implementing and managing a solid waste management project in the state.

Exhibit 3: MSWM Project Cycle

Identification

- Identify the project need and features
- Submit project proposals to Commissionerate of Municipal Administration (CMA) (if identified as a weak ULB by the state government
- Identify land for sanitary or scientific disposal of inert municipal waste

1

Approval

- Obtain approval of municipal council for the project
- Obtain permission from village panchayat/state government for transfer of land (if land is to be acquired)
- Obtain statutory clearance from relevant authorities such as CMA, TNPCB, etc.

2

Financial Arrangement

- Assess required capital investment
- Assess required operational expenditure over the project life
- Assess available financing sources
- Identify accessible financial resources from various sources

3

Procurement

- Prepare tender documents
- Form committee if tender value > 5-10% of department estimates (internal)
- Form tender inviting committee with members as per Tamil Nadu Engineering Manual

4

Monitoring

- Establish Project Monitoring Unit (PMU) and form Project Monitoring Committee (PMC)
- Formulate and submit compliance reports on projects to TNPCB
- Formulate and submit reports on the project to TUFIDCO and TNUIFSL for central/state/external assisted projects, respectively

5

Post-award Governance

- Set up dispute redressal system
- Re-visit risk-mitigation measures
- Pass resolutions in the corporation/municipal council to settle project related issues

6



I.3 Key Challenges in MSWM in Tamil Nadu

In a socially sensitive sector like municipal solid waste management, there is a need for undertaking a series of public consultations for various aspects of MSWM planning

- Lack of adequate emphasis on planning and lack of technical & managerial capacity at all levels within the ULB have led to the deterioration of the quality of delivery of MSWM services
- Lack of reliable data on the quantity and quality of waste generated results in the emergence of severe issues during the operational stage
- Inadequate supporting infrastructure for efficient management of municipal solid waste is another key concern. The shortfall in infrastructure is observed in all the three segments of MSW value chain namely – collection & transportation (both primary & secondary), processing, and disposal of waste
- Lack of standard norms for undertaking public consultations to incorporate the needs of citizens
    - These consultations should focus on overall project features including aspects like convenient collection method, collection time& frequency, design of waste bin (for community bin), etc.
    - The outputs of the consultative meetings need to be absorbed into the project identification process to decide the key project features

On several occasions, IEC campaigns have not been productive due to lack of supporting infrastructure to handle segregated waste



- Inadequate emphasis on spreading awareness on the merits of practicing source segregation of municipal waste
    - Inculcating good MSWM practices, e.g., segregation of waste into biodegradable and non-biodegradable waste at source among the citizens requires intensive efforts for longer time periods
    - It is important that Information, Education and Communication (IEC) campaigns are initiated in the early stages of the project cycle

Availability of sound monitoring systems ensures continuity of service delivery at set standards and adoption of preventive measures in time

- Lack of adequate monitoring frameworks is another issue faced by the municipal authorities
    - The information gathered through monitoring systems will help the ULBs to have an understanding of the issues at every stage of service delivery
    - In addition, monitoring frameworks are vital for identification of issues at the micro level and could assist in the application of customised solutions for specific issues



I.4 Key Initiatives In MSWM In Tamil Nadu









Several initiatives have been taken by the government to improve the management of MSW in the state. Some of these are listed below:

- Drafting of an integrated solid waste management policy
  - The policy is expected to focus on promoting source segregation of waste into degradable and non-degradable components
  - Recycling of waste articles and appropriate technology for generating energy from wasteis also expected to feature in the proposed policy
- Steps to expedite public private partnerships
  - A PPP Cell has been constituted in the Department of Finance
  - The government has enacted the Tamil Nadu Transparency in Tenders (Public Private Partnerships Procurement) Rules, 2012 to standardise procurement of urban projects including SWM projects through PPP
- Availability of adequate funds to ULBs for MSWM has been ensured. These include funds from the Tamil Nadu Urban Development Fund, Integrated Urban Development Mission, Infrastructure Gap Filling Fund, O&M Gap Filling Fund and the Chennai Mega City Development Mission, among others
  - During the year 2012-13, INR 750 crore and INR 500 crore were allocated to Integrated Urban Development Mission and Chennai Metropolitan City Development Mission, respectively out of which INR 124.54 crore was for MSWM projects under IUDM
  - The amount of devolution to municipalities increased to INR 1,987 during the same time period
  - The Chennai Metropolitan Development Authority (CMDA) under its 'Local Bodies Assistance Project' provides up to 90% of the project cost as grants to ULBs for improvement of infrastructural facilities for MSWM
  - The government has also launched a Community Based Environmental Development Project for all ULBs tofund environment friendly MSWM initiatives. Under the scheme,CMDA funds 80% of the project cost whereas the ULB and local community share 10% each
  - In order to provide equitable services to all sections of the society, a minimum of 25% of municipal finance is earmarked to provide basic services to the urban poor including MSWM services







There is a need to adequately indigenize the technology to suit local conditions.

The state is promoting technological innovation for utilising plastic waste along with bitumen for laying roads.

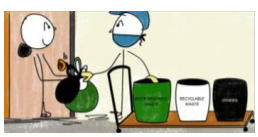
Tamil Nadu has the potential to add around 1,000 MW of capacity through recovery of energy from municipal waste. At present, the state has 4.5 MW of installed capacity generated from such sources.

- The government has laid greater emphasis on building the capacity of the ULBs. The issue of inadequate capacity is being addressed by:
  - Filling vacant positions
  - Imparting training to ULB functionaries. Training is being imparted at basic, intermediate as well advanced levels by premier institutes like Administrative Staff College of India (ASCI), Engineering Staff College of India (ESCI), CIDC, and Yashwantrao Chavan Academy of Development Administration (YASHADA), among others
  - Arranging national and international exposure visits for ULB representativesto provide them with a better understanding of the best practices in MSWM
- Other reformatory steps taken include:
  - Introduction of double entry system (accrual based accounting system) in all ULBs
  - Property tax coverage by all ULBs
  - Updation of the Municipal Accounting Manual, Municipal Budget Manual and preparation of Outcome Budget for the ULBs
  - Updation of the Engineering Manual for ULBs to suit contemporary realities
- Adoption of appropriate technological solutions for minimisation of waste streams that reach landfill sites
  - Composting, recycling and waste-to-energy technologies feature in several projects that have been undertaken by the urban local bodies
  - The MSWM project that is currently under implementation by the Coimbatore City Municipal Corporation has identified windrow composting as the processing method for the city waste
  - The Integrated MSWM project being implemented jointly by Alandur, Pallavaram and Tambaram Municipalities has also adopted aerobic windrow composting method for converting organic waste into manure
  - CMDA has installed a 250 KW vegetable waste based power plant at Koyambedu wholesale vegetable market in Chenna.[iiii]
  - Another biogas based waste-to-energy plant has been set up in Arcot while the Coimbatore City Municipal Corporation has recently received approval from its municipal council to set up a waste-to-energy plant to handle the additional waste in the wake of its merger with three municipalities, seven town panchayats and one village panchayat



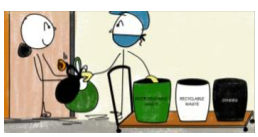
- The government has sanctioned INR 80 lakhs for setting up plastic waste collection centres equipped with shredding machines of required capacities along with facilities for handling and packaging of shredded plastics in ten ULBs.The programme has engaged Self Help Groups (SHGs) in collection, segregation and transportation of plastic waste. Around 186.80 km of road has been re-laid using plastic waste at a cost of INR 13.89 crore during 2011-12.

Box 1: Waste-to-Energy Plant in Arcot	
Arcot Municipality	Arcot Town extends over an area of 7.49 sq. km. and has a population of 49,953 as per 2001 census. The town has a Grade I municipality with a Public Health department that is entrusted with delivery of solid waste management services. The town generates 38 MT of waste per day. The number of wards in the town is 30.
Arcot Municipality has set up a waste-to-energy pilot project at a cost of INR 45 lakhs of which INR 21.90 lakh was provided by the District Rural Development Agency and the remaining INR 23.10 lakh was contributed by commercial establishments, residents and others. The mini biogas plant built on a land measuring 6,970 m^2 will generate between 265 to 285 units of electricity per day. In addition, the plant will produce 100 kg/day of rich manure from the slurry that will be sold at INR 5/kg in the market. The electricity generated from the plant will be used to power street lights in 3-4 wards of the municipality. The city generates around 25 MTD of which the 3 tonne organic component will feed as input to the plant.	**Project cost and features**
Expected savings	The project is the first of its kind in Tamil Nadu. It has been estimated that the project would translate into an annual savings of INR 5.24 lakh to the municipality through electricity generation.





This section highlights the need for undertaking comprehensive studies to gauge the magnitude and quality of waste. It discusses different methods for collection and processing of waste and suggests creation of scientific landfill facilities only for disposal of inert waste. It lists steps and discusses methods for involving community in the project process. It highlights the key features of different operational models and proposes a framework for co-existence of centralised and decentralised waste management systems.



II.1 Understanding Waste

Treat Waste as a Resource

Waste is a resource if it is used in a productive way. Existing and emerging technologies along with holistic waste management programs can help in conversion of waste into valuable end products. In addition to contributing to a clean and hygienic city, it can generate revenue for ULBs and make MSWM operations sustainable in the long run.

Need for Integrated Management of Municipal Solid Waste

The practice of collecting waste in a mixed form, its transportation in open vehicles and open dumping of waste is contrary to the MSW (Management & Handling) Rules 2000 and adversely impacts health and the environment. These impacts can be reduced by instilling holistic waste management practices that integrate various aspects related to MSW management.

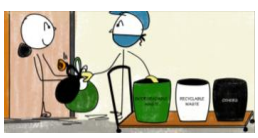
II.2 Characterisation of Waste Generation: Methods

Waste Characterisation

In order to manage waste in a holistic manner, it is important to understand the composition of waste. It is equally crucial to assess the quantity and characteristics of waste that is generated in a designated locality. This will help to assess the resource requirement for its management and assist in the identification of an appropriate method for harnessing value from different kinds of waste.

Appropriate Method

Various approaches can be used by municipal authorities to estimate the magnitude of waste generation. Each one of them has its own set of advantages and disadvantages. Hence, a ULB should assess each approach to identify the most appropriate methodology that meets its requirement in terms of time, cost and other resources. Some of the methods commonly used to assess the characteristics of waste are discussed below.



Method 1: Desk Based Study

This approach has two variants.

a Materials Flow

The ***materials flow technique*** is relatively complex and therefore its usage has been limited. It requires macro level data on different kinds of materials, for instance, paper, plastic, metals, glass, etc. that go into the production process. Thereafter, based on certain assumptions regarding the proportion of materials that would end up as residues, expected life of the product, etc., the overall quantity of waste is estimated.

b Modelling

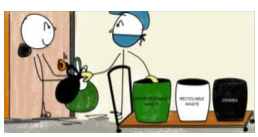
The***modelling technique*** requires ULB level data on certain important parameters such as the population (number of households, institutions, commercial and industrial establishments, etc.), per capita waste generation, per capita income, etc.

Advantages

- ✓ It is cost effective
- ✓ It consumes relatively less time compared to census or sampling methods
- ✓ It can be carried out based on available past and current data

Disadvantages

- × Output depends upon the skill level of the professional team undertaking the study for waste characterisation
- × It is not possible to get information on qualitative aspects of waste e.g., waste quality, moisture content, carbon-nitrogen ratio, etc.



Method 2: Site Based Study

Another way to estimate waste quantity is by undertaking ***site specific studies***. Site specific study requires undertaking a census or a sampling exercise involving collection, weighing and characterisation of waste generation in the project area.

a Census

The census involves carrying out the exercise for the entire project area for a specified time period and drawing inferences based on the collected data. This method is time consuming and costly but can be designed to generate accurate information.

b Sampling

The sampling exercise could be undertaken in several ways — *block, grid or quartering*. Each one of them have their own set of advantages and disadvantages. A ULB needs to identify the appropriate method that meets its requirement given the availability of time and resources. The process involved in each of these techniques is described below.

Block





It can be used when it is difficult to mix a group of sample waste due to presence of large waste articles like carpets, wood logs, etc and/or non availability of waste handling equipments.The sampling team therefore chooses a particular waste heap for analysis that is finds to be a fairly representative sample. This approach should be chosen only if the sampling team is well experienced and possesses the necessary technical and analytical skills to define and standardise a representative sample.[iv] The steps are as follows:

1. Choose representative secondary transportation vehicles through random sampling method
2. Take the sample vehicles to a clear area or carry this exercise at the dump yard or landfill site
3. Dump the waste from the sample vehicles separately in a clear area
4. Subsequently choose a waste heap that the sampling team deems to be representative of the overall waste and carry out characterisation

Grid

While the quartering and block approach assist in waste characterisation at the landfill or dumping ground, the ***grid technique*** can be applied even at the floor of a transfer station. The Grid technique isused extensively in Canada.



The steps are as follows:

1	Divide the floor of the transfer station into squares of equal sizes
2	Assign each square with an alpha numerical code for identification
3	Unload the waste onto the squares and mix approximately equal quantity of waste from each square
4	Finally, analyse the samples for a set number of grid squares and compare its weight and composition with that of the weight or volume of the entire load

Quartering

Quartering is another technique that is used to assess the quantity and quality of waste. The steps involved in this method are as follows:

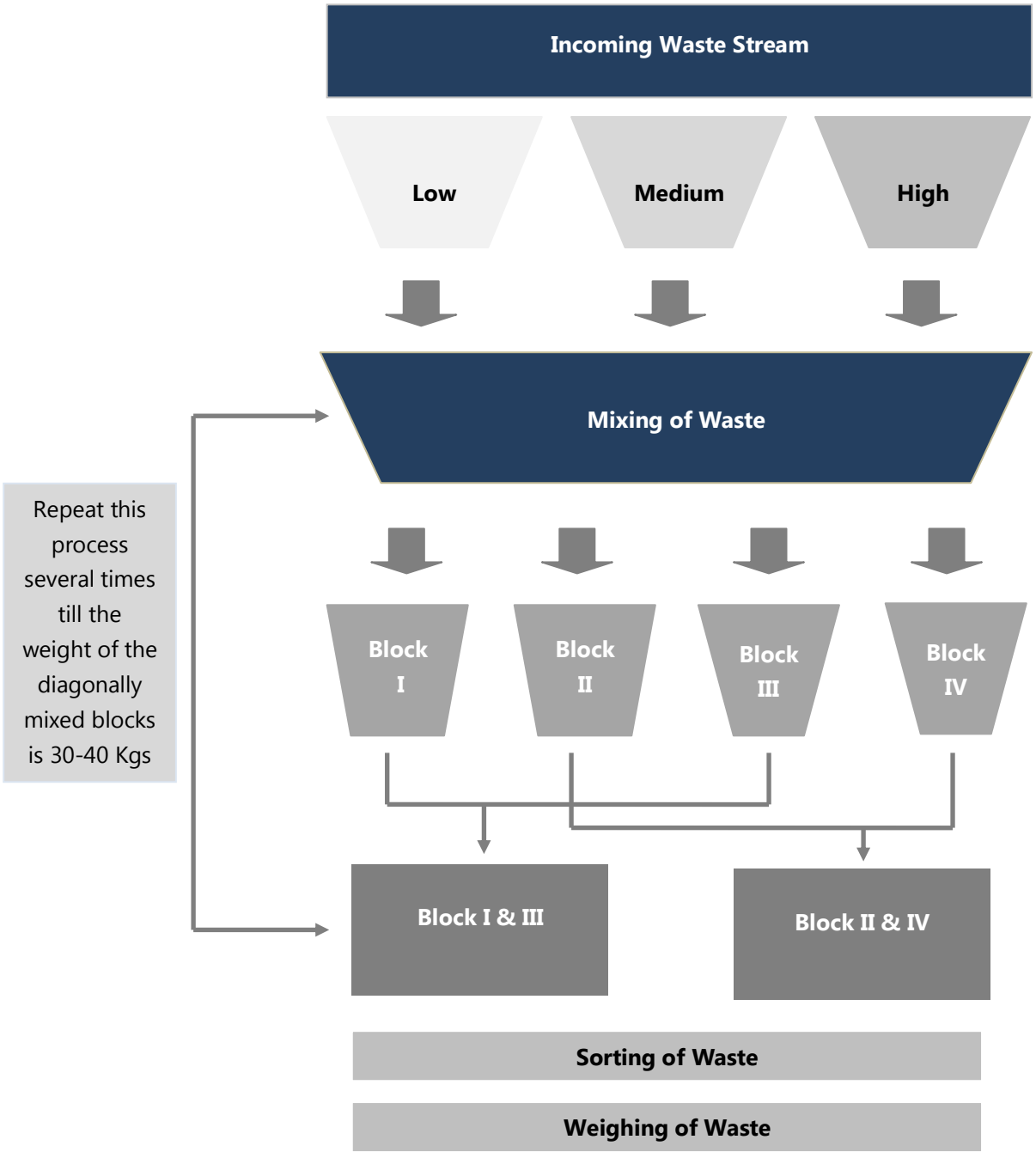
1	Classify zones/divisions/wards of the urban area into low, medium and high income groups
2	Select vehicles (that bring waste to landfills) through random sampling from each type (vehicles bringing waste from low, medium and high income groups)
3	Mark vehicles collecting and transporting waste from low, medium and high income areas to the landfill sites with distinct signs
4	Mix the waste thoroughly at one location (cut the waste if required)
5	Segregate waste into 4 blocks (Block I, Block II, Block III and Block IV)
6	Mix the diagonal blocks (E.g., mix Block I with Block III and Block II with Block IV)
7	Sort the waste into different categories and weigh each category

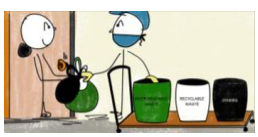


Due to seasonal variations in the waste volume, this exercise should be repeated for several days to get consistent results. Also, the final quantity should be adjusted for the quantity of recyclables collected and sold by the informal waste pickers. Exhibit 4 graphically represents the quartering process.

Eluru Municipal Corporation (EMC) in Andhra Pradesh has used the quartering technique to estimate the quantum of waste generated in the area. Box 2 presents a brief case on the outcomes of the study carried out by EMC.

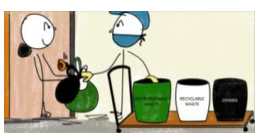
Exhibit 4: Quartering Technique for Waste Characterisation





Box 2: Application of Quartering Technique in Eluru Municipal Corporation	
Eluru Municipal Corporation	**Eluru** is a Class IC City of Andhra Pradesh with a population of 250,693 people as per the provisional estimates of 2011 Census. Eluru Municipal Corporation (EMC) is a part of the larger Eluru Metropolitan Region.
The EMC used the quartering technique to estimate the total quantity and composition of waste generated in the area. **EMC** has 50 divisions. These divisions vary in terms of the socio-economic profile of the households. EMC was exploring the possibility of generating energy from the city waste. This required information on the waste composition, calorific value, moisture content, etc. of the municipal waste. EMC used the quartering technique to get information on these aspects. The study not only helped the ULB understand the quantitative and qualitative aspects of waste but also highlighted the discrepancy between the actual volume of waste generated and the waste estimated using standardised per capita waste generation estimates.	**What Was Done?**
The Outcomes	▪ The study found that the per capita waste generated ranged between 0.14 kg/day (Division 23) to 0.09 kg/day (Division 50) ▪ Also the average calorific value was found to be 1027.75 Kcal/kg which is lower than the desirable range of 1200 Kcal/kg prescribed by the Central Pollution Control Board for adoption of certain waste processing methods ▪ Given the quantity and quality of waste generated in Eluru, it was estimated that 3MW of power could be generated

Concerns in Site based Studies	Waste characterisation may pose several health and safety hazards to the personnel involved in the survey process due to pollution, exposure to waste during manual handling, accidents, infections and diseases, among others. However, the hazards and welfare loss can be mitigated by addressing all concerns well in advance and introducingappropriate risk mitigating mechanisms. Appropriate training, provision of protective equipments, e.g., hand gloves, helmets, masks, glasses, disinfectant wipes, high visibility jackets and health insurance and/or vaccination for certain diseases like hepatitis A, hepatitis B, tetanus and diphtheria will help offset the risks associated with this approach significantly.



II.3 Collection and Transportation of Waste: Methods

Collection of Waste

As per the statutory provisions pertaining to MSW in India, every ULB has to collect and store waste into three broad categories — bio-degradable, recyclables and other waste.

Methods

The MSW (Management & Handling) Rules 2000 lists several methods for collection of waste. They are:

- Community bin collection (central bin)
- House-to-house collection
- Block collection (collection at regular pre-informed schedules and alerts using the bells of the collection vehicle)

Community Bin

A community bin is a large bin provided by the municipal authority that is shared by a number of households in the area. A ULB should have a provision for separate community bins for biodegradable and non-biodegradable waste.

Block Collection

Under the block collection method, a collection vehicle visits a residential / commercial block as per a pre-informed schedule and alerts the citizens by ringing the bell of the collection vehicle, upon which waste is brought by the waste generators to the collection vehicle. The vehicle should contain separate compartments for collection of segregated waste. Some community bins are still placed to collect street and other waste that does not get collected by the block system.

Door-to-door Collection

In a door to door system, a person comes to the door step of every waste generating unit and collects waste. Provision should be made for collection of segregated waste. This method has the highest chance of promoting the practice of source segregation of waste as well as creating adequate awareness on the need for source segregation among people.

Advantages and Disadvantages

Each method has its own set of advantages and limitations. Hence, a ULB should carefully evaluate the three options and chose the one that best fits its requirement. Exhibit 5 evaluates the three waste collection methods on seven key parameters. Exhibit 6 explains the key parameters in detail.

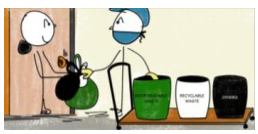


Exhibit 5: Methods of Waste Collection

Parameters	Door-to-door	Block	Community bin
Collection of Segregated Waste	Yes	Yes	No
Levy of Differential Tariff	Yes	Yes	No
Regulating/Penalising Offenders	High	High	Low
Staff Requirements	High	Medium	Low
Collection Timings	Fixed	Fixed	Flexible
Cost to ULB/Contractor	High	Medium	Low
Environmental & Health Risks	Low	Low	High

Favourable | Less Favourable | Not Favourable

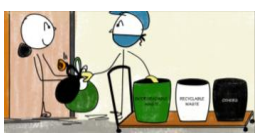
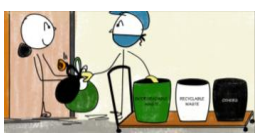


Exhibit 6: Key Parameters: Methods of Waste Collection

Parameter	Explanation
Collection of Segregated Waste	This parameter assesses each of the three collection methods on their ability to promote collection of segregated waste. In a community bin system, where only one single bin is kept for all kinds of waste, even segregated waste will eventually get mixed. Such a system discourages the practice of segregating waste at source.
Levy of Differential Tariff	The quantity of waste generated differs for different categories like residential, commercial, industrial, etc. With respect to residential waste, the waste quantity differs for residents across high, medium and low income groups. The cost of waste management is linked to the quantity and quality of waste that is generated. In order to promote equitable distribution of cost of MSWM service provision, a ULB may levy differential tariff for different categories of waste generators. However, under the community bin system, it is not possible to implement differential tariff rates. However, the block and the door-to-door collection systems allow implementation of such a tariff system.
Regulating/Penalising Offenders	ULBs have or may enact municipal bye-laws to regulate the practice of non-segregation of waste at source. The community bin system does not allow the ULB to identify the waste generators who do not segregate waste at source. However, since the block and door-to-door method of waste collection allow face to face interface between the waste generators and the collection staff, identification and penalising offenders is possible.
Staff Requirement	This refers to the number of staff required for collection of waste for a given number of waste generating units. The units could be households, commercial establishments, institutions, etc. The community bin system requires lesser number of staff for collection and transportation as the same staff may be engaged to collect waste from different localities at different points of time in a day. However, under the door to door collection and block collection method, the number of staff required is higher due to the longer time involved in the collection of waste.
Collection Timings	This refers to the schedule of waste collection. Under the community bin system, secondary collection of waste may be undertaken at any time convenient to the ULB. Therefore, the schedule of the waste collection staff may be flexible. However, the block and door-to-door collection methods entail certainty of collection timings and hence ULBs need to have a fixed schedule.
Cost to ULB/Contractor	This refers to the operational cost involved in the collection of waste. Staff and fuel cost (wherever non-manually driven vehicles are deployed) constitute the two major costs to ULBs. Due to relatively lesser number of staff deployed for collection of waste under the community bin system, the associated cost is also relatively lower than that incurred under block and door-to-door collection



	systems.
Environmental & Health Risks	This refers to the environmental and health risks posed by decomposition of waste. Biodegradable waste constitutes a sizable proportion of total municipal waste and if not collected, processed and disposed within a given time; it becomes a biologically unstable substance and may cause an adverse impact on human and environmental health. The community bin method of collection often collects mixed waste, which if not attended at regular intervals, may cause severe health and environmental risks. The block collection method significantly reduces the quantity of waste that gets collected in community bins and therefore poses relatively lesser risk to human and environmental health.

Colour Coding of Waste Storage Bins (As Per MSW Rules, 2000)	Biodegradable	Recyclables	Other Waste
	Green	White	Black

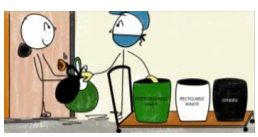
Transportation of Waste

The current system of waste management normally involves primary and secondary transportation of waste. Primary transportation implies transportation of waste from the point of generation to a transfer station. Secondary transportation of waste is the transportation of waste from the transfer stations to processing and/or disposal centres.

Key Considerations

ULBs spend a significant amount of their total waste management budget on primary and secondary transportation of waste.[v] The following points should be considered while planning for transportation of waste:

- Fuel and cost efficient methods of waste transportation should be employed factoring in continuous increase in fuel prices
- Use a combination of manually driven and fuel powered vehicles wherever found appropriate
- Fuel powered vehicles like trucks, hydraulic compactors, etc., should be used only for terrains unsuitable for manually driven vehicles, secondary transportation and for long distance transportation
- ULBs that have a common waste processing and/or disposal centre are required to practice primary as well as secondary transportation of waste due to vehicle, fleet and human resource constraints
- Processing of waste at the ward or zone level (decentralised approach) can result in substantial cost savings on collection &

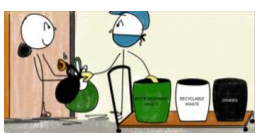




transportation activities as only refuse and inert waste would have to be transported to landfill sites

The decision to have primary and secondary transportation or a direct transportation system depends on the operational model of an MSWM project. Direct transportation system refers to transportation of waste directly to the processing and/or disposal site without the use of a transfer station. Some of the points to be considered in this regard are as follows:

- Only those ULBs that already have waste processing centres located at significant distances from each other should resort to primary as well as secondary transportation
- ULBs that are planning to establish waste processing infrastructure should first estimate cost involved in having both primary and secondary transportation system in place
- Decentralised waste management approaches allow ULBs to undertake only primary transportation of waste and limit secondary transportation to only refuse and inert waste components
- Irregular schedules for secondary transportation of waste result in piling of waste that causes odour, health, environmental and quality of life concerns around the transfer stations



II.4 Processing Alternatives

Processing of Waste



Processing of waste refers to subjecting the collected waste streams to further treatment. The processing technique that a ULB must adoptshould be a function of the charecteristics of waste generated. As per the MSW (Management & Handling) Rules 2000, the processing methodology should be chosen as per the following directives:

- Biodegradable waste should be subject to an appropriate biological processing method that can stabilise waste
- Mixed waste should be recycled
- Incineration with or without energy recovery including pelletization can be used only in specific cases. The MSW (M&H) Rules 2000 however do not specify the situations in which these methods could be adopted.

1	To reduce the *quantity* of waste reaching landfill
2	To minimize the *impact* of residual waste that is land filled
3	To offset the *cost* of provision of waste management service

Holistic Management of Waste

Holistic waste management is based on the principles of 6 'R' i.e. reduce, reuse, recycle, recover, return nutrients to soil and residual management. It is important to understand what each of these words mean in institutional and technical parlance. A ULB's SWM approach should be evaluated on the basis of their adherence to the 6 'R' principles.

Waste management should optimise the cost of managing municipal waste with our compromising on environmental and other aspects of safety; The principles of 6 R enshrined in the MSW Rules ensure that municipal waste is handled in a holistic manner.

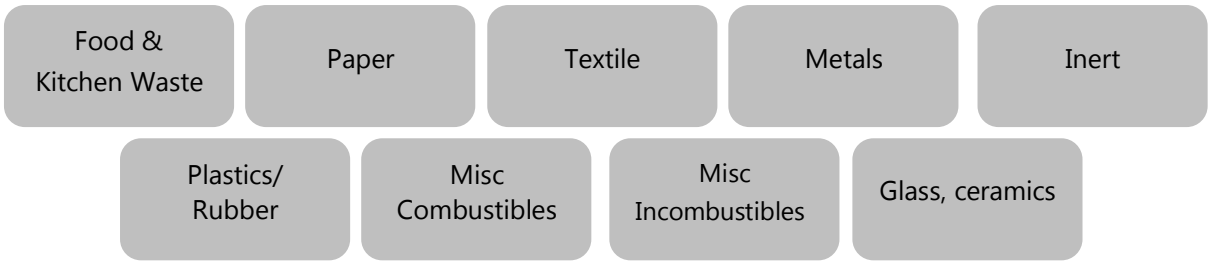


Exhibit 7: The Principles of 6 R in MSWM

Principle	Approach
Reduce	It refers to changes in production processes as well as products themselves that consume lesser resources.
Reuse	It refers to identification and retention of products for further and alternative usage. For example, plastic bags, glass bottles, clothes, metal cans, wood articles, etc.
Recycle	It refers to the process of transforming segregated solid wastes into raw materials for producing new products, which may or may not be similar to the original products.
Recover	It refers to the process of recovering energy in the form of biogas from organic waste, electricity through RDF and capture of methane from landfill sites. At the primary level, it refers to recovery of resources or materials like paper, plastic, metals, glasses by sorting or separation. At the secondary level, it refers to recovery of energy through biological, thermal or other environmentally safe processes. Collection of large quantities of gas generated at landfill sites is an example of energy recovery.
Return Nutrients to Soil	It refers to the process of enriching the soil through organic supplements.
Residual Management	It refers to the process of management of inert waste and refuse from waste processing facilities.

Competing Choices	In recent times, several new technological methods are being used for treatment of waste. At the same time, traditional methods like composting, bio-methanation, etc., have been sophisticated to address issues like high turnover time, foul odour, large space requirement, and high cost, among others. Municipal solid waste is classified into 9 broad categories (please refer to Exhibit 8) and there are a number of ways to segregate and treat each waste type, thereby minimising the amount of wastes that is transported to the landfill.

Exhibit 8: Key Components of MSW





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Waste Minimisation Techniques

In this section, some of the waste minimisation techniques are presented. Composting, biomethanation, etc. are appropriate methods to treat organic waste, i.e., food and kitchen waste. Composting can be done through several methods. The choice of the right composting technique such as aerobic composting, anaerobic composting, vermi-composting is function of several factors such as quantity & quality of waste generated, time and infrastructure required, among other factors. Some of the waste processing techniques are discussed below.

Aerobic Composting



It involves placing the organic waste into trapezoidal shaped parallel lines called windrows. Each windrow conventionally has a base of 4 to 5m and a height of around 2.5 to 3m. In order to accelerate the degradation of waste, microbial cultures like cow dung may be added along with timely turning of the windrows. This process requires around 6-7 weeks and windrows should be turned every 6th or 7th day from the initiation of the process.

Key infrastructure required: Concrete platform, front loaders, storehouse

Vermi Composting



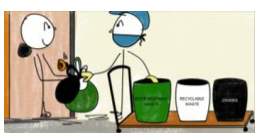
This process involves conversion of organic waste into manure through earthworms. It is a two stage process. In the first stage, organic waste is partially decomposed for 2-3 weeks through the aerobic composting method that involves formation of windrows. In the second stage, the partially decomposed waste is fed to earthworms that generate castings over a period of 4-6 weeks which is used as manure. This process can reduce the organic waste volume by 40-60%.[vi] Around 350 earthworms will be required for every m^3 of vermi-bed volume.[vii]

Key infrastructure required: Compost shed, Vermi-beds

Advantages of Composting



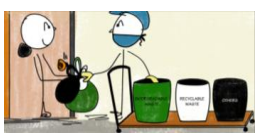
- Increases overall waste diversion from final disposal, especially due to the large component of compostable waste
- Enhances recycling and incineration operations by removing organic matter from the waste stream
- Produces a valuable soil amendment—integral to sustainable agriculture
- Flexible for implementation at different levels, from household efforts to large-scale centralised facilities
- Can be started with very little capital and operating costs
- Addresses significant health effects resulting from organic waste, such as reducing dengue fever, malaria
- Can integrate existing informal sectors involved in the collection, separation and recycling of wastes



There are hidden costs, benefits and savings from composting. Therefore composting should not be evaluated solely by the sale of finished compost. The traditional cost accounting approach used by municipal authorities has resulted in the closure of several compost operations established in the past.[viii] Exhibit 9 provies a list of dos and don'ts of composting.

Exhibit 9: Dos and Don'ts of Composting

To Do	To Not Do
✓ All stakeholders should be educated about the benefits of composting ✓ Composting should be integrated within the existing MSW management system ✓ Compostable waste should be separated from other wastes at source ✓ Detailed market research on the utility and linkages for the end products from composting must be undertaken ✓ Lessons must be drawn from existing and past composting projects ✓ Composting projects should be initiated with labour intensive technology in the early stages ✓ Community based and non-governmental organisations must be involved by providing incentives that encourage implementation and operation of composting projects ✓ Initiative to promote ward/zone level decentralised composting projects should be undertaken and public consultation must be held to assess public needs and their willingness to participate ✓ TNPCB guidelines must be followed for establishing compost quality standards	× Do not compost mixed municipal solid waste × Do not establish large-scale composting facilities at the beginning × Do not rely on highly mechanised composting processes in the initial stages × Do not assume that the compost will have an immediate use as there is currently low level of awareness about the benefits of using compost as manure × Do not choose technology which is unreliable and not replicable × Do not fund composting projects without putting in place adequate performance monitoring, and implementation mechanisms in place as compost made of mixed waste may contain heavy metal contamination that may result in soil contamination × Do not assess composting success solely on the basis of direct financial benefits as composting has indirect environmental benefits that are not factored into in the current municipal accounting system × Do not rely on enzymes or "special" inoculates to enhance the process. Inoculation requires expertise and inappropriate method of inoculation may not produce high quality compost



Bio-methanation



It involves decomposition of organic matter by microbial action to produce methane rich biogas. It is an anaerobic process that results in production of biogas containing mixture of methane and carbon dioxide approximately in the ratio of 60:40. The process also generates an enriched sludge fertilizer with an energy content of 22.5 MJ/m^3. The advantage of this process over composting is that it results in a net energy gain by production of methane as well as manure.

Key infrastructure required: Biogas plant, shredder unit, slurry preparation cum feeding plant, scum breaking pump, digester unit, biogas balloons, and valve & gas meters.

Mechanical Biological Treatment

Waste C&T

Waste Preparation

Waste Separation

Biological Treatment

Sale of Products

Landfill of Refuse

Mechanical biological treatment (MBT) is an integration of mechanical and biological treatment processes involved in other waste management technologies such as sorting & composting, anaerobic digestion, and material recovery among others. MBT is not an alternative for recycling and composting, instead it compliments such activities. MBT involves the following:

- Pre-treatment of waste going to landfill
- Mechanical sorting of MSW into materials for recycling and/or energy recovery
- Stabilisation into a compost like output (CLO) for use on land
- Conversion into combustible biogas for energy recovery
- Dehydrating materials to produce high calorific and organic rich substance for use as RDF

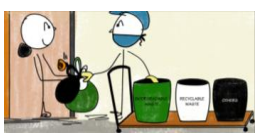
Waste Preparation



Waste preparation is the first step after waste is collected and transported for any further treatment or processing. It involves removal of objects like concrete, carpets or any bulky wastes that may obstruct the functioning of processing equipment in the later stages.

Mechanical equipments can be used to shred and homogenise waste into smaller sizes to suit subsequent waste separation and biological treatment process.

Some of the waste preparation techniques that may be employed include hammer mill, shredder, rotating drum and wet rotating drum with knives.



Waste Separation



This process helps to separate materials that are suitable for different end uses and include material recycling, biological treatment, energy recovery through production of RDF and landfill. Sorting of waste should be done before the biological treatment of waste. If unsorted waste is used to produce CLO, it will be of lower quality and will have large amounts of physical contaminants. Some of the waste separation techniques that could be employed are manual separation, magnetic separation, wet separation technology, air classification and optical separation, among others. It requires application of material specific (manual) sorting techniques if waste needs to be recycled into high-value products.

Biological Treatment

Aerobic bio-drying technology can be applied for partially composting whole waste without separation. Aerobic in-vessel composting and anaerobic digestion can be applied only for segregated organic waste.

Products

Compost like output	Biogas	RDF

Land Requirement & Cost

Plant Size (tonnes per annum)	Total land requirement	Building area
50,000	-	3,000 m^2
75,000	15,000m^2	5,500 m^2
1,40,000	--	9,000 m^2
1,80,000	35,000 m^2	-

Source: Mechanical Biological Treatment of Municipal Solid Waste, Dept. of Food

Cost*

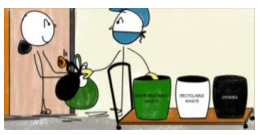
Process →	Aerobic		Anaerobic	
Plant size (tonnes per annum)	CapEx (£)	OpEx (£)	CapEx (£)	OpEx (£)
<50,000	70-150	Up to 140	160-420	<23
> 50,000	28-225	20-69	107-278	16-69

Source: Mechanical Biological Treatment of Municipal Solid Waste, Dept. of Food Environment and Rural Affairs, Government of UK (2007)

*These costs are predominantly based on European examples. Costs in India will vary subject to labour cost, technology transfer, and other requirements.

Pyrolysis

Pyrolysis is the process by which organic (carbon containing) compounds are heated in the absence of oxygen and broken down into basic components. Typically, temperatures of 300° C to 850° C are used during pyrolysis of municipal waste. In the case of municipal solid waste pyrolysis, organic compounds refer to ordinary garbage which is converted into liquid fuel, gas and carbon.[ix]



Advantages	▪ It is safer and more environment friendly than incineration and land filling and many other gasification processes ▪ It can convert municipal waste into valuable new products like oil, carbon and gas ▪ It allows for the recovery of metals and glass either before or after the process ▪ It is suitable for application on mixed (heterogeneous) waste ▪ It complements traditional recycling efforts
Concerns	▪ Ranks below recycling in the waste management hierarchy ▪ Not suitable if proportion of wet waste in overall waste is high ▪ Not suitable for Indian conditions where the proportion of combustible items like paper and plastic are put to the recycling stream ▪ Combustion produces harmful gases that require strict environmental monitoring ▪ It generally entails usage of complex technology that is still classified as 'emerging technology. Its efficacy and applicability is not yet rigorously proven ▪ Large capital and operational expenditure required

Incineration

Incineration does not mean open burning. Incineration is a process of controlled combustion of waste (often unprepared and mixed) at extremely high temperature in excess of 850^{o} Celsius that leaves carbon dioxide, waste and non-combustible articles like metal, glass and concrete.[x] Incineration should be used only if a particular waste cannot be put through other processing methods. It can result in serious health and environmental impact in the absence of strict environmental norms and monitoring. The key concerns with this technology are similar to those of pyrolysis as described above.

Appropriate Waste Minimisation Strategy

As seen above, different waste components can be put to alternative processing methods. However, a mismatch between characteristics of different waste articles and the processing techniques could be environmentally unsustainable. Exhibit 10 provides appropriate waste minimisation methods for the broad categories of waste articles.



Exhibit 10: Appropriate Waste Minimisation Strategy

Waste component	Appropriate Minimisation Strategy		
Food & Kitchen	Composting	Bio-methanation	Pelletization
Plastic	Recycle	RDF	Incineration
Paper	Recycle	Biogas	Composting
Metal	Recycle	Landfill	...
Glass	Recycle	Landfill	...
Other Waste	Incineration	Landfill	...

Processing Methods: Merits & Demerits

The Municipal Solid Waste Management Rules 2000 prescribes composting as the method fortreatment of organic waste. Other technologies like incineration and pelletisation are also recommended, *only* in specific cases. Municipal authorities or operators that seek to employ state-of-the-art technologies like pyrolysis, plasma gasification, etc., will have to obtain standards specified by CPCB before applying for authorisation.

There has been a significant increase in the number of MSW treatment technologies in recent times. This has been primarily due to the rising need to reduce the quantity of waste reaching the landfills, proper management of odour arising from the processing/ treatment plants and landfills, ban on manual handling of waste and ever increasing demand for energy, among others. However, each of the alternatives has its own set of advantages and disadvantages that need careful examination before the selection of any particular method.

Exhibit 11 provides an assessment of composting, inceneration and waste-to-energy methods on select parameters. Exhibit 12 provides some of the end products that could be made from different waste articles and their associated market linkages. Exhibit 13 lists some strategies that could be adopted to imbibe the principle of 6 R in the waste management system.

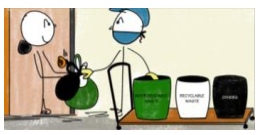


Exhibit 11: Assessment of Processing Methods

Parameters	Composting	Incineration	Waste-to-energy
Allowed by MSW Rules 2000	Yes	Yes#	Yes
Environmental &Health Risks	Low*	High	High
Market Linkages	Medium	Medium	High
Technical Skills Requirements	Low	Medium	High
Land Requirement	High	Low	Low
Critical Mass Requirements	No	Yes	Yes
Labour Intensity	High	Low	Low
Calorific Value Requirements	No	Yes	Yes
Economic Viability	Medium	Low	High

Favourable | Less favourable | Not favourable

Permitted only under certain conditions (the conditions are not defined in the rules); *If compost is made of mixed waste the end product may contain heavy metals and hence affect soil quality.

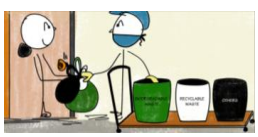


Exhibit 12: End Products from Waste and Possible Market Linkages

	Waste Article	End Product	Market Linkage
Outputs and Market Linkages	Food & Kitchen Waste	Compost/fertilizer Organic soil additive Crop substrate (to improve soil quality) RDF Substance for land remediation	▪ Compost can be sold to a) Forest department b) Horticultural department c) Private nurseries d) Apartment complexes for garden use e) ULBs for gardens, parks, remediation of waste land ▪ RDF can be sold to industries e.g., paper mills that can use it as fuel
	Paper	Raw material for various purposes ▪ Recycled paper ▪ Paperboard ▪ Moulded packaging ▪ RDF	▪ Recycled paper can be sold to a) Paper mills b) Packaging units ▪ RDF made from waste paper can be sold to a)Paper mills b) Other industries with boilers and furnaces
	Glass/ceramics	Recycled glass/incinerated to make fly ash	▪ Public Works Departments ▪ State Road Departments
	Plastics/ Rubber	Recycled plastics Used as fuel RDF	▪ Cement industries ▪ Other industries with boilers and furnaces
	Construction & Demolition Debris and Inert Waste	▪ Crushed concrete ▪ Bricks ▪ Wood chips that can be used as fuel	▪ Public Works Departments ▪ State Road Departments

Exhibit 13:Strategy to Achieve 6R

Principle	Strategy
Reduce	▪ Educating the citizens about waste reduction ▪ Enforcing Extended Producers Responsibility[xi] ▪ Banning of select kinds of plastics
Reuse	▪ IEC campaigns targeting certain articles that can be reused
Recycle	▪ Opening recycling centres to collect plastic, metal, glass, paper articles from households and other establishments
Recover	▪ Composting of organic waste ▪ RDF ▪ Bio-methanation/Bio-gasification
Return Nutrients to Soil	▪ Production of soil substrate from compost
Residual Management	▪ Use of Compost Like Outputs (CLO) for soil remediation – reclamation of dump yards, marshlands



II.5 Landfill for Inert Waste



Even with adoption of appropriate waste minimisation technique, some quantity of waste like rejects from waste processing plants and inert waste are likely to be left behind. Such waste should be scientifically land filled. Research studies have found that not more than 6% of the total waste generated should reach the landfill sites. Exhibit 14 provides a basic method to estimate the landfill requirement based on the quantity of waste generated.

Method for Estimation of Landfill Requirement

(*Only For Inert Waste*)

Factors to be Considered While Estimating Landfill for Inert Waste

- Waste Generation Quantity (Current and Future)
- Waste Density (For Mixed Waste)
- Quantity of Inert, Pre and Post-Process Rejects Reaching Landfill
- Topography Details
- Possible Maximum Landfill Height
- Operational Life of the Landfill

Exhibit 14: Basic Method to Estimate Landfill for Inert Waste

Step 1

Total Waste Generation (TWG) =
[(Current + Future waste generation) × 1/2 × 365 × Estimated Life]

Step 2

Total Waste Volume (TWV) = TWG × Waste Density

Step 3

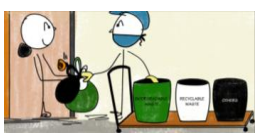
TWV × Volume of Daily Cover × Volume of Liner and Cover Systems

Step 4

Adjust value derived in Step 3 with estimated landfill height and inert that would reach landfill

CPHEEO Norms are as follows

Type	Waste quantity of rejects (TPD)	Area required (In hectares)
Landfill I	10	1.5
Landfill II	20	2.6
Landfill III	40	4.7
Landfill IV	75	8.2



Landfill Fire Management

Management of landfill fire poses a major challenge for ULB staff engaged in landfill operations. Fire in landfill sites are of two kinds; surface fire and sub-surface fire. Surface fires burn between the surface and one foot under the ground whereas sub-surface fire can smoulder up to 40 feet beneath the ground.[xii] Surface fires may occur due to disposal of undetected hot waste articles like smouldering coal/wood, due to excessive gas production, or due to presence of articles that can cause spontaneous combustion. Spontaneous combustion of certain types of waste is the prime reason for sub-surface fire.

How to Detect Sub-surface Fire?

- Substantial decline in the height of waste heaps in a short period of time
- Smoke or smouldering odour emanating from the gas extraction system or landfill
- Levels of CO in excess of 1000 parts per million (ppm)
- Combustion residue in extraction wells and/or headers
- Increase in gas temperature in the extraction system (above 140° Fahrenheit) or
- Temperatures in excess of 170° Fahrenheit

Suppression Methods

- ☐ Envelop the fire completely with soil
- ☐ Use heavy equipment and a suppressant agent

No one method will work for all conditions. Suppression plans will depend on site-specific conditions. At times, only an interim cap will prevent the extension of the fire, while other times, the use of heavy equipment and foam may be used

Interim Cap Recommendations

Until the subsurface fire is extinguished, geomembrane or Geosynthetic clay liner (GCL) should not be used to cover the landfill unit. The interim cap should be constructed from soil with the following properties:

- A clean, low permeability soil capable of obtaining a permeability of 1x10-5 cm/sec with a maximum particle size of three inches or less
- The soil should be classified as clayey sand (SC), silt (ML),clay (CL), or clay of high plasticity (CH) according to the unified soil classification system
- The soil should be compacted to a minimum of 89% of the maximum dry density as determined by American Society for Testing and Materials (ASTM) D-1557 or as stipulated by CPCB/TNPCB guidelines
- The cover should extend to a minimum of 10 feet beyond the landfill area if feasible



- The clay cover should be a minimum of 18 inches, but ideally a clay cover of 24 inches placed over a graded foundation layer is recommended
- Each lift of clay should not exceed 9 inches before compaction

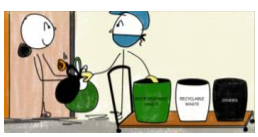
Once the fire is confirmed extinguished, other layers including geotextile, geomembrane, GCL, and/or vegetative could be installed.

Suppression Agents

There are many types of foam and wetting agents; however, it is best to use a Class A foam or wetting agent. These chemicals include a surfactant that reduces surface tension and improves penetration depth. Class B foams are ineffective because it is impossible to separate the oxygen from the fuel as it is done with flammable liquids. Class B foams are two dimensional products, while Class A and wetting agents work on three dimensional fires such as landfill and tire fires.

Water

Large quantities of water without a suppression agent should not be sprayed over the fire as it may actually acerbate the fire by increasing the amount of biodegraded matter and heat. The excess water will also increase contaminated runoff and leachate.



II. 6 Participatory Decision Making

Need

Stakeholder management at both pre and post-award of a project is critical for its successful implementation. In a socially sensitive sector like municipal solid waste management, the stakeholders are many with varied perceptions and interests in the way waste should be managed. Stakeholder expectations could be better managed if the decision making process must be representative of these varied interests and inclusive and participatory. The first step for the ULB in this regard is to identify all relevant stakeholders. Exhibit 15 displays broad categories of stakeholders in MSWM projects. The second step is to identify and list expectations of each stakeholder and group together stakeholders that have common expectations.

Exhibit 15: Key Stakeholders in MSW Management

Community	Private	Government
Informal Rag-Pickers	Service Provider	ULB/ULB Council
Resident Welfare Associations		SWM Staff
Representatives' of Bulk Waste Generators		State/Central Government
SHGs/NGOs/CBOs		
Project Affected Community		



This sub-section highlights the need for effective consultation with the ***community*** and the ways in which the consultation process should be carried out. Under the ambit of 'community' there are rag-pickers, residents, non-governmental organisations, community based organisations, among others. The MSWM approaches adopted must accommodate theinterest of these various groups. Some of the key expecations of the stakeholders during the pre and post-award of a project are presented in Exhibit 16.

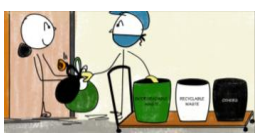
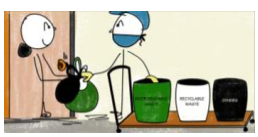


Exhibit 16: Stakeholder Expectations: Pre and Post-Project Award

	Community	Private	Government
Pre-Award Expectations	▪ Participatory decision making ▪ Project approval ▪ Willingness to pay ▪ Addressing concerns	▪ Robust procurement system – transparent and efficient ▪ Clarity in project scope ▪ Community support	▪ Robust procurement system – transparent and efficient ▪ Compliance with MSW Rules/State policy on MSW management ▪ Competitive procurement ▪ Value for money
Post-Award Expectations	▪ Efficient and timely service ▪ Complaint redressal ▪ Cleanliness and hygiene ▪ Relief and rehabilitation ▪ ULB support	▪ Flexible contractual governance ▪ Political support ▪ Timely payment ▪ Robust dispute redressal mechanism ▪ Community support	▪ Achievement of SLBs ▪ Robust dispute redressal mechanisms ▪ Stringent monitoring and reporting

Degrees of Community Involvement

There are varying degrees of community involvement which often depend on project design, willingness of the ULB to engage with community, degree of coordination between the ULB and the local citizens and capacity of the community to be a part of the project. Broadly, there are four different forms in which a ULB could seek participation of the community. At one end, it may involve information dissemination by the ULB, while at the other end, the implementing agency may execute the project hand in hand with the community.



Community–Led Models with Expert Opinions	A project initiated, approved, designed, managed and monitored by the community. The community may take relevant suggestions from the experts/local government wherever required and necessary.
Agency Initiated, with Community Participation	A project initiated by the local government/implementing agency that is approved & designed jointly by the ULB and community with involvement of the latter in project execution. This form of community engagement is apt for SWM projects as there is huge potential for promotion of micro-entrepreneurial activities that includes informal rag-pickers in the SWM framework.
Informed &Consulted	In this engagement, the community is informed about the project and their inputs are taken. The project is implemented and managed by the government/private agency.
Informed	Community is only informed about the project features via local media and other public channels.

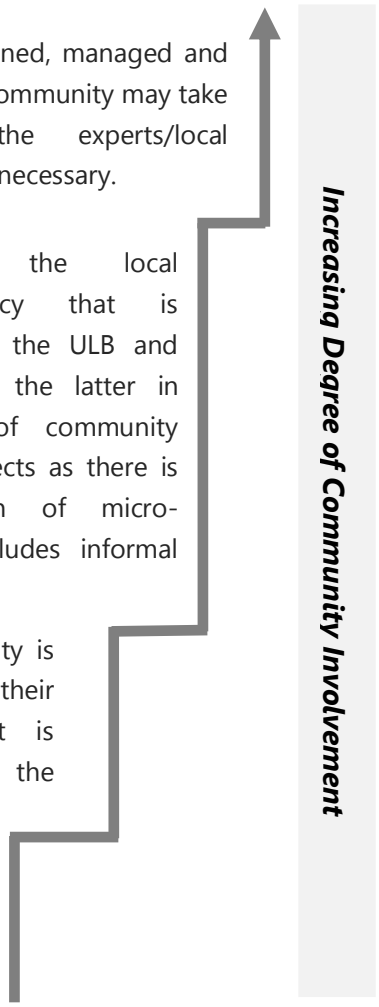


Exhibit 17 describes the flow of information between the community and the ULB. The simplest form of community engagement will involve the flow of information from community to the government agency, which is normally in the form of complaints or *suo moto* suggestions. At a slightly higher level, the implementing agency chooses to inform the local citizens about the project scope, objective, features and the intended outcomes. The most ideal form of engagement will involve a two-way interaction between parties or a two way flow of consultation.

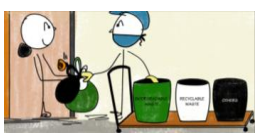
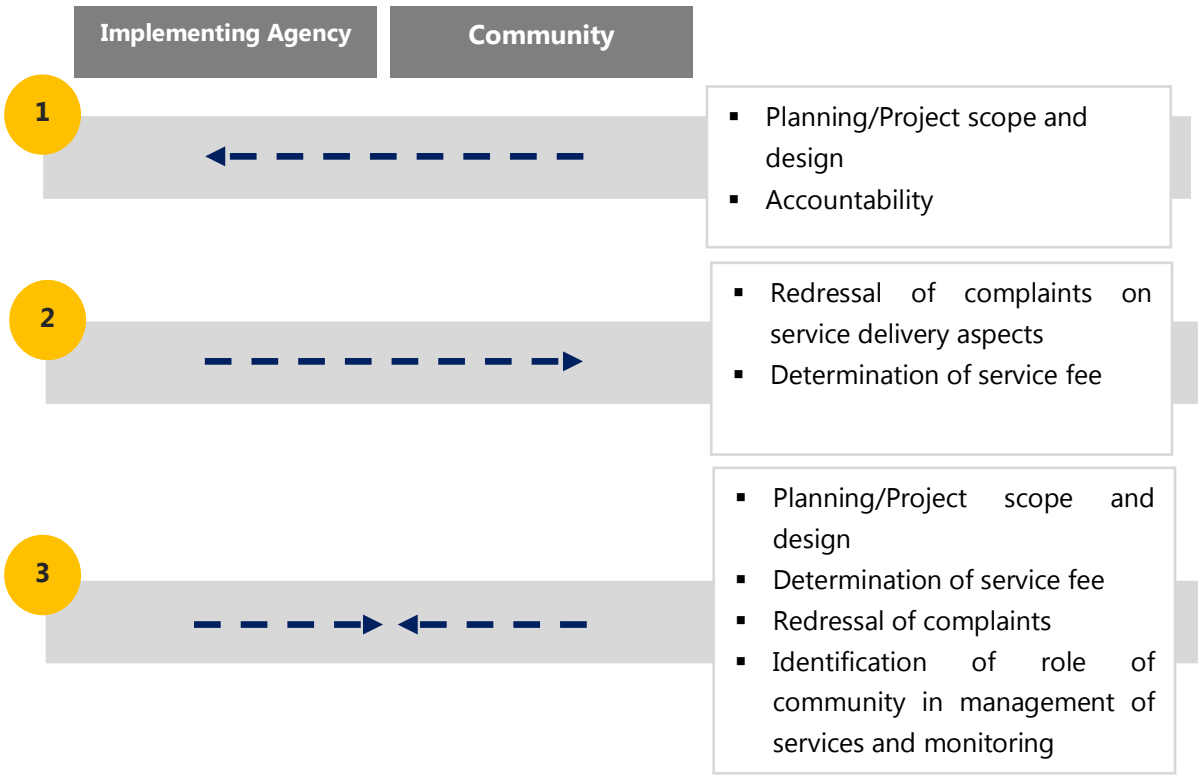


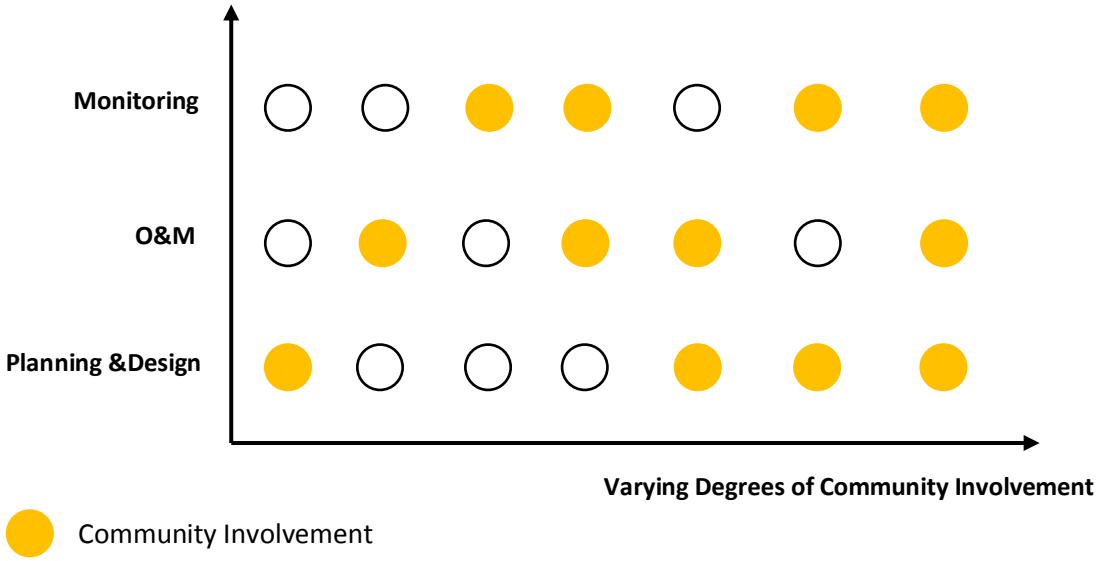
Exhibit 17: Flow of Information between Community and Implementing Agency

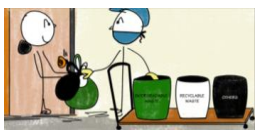


The role that the community can play at one or multiple stages of the project cycle is listed belowin Exhibit 18. The three key categories in the MSW value chain include:

1) Planning and design
2) Management of operations and services
3) Monitoring of projects

Exhibit 18: Community Involvement at Various Stages of Project Cycle



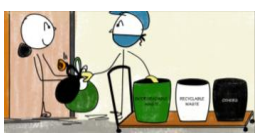


The following sub-section focuses on how to involve community for the three identified categories, namely planning, management of services, and monitoring. It also provides sample methodologies and tools that could be used for community mobilisation and capacity building.

Planning and Project Identification	Community may be involved in this phase for obtaining approval for select project features, establishing the need for the project by taking public opinions and for assessing the willingness to pay for basic and value added SWM services. The steps to be followed to facilitate participatory decision making are listed in Exhibit 19.

Exhibit 19: Steps to Facilitate Participatory Decision Making

Steps	Methodologies
Initiating the Process	▪ Obtain information on community expectations. This could involve: ✓ Communicating project details ✓ Getting community buy-in ✓ Gathering opinions on project design and implementation ✓ Understanding the needs of local citizens, including the urban poor through the use of process/ tools such as focused group discussions, use of local media, kiosks, street plays, etc. ▪ Design survey templates and questionnaires (as required) ▪ Design a work plan to carry out the participatory planning process ▪ Engage with a local NGO (if required)
Engage With the Community	▪ Mobilise people by communicating events planned for participatory process. This could be done via posters, radio announcements, requesting community leaders involved in the concerned sector (if any), etc. ▪ Hold consultative meetings, workshops and focussed group discussions with citizens, community leaders, and other stakeholders ▪ Disseminate information about the project. Create awareness about the need for the project, its features and expected outcomes

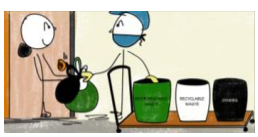


Take Inputs and Feedback from the Community	▪ Divide the area for project implementation into wards/ divisions ▪ Perform needs assessment in every ward ▪ Identify priorities, i.e., issues in current SWM services that demand highest attention for each ward ▪ Collect feedback on the relevance of the proposed project
Information Gathering	▪ Gather information from the meetings and Focus group discussions(FGD) ▪ Match the inputs collected from the people with the objectives that the proposed project seeks to achieve ▪ Re-design project as per needs assessment
Further Consultations & Final Decisions	▪ Discuss the re-structured projects with the local citizens to gather final inputs from them ▪ Create a vision for the community and address the objectives and strategies of the project from long and short term perspectives ▪ Present an action plan to the citizens on the same

Who should attend the meetings?

Exhibit 20: Criteria for Selection of Members for FGD

Criteria for Selection of Members of FGD
✓ Degree of engagement in MSWM activities
✓ Available expertise
✓ Networking abilities
✓ Capability and inclination to reach out to informal workers



Box 3 Modes for Public Outreach

Public outreach can be done through the following means:

- Special public meetings
- Interviews with local newspapers for feature stories
- Interviews with media editorial boards
- Interviews with broadcast media
- News conferences, press releases, and press kits
- Paid advertising
- Internet sites
- Informational literature
- Direct mail with project updates
- City council presentations
- Presentations to civic, environmental, religious, and professional groups
- Presentations to neighbourhood groups
- Community education programs and workshops
- Reading files located in public libraries or community centres that document the process

Beyond the community, outreach efforts may also be made to initiate discussions with key members of potential host communities, and identify community specific conditions that need to be considered.

Box 4: Participatory Decision Making Process for Urban Planning in Kitale, Kenya

The Need	Practical Action (UK and Eastern Africa) in partnership with the Municipal Council of Kitale undertook a project using the Sustainable Livelihoods approach and Participatory Urban Appraisal model.
The project activities sought to help poor women, men and children living in informal settlements identify their development priorities, and prepare spatial and settlement specific neighbourhood plans.	**What were the objectives?**
How was it done?	The participatory planning process involved the following stages: 1. ***Community mapping:*** Detailed listing of all community infrastructure facilities and services 2. ***Data verification and validation:*** The data collected and analysed from the first stage was communicated to the citizens for their further feedback. This was done via house-to-house survey and focus group discussions 3. ***Community vision and action plan:*** The discussions with community regarding the issues were transformed into a short term vision, which were further converted into strategies, programmes and activities 4. ***Evaluation*:** These programmes were discussed further with community leaders to get their inputs, create realistic frameworks, look for alternative options and design the work plan



Management of Services

Community may participate in managing the services whereas decentralised approach has been adopted for implementing the project. Community management in this context is expected to go beyond mere consultation and seeks to engage with the citizens to:

- Enhance quality of service delivery
- Promote greater inclusiveness and equity in the development process
- Promote a more prominent role for women in development
- Ensure adoption of appropriate choices of technology and service delivery standards
- Reduce the costs to agencies by making better use of local resources, skills and knowledge
- Build community confidence and capacity to undertake further development activities

Basic Components

Community management usually comprises of three basic components:

1) **Responsibility**: Community takes ownership of the assets created and is obliged to represent community interests and perform services[xiii]
2) **Authority**: The community is authorised to take decisions on behalf of the consumers
3) **Control**: Community evaluates outcomes and gathers opinions from the people

Based on the comparative advantage of the citizens to operate MSWM projects, areas for management need to be identified, training needs tobe provided and mechanism for monitoring their performance must be created. Exhibit 21 provides the steps and methodologies for involving community in the project process.

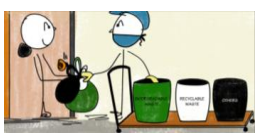


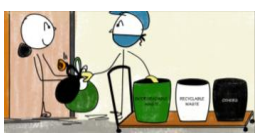
Exhibit 21: Steps for Community Involvement

Steps	Methodologies
Identification of Areas	▪ Identify community–based organisations that are willing and capable of managing MSW and hand over specific aspects of the project to them. Some of the areas where community involvement is required include: ✓ Representation of community interests and ensuring its incorporation in the project planning process ✓ Organise contributions by the community, in cash or kind, towards construction, and towards operations and maintenance, if any ✓ Project governance and monitoring ✓ Promote hygienic and effective use of the new facilities ✓ Hold regular committee meetings to discuss and decide on issues, procedures, and problems
Community Staff Planning	▪ Clearly state the roles and responsibilities of the community members at every phase of project implementation ▪ Identify the pre-requisites of the community staff to qualify for project management. For example, fluency in speaking, reading and writing the local language, twelfth standard pass, basic knowledge of computers
Assess Community Readiness for Contribution	▪ Conduct a quick survey to identify the list of households willing to contribute labour ▪ Create incentives to increase community participation, such as: ✓ Fixed weekly remuneration per person for doing certain work ✓ Households may be given a discount on user charges for contributing labour, if applicable ✓ Below Poverty Line (BPL) households may be levied subsidised user charges, if any
Provide Training & Allocate Roles	▪ Design manuals to equip citizens/communities with the required knowledge/tools to operate and maintain assets ▪ Conduct field visits/on-site training where community managed projects have been successful
Monitoring & Evaluation	▪ Create a list of indicators for evaluation of performance for all community managers under each role. For example: ✓ Attendance ✓ Regularity in reporting ✓ Number of households trained on waste segregation ✓ Improvement in tariff collection efficiency ▪ Design a framework for carrying out monitoring and evaluation activities



Box 5: How to Undertake Focus Group Discussions?

What is a Focus Group?	A focus group is a small group of six to ten people led through an open discussion by a skilled moderator. The group needs to be large enough to generate rich discussion but not so large that some participants are left out.
Nature of Group	Similar group of participants is required. It provides a level playing field to participants and reduces inhibitions.
Time Required	The ideal amount of time to set aside for a focus group discussion is anywhere between 45 to 90 minutes. Beyond that most groups are not productive and it becomes an imposition on participant time.
Number of Questions	Focus groups are structured around a set of carefully predetermined questions – usually no more than 10 – but the discussion is free-flowing. Ideally, participant comments will stimulate and influence the thinking and sharing of others.
Number of FGDs	Usually three to four! You'll know you've conducted enough groups (with the same set of questions) when you're not hearing anything new anymore.



Sample Questions



Focus group discussions require careful planning in terms of preparation and structuring of the questionnaire. An FGD should be initiated with engagement questions followed by exploratory questions and should end with exit questions. Some of the sample questions are provided in Exhibit 22 below:

Exhibit 22: How to conduct FGDs

Types of questions	Sample questions
Engagement Questions	How many members are there in your family? What do you feel about the state of waste management in your street/ward/zone? Is waste collected regularly in your street? How often is your street cleaned? What according to you is the biggest problem when it comes to the management of solid waste?
Exploration Questions	What kind of collection and transportation services will be convenient to you? What kind of value added services would you like from the municipality? Will you segregate your waste and participate in a decentralised waste management program in your ward? How do you dispose recyclable articles like plastics containers, computer parts, etc.?
Exit Questions	Is there anything else you would like to say about the overall management of waste in your area?
Limitations of FGD	✓ Low in depth ✓ Suffers from the degree of willingness of the participants to share their views on the subject ✓ May not be suitable for topics where people have strong or opposing opinions ✓ The views of participants could be influenced by other members of the group ✓ Risk of conforming to dominant ideas



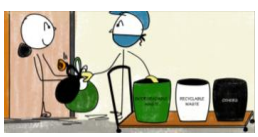
II. 7 Cost Recovery



Recovery of cost incurred in the provision of MSWM services is essential for ensuring sustainability of operations. It is important that ULBs are able to at least cover up the operational cost in the short run and capital cost in the long run. Most of the ULBs rely on revenue from property tax collections for meeting the O&M expenses. ULBs that may provide *value added services* may choose to recover the costs of the same through the levy of a user-fee. Undertaking a survey for gauging the nature of services sought by residents and assessing their willingness to pay (WtP) is therefore a critical step in finalising project features. Exhibit 23 describes the steps involved in a WtP survey.

Exhibit 23: Need and Steps for WtP[xiv]

Why is there a need to assess the willingness to pay?	✓ To ascertain people's perception of the municipality and its customer care ✓ To document results, highlighting issues and trends in customer care ✓ To make recommendations for interventions that could improve customer satisfaction and willingness to pay ✓ To find a basis for an improved payment strategy	
When?	Before developing a final version of the questionnaire and conducting the survey, a feasibility study to determine the service options that could be viable, and the full amortization, operating, and maintenance costs of each must be estimated. Costs need to be developed in terms of costs per tonne and costs per capita per year.	
Time required?	**Four** to **seven** weeks	
How?	**Step One**	Select representative units An indicative classification is described below: ▪ High income residential ▪ Middle income residential ▪ Low income residential ▪ Mixed commercial and residential, and market areas
	Step Two	Prepare the questionnaire
	Step Three	Undertake the survey
	Step Four	Analyse quantitative and qualitative information



Pre-Requites for Undertaking Willingness to Pay Survey	✓ Undertake feasibility study to a. Identify viable service options b. Establish full capital and O&M cost of each option ✓ Prepare questionnaire and undertake a pilot test ✓ Incorporate feedback from the pilot test and prepare a revised questionnaire ✓ Undertake survey in the target area

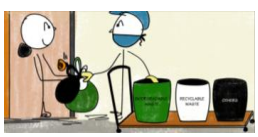
Box 6: Alandur Sewerage Project

Alandur Municipal Corporation	Alandur is a suburban town near Chennai with a population of around 1.5 lakh. Alandur Municipality (AM) planned an underground sewerage network to address the health hazards posed by sewage from overflowing septic tanks and households. The estimated cost of project was estimated to be INR 45 crore whereas the municipality's budget was only INR 3 crore. As the borrowing capacity of the municipality was low, it could not seek debt from the market. Subsequently, it was decided to take a onetime deposit and levy monthly user charges from the residents to meet the deficit. The deposit mobilisation programme entailed assessment of willingness and ability to pay through a survey.
What was done?	▪ Public Consultation Plan was prepared and subsequently a Public Participation Campaign was undertaken to secure deposits from residents to finance the project ▪ Communication plan included meetings with RWAs, door-to-door visits, notifications, press releases and newsletters ▪ Technical team and TNUDF officials accompanied the AMC team to address the questions of residents ▪ Funding pattern and the process of estimating the user charges were explained to residents ▪ Municipal budget and accounts were kept open for public scrutiny ▪ Separate bank account was opened for the project ▪ Auditing of funds was done by two representatives from RWAs
What were the outcomes?	The survey highlighted that demand for the project existed and the residents agreed in principle for a user-financed project. It highlighted the fact that if adequate information on the project is provided and IEC campaigns are held, it is possible to get support of citizens. Alandur Municipality was able to collect double the amount it expected to raise.



Box 7: Willingness to Pay Survey: Guwahati

The context	An academic study (Mahanta *et al.*, 2011) was conducted to test the hypothesis if residents of Guwahati were willing to pay MSWM fee to the Guwahati Municipal Corporation for door-to-door collection of waste. The study found that willingness to pay for better MSWM services existed not only among the high and the middle income category but also among the low income groups
What was done?	A survey was undertaken to assess the citizens' willingness to pay. This involved a two stage sampling method. In the first stage, 10% of the total wards, i.e., six wards were selected. Two wards each were selected from the old residential area of the city, commercial area, and new settlement. The second stage involved carrying out stratified random sampling of waste generators based on income level. A total of 360 households were interviewed during the survey. The questionnaire was based on a Contingent Valuation Method which helps to elicit people's preferences for public goods by finding out how much they are willing to pay for specific improvements. It involved an iterative bidding game to arrive at the user charge that the respondent was willing to pay. In an iterative bidding game, the nature of service provision (door to door collection of waste) was described to the respondents and a user fee was suggested by the interviewer. If the respondent was willing to pay the suggested user fee, then the fee was raised incrementally until a negative response was obtained. Subsequently, lower user fee was suggested incrementally till a positive response was obtained to arrive at the actual user fee that the respondent was willing to pay for the proposed service.
What were the outcomes?	▪ It was found that, on an average, citizens of Guwahati were willing to pay INR 60.22 per month for door-to-door collection of waste ▪ Zero willingness to pay was found only in 18% of the low income group surveyed ▪ Respondents from commercial areas that had a higher number of regularly cleaned bins had a relatively higher mean value of willingness to pay. This reflected that either the existing waste management facility was not sufficient or that the citizens wanted a cleaner environment



Principles for Determination of Tariff/User Fee

Any tariff that is decided based on the outcomes of the feasibility study and the willingness-to-pay survey should be based on the following three principles:

- ✓ **Economic Efficiency:** An economically efficient tariff structure allows recovery of the project cost to the extent possible/ decided and lets the consumers realise the true value of paying tariffs for the service.
- ✓ **Social Equity:** A socially equitable tariff is one that is designed transparently after consulting the consumers, provides equal access to all and takes into account the income levels of the population/affordability to pay.
- ✓ **Environmental Sustainability:** An environmentally sensitive tariff discourages higher generation of waste and encourages consumers to reuse and recycle waste to the extent possible.

Economic Efficiency

- ✓ Cost recovery
- ✓ Efficiency in collection

Social Equity

- ✓ Ensure equal access to MSWM services for ALL
- ✓ Acceptability by all classes of consumers (allow them to provide their inputs)
- ✓ Designed in a transparent manner

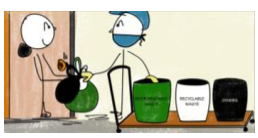
Environmental Sustainability

- ✓ Ensure safe processing of waste
- ✓ Ensure safe disposal of waste
- ✓ Promote reduction of waste generation at source

Exhibit 24: Principles for Determination of User Charges



Exhibits 25 to 28 list the user charges that have been proposed and/or levied for different categories of waste generators in select ULBs.



Indicative MSW Management User Charges: Select ULBs

Exhibit 25: Indicative Fee for MSWM Services (Bhubaneswar)	
User Category	**Fee (INR)**
Household	10-50
Shops/shopping complex	30-500
Guest house/banks/offices/petrol pumps/restaurants/educational institutions	1000
Banquet halls	1000-2500
Hotels	2000
Big hotels/malls	5000

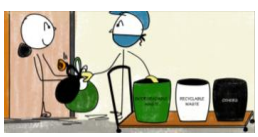
Exhibit 27: Indicative Fee for MSWM Services (Coimbatore)	
User Category	**Fee (INR)**
For property tax less than INR 500	10 per HH/month
For property tax between INR 501-1000	20 per HH/month
For property tax > INR 1,000	30 per HH/month
For shops and establishments	60 per unit/month
For restaurants/marriage &banquet halls/commercial establishments/ industrial establishments	
Through small vehicles (Up to 3.00 tonnes of waste)	500/trip
Through heavy vehicles (Above 3.00 tonnes of waste)	1000/trip

Exhibit 26: Indicative Fee for MSWM Services (Mysore)	
Households	**User Charges per Month (in INR)**
Less than 100 sq. ft.	10
More than 1000 sq. ft. and less than 3000 sq. ft.	30
More than 3000 sq. ft.	50
Commercial establishments	
Less than 1000 sq. ft.	50
More than 1000 sq. ft. up to 5000 sq. ft.	100
More than 5000 sq. ft.	200
Hotels, choultries and marriage halls	
Less than 10,000 sq. ft.	300
More than 10,000 sq. ft up to 50,000 sq. ft.	500
More than 50,000 sq. ft.	600
Industrial establishments	-
Less than 1000 sq. ft.	100
More than 1000 sq. ft up to 5,000 sq. ft.	200
More than 5000 sq. ft.	300



Exhibit 28: Indicative Fee for MSWM Services (Andhra Pradesh)[xv]

Establishment Particulars	Units	Rate
Hospitals & nursing homes	Bed strength	Up to 10 beds - INR 300 per month
		10-25 beds - INR 500 per month
		Above 25 beds INR 1000 per month
Diagnostic centres	Flat rate	INR 300 per month
Clinics	Flat rate	INR 100 per month
Restaurants and hotels (eating establishments) including mess homes, tiffin centres, fast food centres, bakeries, etc.	Tonnage of garbage generated	Per tonne per day INR 200 and collection is monthly
		Minimum charges are INR 500 per month for hotels and restaurants and INR 200 for mess homes and fast food centres
Function halls, lodges and private guest houses including clubs, etc.	Tonnage of garbage generated	INR 200 per tonne per day. Collection will be monthly. However, no charges for days when these are not used
Private markets including agricultural markets	Tonnage of garbage generated	Minimum charge will be in two slabs. INR 500 and INR 1,000. Based on the area of location and the level of business
		INR 200 per tonne. The total tonnes lifted in the month are calculated and charges levied accordingly
Private commercial complexes with 20 and more shops inside	No. of shops in the complex	
	Up to 20	INR 200
	20-50	INR 500
	> 50	INR 750
Private hostels	Tonnage of garbage generated	INR 200 per tonne. Total tonnage lifted in the month is calculated and charges fixed accordingly
		Minimum charge INR 500 per month
Cinema halls and places of entertainment	Flat Rate	INR 500 per month
Roadside vegetable vendor and roadside weekly markets (if uncollected, then the garbage is included in market auctions)	Tonnage of garbage generated	INR 200 per tonne Minimum monthly charge INR 500
Certain types of workshops, small industries like saw-mills, furniture, footwear manufacturing units, coconut trade units and wholesale fruit units, etc.	Tonnage of garbage generated	INR 200 per tonne. Total tonnage lifted in the month is calculated and levied accordingly. Minimum monthly charge INR 300



II. 8 Operational Models



A quick perusal of the various PPP practices in waste management in India reveals the presence of two broad contending approaches namely centralised (technology driven) and decentralised (community based) systems of waste management. In a centralised approach, private players are engaged for either a segment or the entire value chain of solid waste management for handling bulk waste with little or no community participation, while in a decentralised system, self-help groups (SHGs) or resident welfare associations (RWAs) partner with ULBs to manage waste in their own localities with or without assistance from other private entities. The pre-requisites of going ahead with each of the two approaches are listed in Exhibit 29 below.

Exhibit 29: Pre-requisites for Choosing an Operational Model

	Pre-requisites
Centralised Waste Management System	✓ Council and ***community buy-in*** available
	✓ Presence of relatively ***high quantity of non-recyclable*** waste in total waste
	✓ Presence of a plan to ***integrate informal rag-pickers*** in the MSWM system
	✓ Evidence of significant ***economies of scale*** along with adherence to safe management principles
	✓ ***Ability to finance***/fund the project
Decentralised Waste Management System	✓ A ***willing workforce*** – SHGs/NGOs/association of informal rag-pickers
	✓ Availability of ***skilled*** workers – on aspects of waste segregation, disposal
	✓ Strong ***support*** from the ULBs – provision of land (other equipments if available)
	✓ Availability of land for setting up waste collection, segregation and processing units at the ***ward level***
	✓ Presence of ***interdependent users*** of solid and liquid resource in the area (cattle community, recycling units for different categories of segregated wastes)
	✓ Provision of ***primarily segregated***(e.g. biodegradable and non-biodegradable waste) waste from the waste generators
	✓ ***Strong monitoring*** by the community and the ULBs



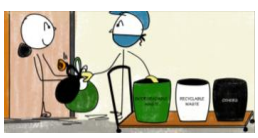
Box 8 and Box 9 briefly present the centralised SWM system of Guwahati and the decentralised community based system of SwaCH in Pune.

Box 8: Centralised Approach: Guwahati Municipal Corporation

Guwahati Municipal Corporation	Guwahati is one among the 63 mission cities under JNNURM. The Guwahati Municipal Corporation (GMC) comprises 23 zones and 60 wards covering a total area of 216 sq. km. As per the census 2001, the population of the city is 8.09 lakh. The City Development Plan of Guwahati stated that the existing MSWM system for the entire city was highly inadequate. In order to improve municipal SWM in the city, GMC implemented an integrated SWM project through PPP on BOOT basis. A unique feature of this project was the formal integration of informal waste pickers within the waste management system.
Project features	Total project cost: INR 102 crore PPP type: BOOT Treatment of waste

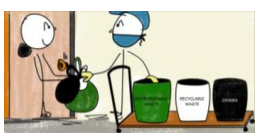
Organic and green waste	Compost
Mixed waste	RDF based power plant

Community consultation and integration of informal waste workers	Guwahati Waste Management Society (GWMS) comprising informal rag-pickers, resident welfare associations, community based organisations and other community representatives, was set up to ensure smooth coordination between different stakeholders and smooth implementation of the project. GMC was entrusted with the responsibility of setting up GWMS and participating in its activities. GWMS not only supervises solid waste management activities but also helps in redressal of disputes among the stakeholders.



Box 9: Decentralised Model: PMC-SWaCH Partnership

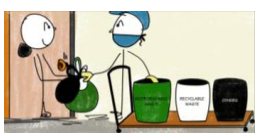
Pune Municipal Corporation (PMC)	Pune City is part of the Pune Urban Agglomeration (PUA) with a population of 5.05 million (Census 2011). PMC has a jurisdiction over Pune City which is spread over an area of 243 sq. km. For administrative reasons, PMC is divided into 48 zones. PMC has a dedicated SWM department that is entrusted with overall management of solid waste in the city. SWaCH is a waste workers' cooperative engaged in collection of waste in Pune. PMC entered into a Memorandum of Understanding with SWaCH to formalise the involvement of waste workers in the waste management system. Subsequently, SWaCH was entrusted with the responsibility of door-to-door collection of waste.
Project features	▪ Door-to-door collection of source segregated domestic waste; maintenance of separate streams ▪ Collection of road sweepings, excluding biomedical waste ▪ Collection of garden waste, construction and demolition waste, e-waste on payment of user fees ▪ Collection of user fee from all classes of users (INR 10-30/ HH/month for general residents and INR 15 per household per month in slums) ▪ Collectors have rights over recyclables and retain income from sale of scrap ▪ PMC provides collection equipment, safe gears, office space, infrastructure and resource recovery centres ▪ Monthly cost of INR 4.38 to PMC per household
Enabling conditions	▪ Presence of a credible organisation of informal waste workers that had been providing waste collection services to citizens for a long time ▪ An enabling legal and policy framework ▪ Inclination of the municipal administration ▪ Support of elected representatives ▪ Presence of a strong, formal municipal employees union that opposed privatisation



Centralised and Decentralised SWM System – A Comparison

Exhibit 30: Centralised and decentralised systems: acomparison

	Centralised	Decentralised
Pros	▪ Suitable for high income cities ▪ Reduces manual handling of wastes ▪ Provides a wider spectrum of technological solutions for treatment of waste ▪ Possible economies of scale ▪ Suitable if the quantum of inert waste to be land filled is small – development and operation of regional landfills provide cost advantage in such situations	▪ Participatory approach – involves community ▪ Promotes source segregation ▪ Effective monitoring by community ▪ Allows integration of informal waste workers ▪ Applicable in cities with strong social factors ▪ Savings in transport cost ▪ Creates employment opportunities ▪ Promotes inter-dependence of stakeholders
Cons	▪ Not suitable for waste with high organic waste content ▪ Complex (technologically and operationally) for ULBs to handle ▪ It is not cost effective ▪ Generally does not allow integration of informal waste workers ▪ Uniform system for all areas of a city/town	▪ Does not address the issue of manual handling of waste ▪ Requires space for a waste processing facility in the vicinity of households ▪ Difficult to sustain commitment from community engaged workers/SHGs



Combinations of Centralised &Decentralised Systems

The possible combinations of centralised and decentralised solid waste management systems that may be implemented are given below. The selection of these options depends on three broad parameters indicated in Exhibit 31.

Exhibit 31: Parameters for Selection of a Suitable Operational Model

Parameters	Example
Economic	▪ Consideration of financial cost of infrastructure and operations ▪ Market linkages ▪ Cost recovery
Technical	▪ Parameters that influence the level of treatment and technology ▪ Space requirement – land availability ▪ Skill requirement
Social	▪ Population size ▪ Willingness to pay ▪ Support from community ▪ Willingness and ability of the community or social enterprises to undertake decentralised MSWM

It is possible for centralised and decentralised MSW management systems to co-exist. However, an enabling ecosystem where the synergies of these two approaches are leveraged must exist to facilitate such co-existence. Three frameworks envisaged in this regard are suggested in Exhibit 32.

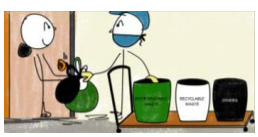
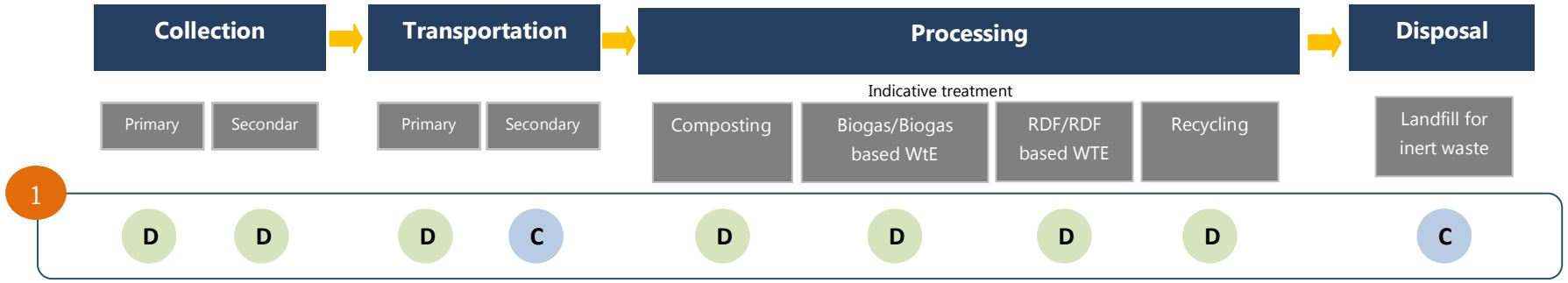


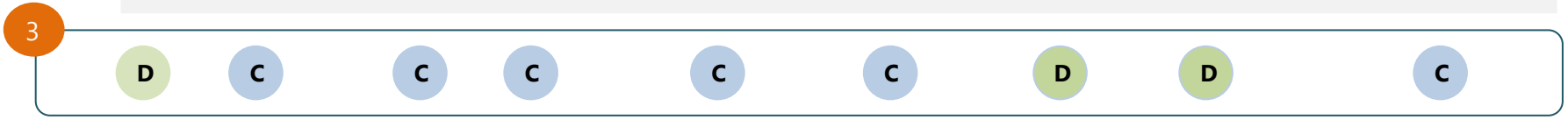
Exhibit 32: Framework for Coexistence of Centralisedand Decentralised SWM Approaches



In this schematic, all operations are decentralised (D) except secondary transportation of waste from composting units and inert articles, to a scientific landfill which is done through a centralised (C) system. The secondary transportation could be undertaken either by the ULB itself or it can be contracted out to a private entity. The decentralised collection and transportation of waste could be executed through Public Private Community Partnerships. Technologies are available for producing biogas or biogas based energy plants at the decentralised level. Community Participation Fund (JNNURM) or Local Area Assistance Project Fund of GoTN could be used to seek grants for initial CapEx.



Under this model, collection (primary and secondary) is done through a decentralised system. The organic waste is composted at the zone or ward level by micro-enterprises. The non-biodegradable waste is collected through a centralised system and segregated further for recovery of articles like plastic, metal and glass. The processing plants for recovered articles are set up near scientific landfill sites for cost savings on transportation of inert waste from the centralised treatment facilities.



In this approach, source segregated waste is collected and transported to composting yards under a centralised manner. This model is suitable when there is lack of local support for ward/zone level composting or there is no land available at the ward/zone level. The non biodegradable wastes are managed in a decentralised manner wherein such waste is segregated further and is either sold as scrap or processed to make pellets. In this approach, the ULB staff involved in the C&T segment may be given ownership of recyclables and other useful waste articles.



Technologies for Decentralised Treatment of Waste

Advance Knowledge and Rural Technology Implementation (AKRUTI)	The Bhabha Atomic Research Centre (BARC) has developed a technology that simplifies garbage disposal. The technology that comes embedded in BARC's Nisargruna biogas plant is a zero energy, zero garbage and zero effluent biodegradable waste handling system. The technology is suitable for treating the following kind of waste:
Applications	▪ Hotel and kitchen waste ▪ Agriculture waste ▪ Market waste ▪ Paper ▪ Abattoir waste ▪ Medical biodegradable waste (after sterilisation in autoclave) ▪ Leaf litter, lawn and garden waste
Infrastructure and Cost Requirement	The following infrastructure is required for setting up a one tonne/day capacity biogas plant Space: 300 m^2 Human Resource: Two unskilled persons Power Supply: 3 phase AC Water Supply: 1.2 kl for one tonne plant Cost: INR 5 lakh
Example	The energy recovered from waste is termed as Nisargajyot and it can be utilised directly in kitchen, compressed in cylinders for use as fuel for vehicles, or for electricity generation. The plant size is scalable to suit treatment requirement. Two Nisargruna plants have been installed at BARC and one in a residential area (Anushaktinagar) in Mumbai for treatment of organic waste. The plants can handle 5 tonnes per day of organic waste. The plant costs INR 6 lakh for installation, INR 3 lakh a year to operate, and can generate revenue of up to INR 12 lakh a year.[xvi]



Appropriate Rural Technology Institute (ATRI)

The Appropriate Rural Technology Institute has developed a technology that can help the ULBs in promoting decentralised processing of organic waste. The technology is simple, low cost and can be operated easily by households. The plant can be used anywhere provided that there is enough space and the temperature is sufficiently high – anything above 30ºC. The technology has won the Ashden Award for renewable energy for the year 2006. The biogas plant using this technology can treat 1 to 50 kg of organic waste. The plants come in three models: ATRI Terrace Model, ATRI Balcony Model and ATRI Large Digester Model.

The ARTI Technology

The ARTI compact biogas plants are made from high density polythene (HDPE) water tanks, which are adapted using a heat gun and HDPE piping. The standard plant uses two tanks, with volumes of 0.75 m^3 and one m^3. Gas produced gets stored in the smaller tank which is inverted and attached to the larger tank thatholds the mixture of decomposing feedstock and water (slurry). An inlet is provided for adding feedstock, and an overflow for removing the digested effluent. Since the feedstock is almost completely digested, the effluent contains a much smaller amount of solid matter than the residue from a manure-based plant, and ARTI recommends that the liquid is mixed with the feedstock and recycled into the plant. The gas holder gradually rises as gas is produced, and sinks down again as the gas is consumed. ARTI has found that the gas produced by these plants has a higher methane concentration than is found using manure-based plants, and thus has higher energy content. This is probably because the CO_2 produced by the bacteria dissolves in the very liquid slurry. The methane concentration increases further when weights are used on the gas holder, because more CO_2 dissolves under the increased pressure. This has the advantage of increasing the gas pressure.

Exhibit 33: Features of ARTI Biogas Plant

Parameter	Requirement
Amount of required feedstock	1-1.5 kg + 15 lit water
Nature of required feedstock	Any starchy material
Amount and nature of slurry to be disposed	15 liter, watery
Reaction time for full utilisation of feedstock	48-72 hours
Standard size for household	1000-1500 litre
Capital investment per unit including stove	INR 10,000



ARTI has embedded its technology in three basic biogas models: ARTI Compact Biogas Terrace Model, ARTI Compact Biogas Balcony Model, and ARTI Large Digester. The key features of these models are illustrated here. Around 2000 ARTI plants are in use in both urban and rural households in Maharashtra.

ARTI Compact Biogas – Terrace Model:

- Size: One m^3 digester
- Capacity: up to 2 kg kitchen waste
- Quantity of gas produced: up to 1 kg biogas, capable of replacing 250 gm of LPG. (Depending on type of cooking done, one meal can be cooked entirely on biogas)
- Requires space on open terrace with good load bearing capacity or open to sunlight area of land – about 2-3 m^2

ARTI Compact Biogas – Balcony Model:

- Size: 0.5 m^3 digester
- Capacity: up to 1 kg kitchen waste
- Quantity of gas produced: up to 0.5 kg biogas, capable of replacing about 100 gm of LPG. (Depending on type of cooking done, tea, snacks, etc., can be cooked)
- Can fit into a balcony



ARTI Large Digester

Capacity: 7000 litre digester (plastic tank or masonry work)
5000 litre gas holder (plastic tank)

Unit Cost: Approx INR 2, 00,000

Payback period: 3-4 years

Operating cost: Electricity for Food pulper, 1 hp
Labour 2 hr/day (at actual)

Gas production: 2.5 kg LPG eq. /day or 75 kg/month

Additional benefit: Spent slurry in watery form can be used directly as liquid fertilizer (100-125 lit/day).

Requirements:

Areas open to sunlight throughout the day 10 m^2

Water ~ 100-125 litre/day

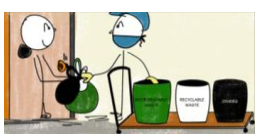
Feedstock: Food waste, pulped, 40-50 kg (cooked food, over-ripe fruits, peels of banana, papaya, mango, etc.)



Section III: Project Procurement

- Project Procurement
- Procurement Options
- Risk Sharing

This section presents the various procurement options for undertaking an MSWM project by a ULB. It discusses the features and limitations of public procurement and public private partnerships and highlights the need for pre-procurement and Value for money analysis. It also lists the steps to be taken before finalising a procurement mode.



III.1 Project Procurement

1 Identification

2 Approval

3 Financial Arrangement

4 Procurement

5 Monitoring

6 Post-Award Governance

In the solid waste management sector, the interplay of a large number of factors makes the choice of an appropriate procurement mode a challenging process demanding close attention. Some of the key parameters that a ULB must investigate into before finalising the procurement mode are the socio-economic profile of citizens, size of the informal sector, cultural attitudes, propensity to adopt centralised/decentralised models, financial health of the ULB, access to technology and environmental concerns among others.

This section provides a step by step approach to help ULBs adopt a suitable procurement mode.

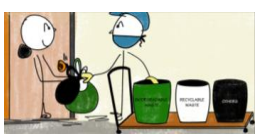
The section begins with an overview of the two main procurement modes — i.e., public procurement and public private partnerships, wherein their definition, features and limitations are listed.

Next, a set of key factors that influence the choice of a procurement mode is listed followed by a competency framework that indicates different procurement options available to ULBs depending on their technical, managerial and financial capacity. The competency framework is supplemented by a risk sharing matrix that provides an overview of the various kinds of risks associated with different procurement options.



III.2 Procurement Options

Types	Public procurement and complete outsourcing of project to the private sector in form of PPPs are the two extreme alternatives available to ULBs. In recent times, PPPs have evolved as an important medium to meet the infrastructure or operational deficits of the ULBs and attempt to leverage the comparative advantages of both the public and the private sector. The features associated with these two modes are briefly outlined below.
Public Procurement	Public procurement refers to the scenario where a ULB undertakes all aspects of project management and service delivery, from project designing to project monitoring by itself. In other words, once the project has been identified and approved, the key aspects of the project like project design, construction, financing, operations & maintenance and monitoring are done by the ULB/public agency by utilising government resources.
Features	▪ Project cost is borne by the ULBs/ state governments ▪ Separate contracts awarded for different works – procurement of goods, works and service ▪ Higher risk retention by the ULBs ▪ Reduces the number of stakeholder consultations
Limitations	▪ No scope for sharing project cost ▪ Limited risk transfer to private sector ▪ Limited efficiency gains



Public Private Partnerships	In this section, the definitions of PPP as per the draft National PPP policy and the Tamil Nadu Transparency in Tenders (Public Private Partnership Procurement) Rules, 2012 are presented.[xvii]

Box 10: Public Private Partnerships

Draft National Public Private Partnership Policy, Government of India, 2011	'Public Private Partnership refers to an arrangement between a government / statutory entity / government owned entity on one side and a private sector entity on the other, for the provision of public assets and/or public services, through investments being made and/or management being undertaken by the private sector entity, for a specified period of time, where there is well defined allocation of risk between the private sector and the public entity and the private entity receives performance linked payments that conform (or are benchmarked) to specified and pre-determined performance standards, measurable by the public entity or its representative'
'Public Private Partnership (PPP) refers to an arrangement between a public agency and a private sector participant for the provision of infrastructure through investment made or through design, development, construction, maintenance or operation undertaken by the private sector participant, where risks are allocated between them such that the private sector participant takes on the risk beyond the stage of design and construction and the payment for the services are performance linked, in the form of user charges, annuities or unitary payments'	Tamil Nadu Transparency in Tenders (Public Private Partnership Procurement) Rules, 2012 Government of Tamil Nadu



Box 11: PPP Types	
User-Fee Based BOT Models	*'This refers to competitively bid concessions where costs are recovered mainly through **user charges** (in some cases partly through VGF from the government).'* [Draft National PPP Policy, GOI (2011)]
'In sectors/projects not amenable for sizeable cost recovery through user charges, owing to socio-political/affordability considerations, the government harnesses private sector efficiencies through contracts based on availability/performance payments. Implementing an annuity model will require necessary framework conditions, such as payment guarantee mechanism by means of making available multi-year budgetary support, a dedicated fund, letter of credit etc. Government may consider setting-up a separate window of assistance for encouraging annuity-based PPP projects. A variant of this approach could be to make a larger upfront payment (say 40% of project cost) during the construction period.' [Draft National PPP Policy, GOI (2011)]	Annuity Based BOT Models
Performance Based Management/ Maintenance Contracts	*'Under a management contract, a private party is paid a fee for managing an existing asset or business. Management contracts transfer limited responsibilities and risk to the private party. Performance based management contracts are 'output' based contracts and the payment made to private partner is measured on outputs reflecting the service quality levels. The service quality levels are pre-defined in the contract.' [Draft National PPP Policy, GOI (2011)]*
'In traditional design-build (DB) contract, the private contractor is engaged for a fixed-fee payment on completion. The primary benefits of DB contracts include time and cost savings, efficient risk-sharing and improved quality. Government may consider a turnkey DB approach with the payments linked to achievement of tangible intermediate construction milestones (instead of lump-sum payment on completion) and short period maintenance / repair responsibilities. Penalties/incentives for delays/early completion and performance guarantee (warranty) from private partner may also be incorporated. Subsequently, as the market sentiment turns around these projects could be offered to private sector through operation-maintenance-tolling concessions.' [Draft National PPP Policy, GOI (2011)]	Modified Design-Build (Turnkey) Contracts



Box 12: EPC Contract	
Definition	*'An EPC agreement specifies the **required** design and performance standards and allows the contractor to design and construct the project using best practices and innovation to optimise on efficiency and economy as compared to the rigidity of the item rate contract that relies on a single design provided by the government. The contractor also has full freedom to plan the construction schedule for efficient use of its manpower, equipment and other resources while payments are linked to specified stages of construction as compared to payment for individual items/ units under the item rate contracts. Awarding contract for a **lump sum price** ensures predictability and financial discipline, both for the contractor and the government. Clearly stated obligations and risks of the respective parties help in achieving timely completion of the project while minimising the disputes.'* (EPC Agreement for Construction of Two Lane National Highway Works, Ministry of Road Transport & Highways, GOI (2012)

To sum up, PPPs in general have the following features and limitations:

Features	✓ Allows ULBs to access private finance ✓ Brings together the strengths of both public and private sector ✓ Allows greater sharing of responsibilities ✓ Allows public sector to tap gains of innovation ✓ More effective risk management
Limitations	× A sustainable revenue model is a pre-requisite to incentivise private finance × Reduces accessibility as the issue of cost recovery may result in limited access to services by users × Exclusive rights to a preferred player may result in private monopoly (anti-competitive issues) × Demands highly capable governance mechanisms to offer value for money



Steps in Procurement

The choice of procurement is influenced by several factors. Institutional framework, political support, capacity of ULB and commercial factors are four key factors that should be considered.

To begin with, a ULB should undertake a pre-procurement analysis which includes a series of activities. These activities are described in Exhibit 34.

Exhibit 34: Steps in Pre-Procurement Analysis

Steps	Activity	Description	Reference exhibit
1	Review the institutional factors	It involves the following: ▪ Review of the MSW (M&H) Rules 2000 to ensure that the proposed project complies with the directives stipulated in the rules	**35**
		▪ Setting service standards ▪ [The Ministry of Urban Development has set service standards in the form of Service level benchmarks (SLB) that envisages their achievement over the long run. A ULB may prepare a road map that clearly indicates the target achievements on these benchmarks and other parameters, if any, for the short, medium and long run]	**36**
		▪ Based on the stipulations of the MSW Rules and SLBs 1. Identify project features 2. Translate project features into required quantitative and qualitative resources 3. Identify gaps	**37**
2	Assess political support	PPPs require strong political support. The ULB must gauge the extent of political support for PPPs in case the project requires private sector involvement	**…**
3	Assess competency and risks associated with different procurement modes	Finally, the ULB should locate a suitable procurement mode based on availability / deficit of financial, technical and managerial resources	**41**



Step 1	Review the institutional factors.
Step 1.1	Review the Municipal Solid Waste (Management & Handling) Rules 2000 to identify the permissible activities for management of MSW. ▪ Certain activities are prohibited as per the rules. For instance, the rules do not allow manual handling of waste. Further, the rules have specified that incineration of waste as a processing method is permissible only under specific conditions. ▪ The broad contours of the rules are listed in Exhibit 35. The ULB should identify the dos and don'ts as per the rules.

Exhibit 35: MSW (M&H) Rules 2000: Key Features

- Separate bins for biodegradable, recyclables and other waste
- Manual handling is prohibited except in unavoidable circumstances
- Transportation vehicles shall be so designed that multiple handling of wastes, prior to final disposal, is avoided
- Adoption of suitable technology or combination of such technologies to make use of wastes so as to minimise burden on landfill
- The biodegradable wastes shall be processed by composting, vermin-composting, anaerobic digestion or any other appropriate biological processing for stabilisation of wastes
- Mixed waste containing recoverable resources shall follow the route of recycling. Incineration with or without energy recovery including pelletization can also be used for processing wastes in specific cases
- Other state-of-the-art technologies should have standards laid down by the Central Pollution Control Board
- Land filling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing



Step 1.2

Set standards for MSWM.

- The Ministry of Urban Development has set eight service level benchmarks (SLBs) for the ULBs to achieve in the provision of MSWM services to the citizens
- Exhibit 36 lists the SLBs. Based on a realistic assessment of its strengths and constraints, a ULB could set standards to be achieved in the short, medium and long term

Exhibit 36: Service Level Benchmarks

Parameter	SLB (%)
Household level coverage of SWM services	**100**
Efficiency of collection of municipal solid waste	**100**
Extent of segregation of municipal solid waste	**100**
Extent of municipal solid waste recovered	**80**
Extent of scientific disposal of municipal solid waste	**100**
Extent of cost recovery in SWM services	**100**
Efficiency in redressal of customer complaints	**100**
Efficiency in collection of SWM-related user charges	**90**

Step 1.3

Based on stipulations of MSW Rules and SLBs, project features are identified, a feasibility study to estimate resource requirement for the identified project features is undertaken and the gaps to gauge the areas for interventions is identified.

Step 1.3.1

ULB should list down the project features. An indicative list of project features is provided in Exhibit 37. The project features could include all or a combination of the following aspects:

- Method of waste collection
- Method of waste transportation (primary and secondary)
- Method of waste processing and disposal
- Choice of appropriate technology



Exhibit 37: Indicative Project Features

1. 100% bin free area
2. 100% collection, segregation, transportation in the most efficient manner
3. No manual handling of waste
4. Stabilisation of biodegradable waste
5. Recycle and reuse of materials
6. Landfill only for inert
7. Monitoring of environmental standard
8. Inclusive project – involvement of informal sector
9. Awareness creation for effective awareness about solid waste management

A ULB can set project targets for immediate and short run based on resource constraints. This could be in the form of annual targets for household coverage, source segregation, etc. Exhibit 38 provides an indicative template for targets to be achieved over the next five years.

Exhibit 38: Template for Immediate and Short Term Objectives

Targets	Current	Year 1	Year 2	Year 3	Year 4	Year 5
Household coverage (No. of zones/wards/households)	50	55	60	70	90	100
Source segregation (No. of zones/wards/households)	45	50	55	60	65	70
Composting/bio-methanation (Tonnes of biodegradable waste)	25	30	35	40	45	50
Scientific disposal (Tonnes of inert waste)	0	0	0	30	60	90

SAMPLE



Step 1.3.2	Translate project features into the required resources. ▪ Conduct a feasibility study to assess the required financial (capital and O&M cost), quantitative and qualitative resources. Exhibit 39 briefly lists key quantitative and qualitative resources that would be required ▪ The quantitative resources would include assets, inventory and staff while the qualitative resources comprise technical and managerial skills

Exhibit 39: Quantitative and Qualitative Resources

Quantitative Resources	Qualitative Resources
Quantitative resources refers to availability of assets, inventory and staff *Assets* required for MSWM comprise collection vehicles, transfer stations, composting yards, other form of waste processing facilities, sanitary landfill, scientific landfill, IT infrastructure for monitoring, etc. *Inventories* required for MSWM comprise waste bins, collection equipments, etc. *Staff* includes persons for different segments of the MSWM value chain – collection, transportation, processing, disposal, monitoring, management, etc.	*Qualitative resources* refer to availability of staff with design, construction, operational, monitoring and financial management capabilities. *Design* includes technical skills to prepare lay outs for transfer stations, processing plants, and landfill sites. It also includes skills to design route maps for collection and transportation of waste. *Build* includes the technical capability to construct appropriate infrastructure like processing plants, landfill sites, transfer stations, etc. *Operate* includes operational planning, resource planning, regular service delivery, etc. *Financial management* skills include estimation of project cash flows, revenue optimisation, improving cost efficiency, preparation of annual accounts and balance sheets, auditing, etc. *Quality control* includes skills and tools to identify operational problems, monitor service delivery set benchmarks, etc. *Staff management* includes human resource planning, performance appraisal, training need identification, etc.



Step 1.3.3

Identify gaps

Post assessment of the required and available quantitative and qualitative resources, a ULB may find that it needs to focus on either of the following:

1. Construct supporting MSWM infrastructure and build capacities to improve operation
2. Construct only supporting MSWM infrastructure
3. Improve only the operations

Exhibit 40 presents a snapshot of the various scenarios that ULBs may find themselves in depending upon the availability of quantitative and qualitative resources.

Exhibit 40: Possible Areas for Intervention for Improving SWM Situation

Resources	Category	Sub-category	Resource Availability		
Quantitative Resources	Asset (A)		**Low**	**Low**	**High**
	Inventory (I)				
	Staff (S)				
Qualitative Resources	Technical Resource	Design (D)	**Low**	**High**	**Low**
		Construction (C)			
		Operations (O)			
	Managerial Resource	Financial Management (F)			
		Quality Control (QC)			
		Staff Management (SM)			
Intervention Required			**Status 1:** Construct supporting MSWM infrastructure and build capacities to improve operation	**Status 2:** Only construct supporting MSWM infrastructure	**Status3:** Only improve the operations



Step 2	Once the ULB has identified the areas of intervention as indicatedin Exhibit 40, the next step is to gauge the political and community support for PPPs. If the ULB is not able to garner support from the elected representatives and the community, then the success of the project if undertaken through PPP would be adversely affected. Therefore, presence of the following enabling factors is crucial for successful implementation of PPP projects: 1. Political willingness and leadership 2. Political stability 3. Community buy-in 4. Staff support ULBs that are likely to face resistance from staff need to have a mitigation strategy that could be in the form of relocation of staff to other services or departments. Only those ULBs that meet the above listed criteria should consider PPPs as a possible procurement alternative. Exhibit 41 provides procurement modes that may be selected by ULBs based on their financial, technical and managerial capability.
Step 3	This step consists of two actions.
Step 3.1	First, a self-assessment to evaluate ULB competencies must be conducted. The competency framework provided in Exhibit 39 provides a list of scenarios linking financial status (capital and operational), technical and managerial capability to procurement modes. Second (Step 3.2), various types of risks associated with the identified procurement mode must be assessed and risk mitigation strategies must be created. (Please refer to Exhibit 42 for details).

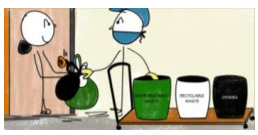


Exhibit 41: Competency Framework

Procurement Option	FUND																RESOURCES											
	CAPEX								OPEX								TECHNICAL						MANAGERIAL					
	IR		GRANT		VGF		LOANS		IR		GRANT		TAX		USER CHARGES		DESIGN		BUILD		OPERATE		FINANCE		QC		SM	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
1. PP																												
SCENARIO 1.1	■								■								■		■		■		■		■		■	
SCENARIO 1.2	■												■				■		■		■		■		■		■	
SCENARIO 1.3	■														■		■		■		■		■		■		■	
SCENARIO 1.4			■								■						■		■		■		■		■		■	
SCENARIO 1.5			■												■		■		■		■		■		■		■	
SCENARIO 1.6							■						■		■		■		■		■		■		■		■	
2. EPC																												
SCENARIO 2.1	■								■				■		■			■		■	■		■		■		■	
SCENARIO 2.2			■						■				■		■			■		■	■		■		■		■	
SCENARIO 2.3							■						■		■			■		■	■		■		■		■	
3. SERVICE CONTRACT																												
SCENARIO 3.1									■												■			■		■		■
SCENARIO 3.2											■										■			■		■		■
SCENARIO 3.3													■								■			■		■		■
SCENARIO 3.4															■						■			■		■		■
4. MANAGEMENT CONTRACT																												
SCENARIO 4.1	■								■									■		■		■		■		■		■
SCENARIO 4.2			■								■							■		■		■		■		■		■
SCENARIO 4.3			■										■		■			■		■		■		■		■		■
SCENARIO 4.4		■		■	■			■					■		■			■		■		■		■		■		■
5.BOT																												
SCENARIO 5.1		■	■			■		■		■		■	■		■		■			■		■		■		■		■
SCENARIO 5.2		■		■	■			■		■		■	■		■		■			■		■		■		■		■
SCENARIO 5.3		■		■		■	■			■		■	■		■		■			■		■		■		■		■

IR: Internal reserves of the ULB. | Grant: A grant that is available to a ULB from external sources including state or central government | VGF: A viability gap funding grant that is available to a ULB for financing only PPP projects | Loans: Loans for infrastructure projects that are available to ULBs from government agencies like TNUIFSL, TUFIDCO | Tax: Revenue generated by a ULB through property tax or any common tax | User charges: Capability to generate revenue through levy of user charge or a fee in lieu of provision of MSWM services to citizens | Design: Capacity and capability to prepare plant layout, operational design, etc. | Build: Capacity and capability to undertake the required construction activities | Operate: Capacity and capability to undertake operations and carry out maintenance activities | Finance: Capability to manage financial aspects of project | QC: Quality control that includes capability to provide standard services, identify problems in advance and take remediation steps | SM: Staff capacity and the capability to manage human resources in a productive and efficient way |



Public Procurement

For a ULB to select public procurement as a mode of project implementation, it *must* have all the required technical and managerial resources. However, based on its ability to fund projects and availability of various financing mechanisms, it may adopt public procurement under 6 possible scenarios. While the financing options may change across scenarios, for a ULB/public agency to undertake the delivery of MSWM services, it must have the required technical and managerial skills listed above.

After self assessment, if a ULB is seen to fit within scenario 1.1 to 1.6, then it may opt for Public Procurement

Scenario 1.1

ULBs that have adequate internal reserves to meet the total project cost and also the operational expenditure during the project life

It is assumed that ULBs going for the public procurement mode have all the required technical and managerial capacities

Scenario 1.2 & 1.3

ULBs have internal reserves that are adequate to meet only the required capital expenditure and have buoyant tax revenues that can take care of the operational expenditure during the project period. The tax may be property tax or any other general tax that may or may not be levied in lieu of MSWM services provided to citizens. Alternatively, operational cost can be covered through user charges levied on citizens in lieu of provision of MSWM services. The potential cost recovery is estimated through willingness to pay surveys and takes into account the administrative capabilities of the ULB in improving collection efficiency.

Scenario 1.4

ULBs do not have internal reserves to meet the capital and operational cost, but have access to external grants (central, state or others). For example, JNNURM or TN Infrastructure Gap Filling fund could be availed to incur capital expenditure while TN O&M Gap Filling Fund could be availed to meet operational expenditures.

Scenario 1.5

The ULBs does not have internal reserves to meet the capital and operational cost, but have access to external grants (central, state or others) to meet only capital cost. Therefore capital cost is met in the same way as in scenario 1.4 while the operational costs are met through user charges. The potential cost recovery is estimated through willingness to pay surveys and takes into account the administrative capabilities of the ULB in improving collection efficiency.



Scenario 1.6

ULBs do not have adequate internal reserves or access to grants to meet the project cost. Such ULBs may take loans from financial institutions such as TNUDF/TNUIFSL provided that ULBs meet the borrowing criteria or the FIRR of the project exceeds the lending rate plus 2%. Here ULB should be in a position to recover the O&M cost through user charges.

EPC Contracts

This option is suitable for those ULBs that possess the requisite managerial capability to operate and manage municipal solid waste facilities, but have a comparative disadvantage with respect to the design and construction of the same. However, the availability and source of funds for capital and operational expenditure is ULB specific. ULBs may choose to adopt an EPC contract under three possible scenarios.

It is assumed that ULBs adopting the EPC mode have the technical capacity only for undertaking the operations but have all the relevant managerial capacities

Scenario 2.1

ULBs that are able to meet the capital cost through internal reserves and O&M cost through internal reserves, tax receipts or other sector specific user charges.

Scenario 2.2

- ULBs do not have internal reserves but have access to external grants (central, state or others), for example, JNNURM or TN Infrastructure Gap Filling Fund
- ULBs meet O&M cost through internal reserves due to ongoing reformatory measures for cost recovery and hence have enhanced tax collection outlook
- Can meet O&M cost through user charges

The potential O&M cost recovery is estimated through willingness to pay surveys and takes into account the administrative capabilities of the ULB in improving collection efficiency

Scenario 2.3

- The ULBs do not have internal reserves or access to external grants (central, state or others), example JNNURM or TN Infrastructure Gap Filling Fund but can take loans from TNUDF/TNUIFSL
- The ULB can meet O&M cost through internal reserves due to ongoing reformatory measures for cost recovery and has an positive tax collection outlook



Service Contract

These types of contracts are suitable for those ULBs that are faced with capacity and capability constraints in operations, financial management, quality control and staff management. ULBs may opt for service contracts under four scenarios:

It is assumed that ULBs choosing the service contract mode do not have adequate managerial capabilities and also lack technical skills required for carrying out operations

Scenario 3.1 & 3.2

- ULBs have internal reserves to make the fixed payments to the service operator

  OR
- Have access to external grants like the TN O&M Gap Filing Fund to meet the payment obligations

Scenario 3.3 & 3.4

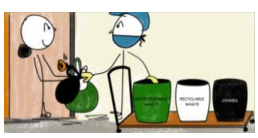
- The ULB has high tax buoyancy or
- The potential to recover annual O&M costs through user charges

Management contracts

Management contracts are one of the simplest forms of PPPs which may be adopted when services rendered by the ULBs are inefficient and the ULBs do not have the capability and capacity to enhance them. They differ from service contracts for two reasons. First, it usually includes some amount of capital works such as rehabilitation of infrastructure. Second, the private operator may take on a portion of the capital cost.

It is assumed that ULBs choosing the service contract mode do not have adequate managerial capabilities and also lack the required technical skills

These types of contracts are suitable for those ULBs that are faced with capacity constraints in design, construction, operations, financial management, quality control and staff management. Since the scope of work may involve some rehabilitation and maintenance work, design and construction capability are required here unlike service contracts. ULBs facing such constraints may vary in terms of availability and source of funds to meet payments that would accrue during the operations stage. Accordingly, ULBs may opt for management contracts under four scenarios:



Scenario 4.1 and 4.2

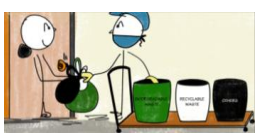
- The required infrastructure for municipal solid waste management already exists within the city, but needs rehabilitation and maintenance
- The ULB is incapable of rehabilitating the existing infrastructural facilities or undertaking expansion works. Further it does not have the resources to operate and manage waste processing facilities, scientific landfills, etc.
- The ULB has internal resources or access to grants (TN Infrastructure Gap Filling Fund) to meet the capital cost
- The ULB has internal resources or access to grants (TN O&M Gap Filling Fund) to meet the payment obligations of the private concessionaire

Scenario 4.3

- The ULB does not have internal reserves but has access to grants to meet capital cost.
- The ULB does not have internal reserves or access to grant to meet fixed O&M cost but can meet O&M cost through internal reserves through ongoing reformatory measures for cost recovery.

Scenario 4.4

- ULBs do not have internal reserves or access to grant to meet capital cost but have access to VGF (e.g., GOI) and meet the rest of the need through private finance (which is minimal in management contracts)
- ULBs do not have internal reserves or access to grant to meet fixed O&M cost but can meet O&M cost through internal reserves in future due to ongoing reformatory measures for cost recovery and hence have enhanced tax collection outlook



BOT Models

BOT models are long term concession agreements wherein the ULB lacks the capability to build and operate MSWM facilities. It also may not have enough financial resources to finance the entire project cost. In such a case, the ULB may invite a private entity to address the financial, technical and managerial gaps.

It is assumed that ULBs choosing the BOT mode have technical skills for project design but do not possess other technical and managerial capacities required for carrying out operations

Scenario 5.1, 5.2 & 5.3

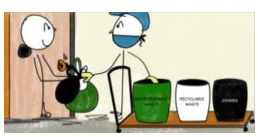
- ULB can source a part of capital cost through any of the 3 sources – centre/state grant, VGF or loan
- The remaining capital cost is financed by the private player who also brings in technical and managerial skills required for construction, operation and maintenance of the project

There are variants of the BOT mode such as the BOT (toll), BOT (annuity), DBFOT, etc. that allow greater sharing of risks with the private entity.

Step 3.2

The various kinds of risks associated with different procurement modes are assessed through the risk sharing matrix provided in Exhibit 40.

Once a particular procurement mode is identified, a value for money (VfM) analysis must be undertaken to establish the rationale for choosing PPP, if the selected procurement mode is PPP.

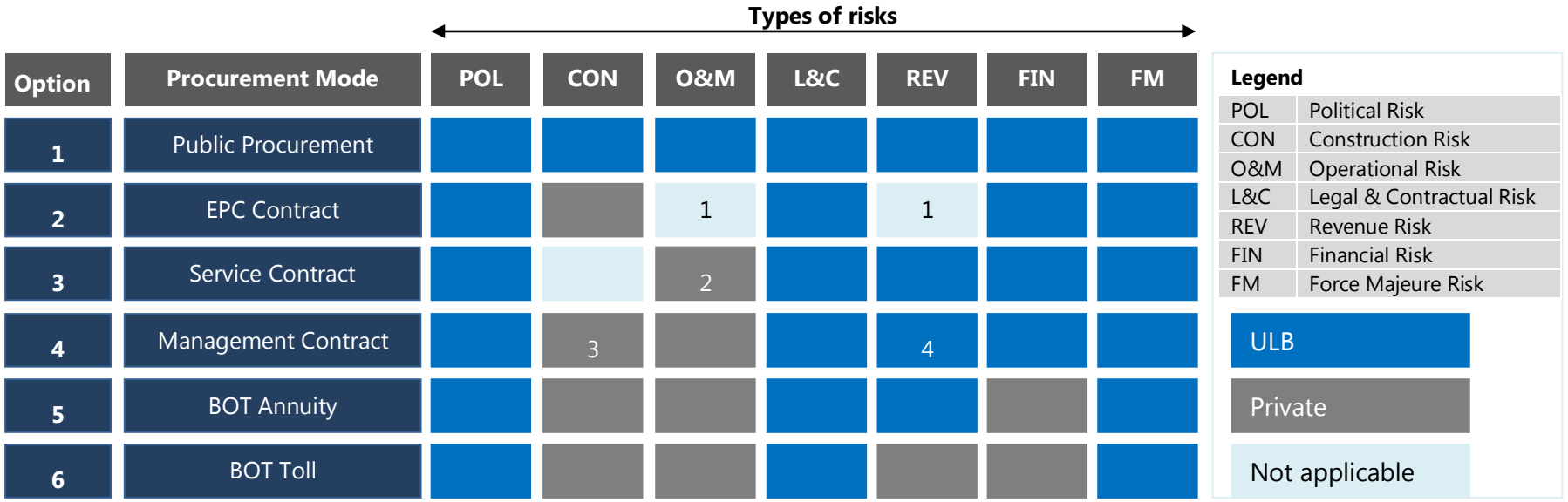


III.3 Risk Sharing Framework

Exhibit 42 indicates how various types of risks are shared between the ULB and private sector as the nature of procurement changes from public to PPP.

- Under the ***public procurement mode***, the ULB/ implementing agency bears the all risks associated with a project.
- An ***EPC contract***, allows the ULB to park the construction risk with the private entity while retaining all other risks, i.e., those associated with design, innovation, project scope, operations, revenue & financial (if not contracted out), and force majeure, among others.
- ***Service contracts*** allow ULBs to assign operational risks to the private operator. Operational risk includes service delivery at set standards, accountability of service delivery, etc.
- In ***management contracts***, ULBs are able to broaden the scope of operational risk by including risks associated with carrying out maintenance works. In addition, the construction risk is also assigned to the private partner.
- As one moves further down the spectrum, to ***BOT contracts***, ULBs can park the construction, O&M and financial risks with the private partner and only retain the political, legal, regulatory and residual risks. BOT contracts have two variants ***– BOT toll and BOT annuity***. The difference between the two is that in the latter, the revenue risk (based on the demand and cost per unit) is borne by the government while BOT Toll allows ULBs to share even the revenue risk with the private partner.

Exhibit 42: Risks in Project Procurement



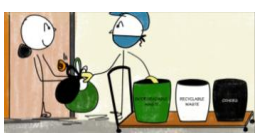
[1] These risks are not applicable here as the procurement is not for O&M.
[2] The O&M risk in the service contract refers to operations & management and excludes maintenance.
[3] Management contracts may include a portion of capital works which is usually in the form of rehabilitation of existing infrastructure (brown field projects) or expansion of current system to meet incremental needs. Although the construction works are limited, the risks associated with it are assigned to the private partner.
[4] In a few instances, revenue risks may be bundled with O&M risks and in such cases, the revenue risks are also assigned to the private partner. The case of Latur water supply project is one such example where Latur Municipal Corporation assigned revenue risks to its private partner.



Section IV: Project Monitoring

- Importance and Methodologies
- Service Level Benchmarks
- Environmental Monitoring

This section discusses the need for robust monitoring frameworks. In social sectors like MSWM, involvement of community in the monitoring framework is critical to service delivery. It also provides a step by step approach on ways in which the ULB can seek public support and identify roles for citizen representatives. A template for monitoring key aspects of MSWM at a disaggregated level has been provided. Lastly, some of the parameters for monitoring environmental norms related to composting of MSW are also discussed.



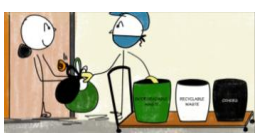
IV.1 Importance and Methodologies for Project Monitoring



Monitoring the performance of the services rendered by ULBs is of significance for a host of stakeholders. The common interest for service providers, users, financiers and government would be improved service delivery over time. Exhibit 43 outlines the need for a robust monitoring framework for different stakeholders.

Exhibit 43: Importance of Project Monitoring for Stakeholders

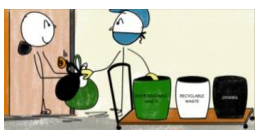
Stakeholder	Importance/ relevance
Solid Waste Management Department, ULB	▪ Provides an analytical platform for benchmarking performance ▪ Allows self-assessment of performance ▪ Rationalizes the need for financial and other support ▪ Identifies project features and helps in planning process
Monitoring Agencies/Regulators	▪ Regulates user charges ▪ Ensures compliance of MSW (M&H) Rules, 2000 and other policy directives ▪ Helps in comparative analysis of service levels to different sections
Customers	▪ Increases accountability as redressal of customer complaints is more effective ▪ Addresses health and environmental concerns
Private Developers/ Financiers	▪ Helps in benchmarking internal processes ▪ Identifies issues and problem areas ▪ Helps in taking preventive measures
Central Government	▪ Helps in evaluation of performance of the sector across region, cities, states, country ▪ Provides a baseline for strategic planning



Methodologies	Exhibit 44 lists the steps involved in developing a monitoring framework and also provides some of the activities to be undertaken under each step.

Exhibit 44: Methodologies for Project Monitoring

Steps	Approach
Organise a Benchmarking Team	▪ Establish a professional team with skills in engineering, technology, finance, solid waste management operations and processes
Identify Study Objectives	▪ Undertake a thorough review of the problems and opportunities ▪ Hold preliminary discussion with stakeholders to address issues in efficiency and finance
Select Benchmarking Methodologies	▪ Identify specific aspects of services to be benchmarked based on the extent to which data on inputs and outputs are available
Data Collection & Analysis	▪ Collect data ▪ Apply data verification procedures ▪ Check for a) Missing data and b) Accuracy (calculations/data errors) ▪ Perform data analysis such as developing performance indices or use of similar statistical techniques
Review Performance & Adopt Strategies for Improvement	▪ Identify weak points that hinder the utility from achieving the target ▪ Devise a plan for the next phase to achieve goals ▪ Create a mechanism for frequent review of the performance based on the indicators/parameters and their respective targets



Need for Monitoring

Management of MSW in a holistic way is a complex task involving multiple stakeholders. Ensuring smooth continuity of services and processing & disposal of waste in an environmentally sustainable way is critical and must be done through greater involvement of stakeholders in the overall management process. In cases where operations of MSW is managed in partnership with private entities, monitoring becomes an even more transactionally complex process and therefore acquires greater significance. Access to independent and cohesive information for addressing the concerns in an efficient and transparent manner is thus critical to successful delivery.

Monitoring Committee

Creation of a monitoring framework that is transparent and inclusive is necessary for making informed decisions and also for settlement of disputes, if any, in an amicable way. A three layered monitoring committee on the lines of the one proposed in the JNNURM guidelines could be formed for continuous monitoring various aspects of MSW management. Here, participatory committees at ward level, review committee at the zonal level and an apex committee at a higher level is recommended. The participatory committee must conduct meetings at weekly or fortnightly intervals while the review committee and the apex committee should meet once in a month. An indicative sample ofthe compositions of these committees is provided in Exhibit 45

Exhibit 45: Indicative Composition of MSWM Monitoring Committee

Participatory Committee	Review Committee	Apex Committee
Ward councillor	Deputy commissioner	Mayor
Junior/assistant engineer	Zonal chairperson	Commissioner
Sanitary inspector of the respective Wards	Assistant executive engineer	Deputy commissioner
RWA/NGO/Voluntary service organisation	Assistant health officer	Deputy mayor
Medical officer of the ULB	Zonal sanitary officer	Chairperson of health committee
Head – Hospital waste management committee of the area	RWA/NGO/Voluntary service organisation	Senior engineer
School representative		Health officer
College NSS coordinator		RWA/NGO/Voluntary service organisation
Sanitary supervisor of the Ward		
One male sanitary worker of the ward		
One female sanitary worker of the ward		



IV.2 Service Level Benchmarks

What should be the Standards for Service Delivery?

The Ministry of Urban Development has developed Service Level Benchmarks (SLBs) that are aimed at helping ULBs in assessing their performance on key service delivery aspects over the entire MSW value chain. However, these SLBs do not reflect issues at the micro level and are inadeqaute to design specific interventions at the ward/zone level.Therefore, ULBs are advised to initiate a performance assessment at the wardlevel. The key performance indicators that need to be tapped at the ward level are presented below:

Household Coverage

Waste generator	Target	Achieved
Household	100	...
Institution	100	...
Commercial	100	...

MSW Segregation

Waste type	Target	Achieved
Food & kitchen	100	...
Recyclables	100	...
Non-recyclables	100	...

Collection Efficiency

Income group wise

Income category	Target	Achieved
High	100	...
Medium	100	...
Low	100	...

Geography wise

Unit	Target	Achieved
Zone	100	...
Ward	100	...



MSW Recovery

Recycled

Waste Type	Target	Achieved
Plastic	80	...
Paper	80	...
Metal	80	...
Glass	80	...

Processed

Method	Target	Achieved
Compost	80	...
Biogas	80	...
RDF	80	...
Electricity	80	...

Revenue Collection Efficiency

Income group wise

Income Category	Target	Achieved
High	90	...
Medium	90	...
Low	90	...

Geography wise

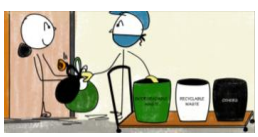
Unit	Target	Achieved
Zone	90	...

Scientific Disposal

Parameter	Target	Achieved
Direct	100	...
Rejects from processing plants	100	...
Mixed waste	100	...
Landfill gas utilisation	100	...

Cost Recovery of MSWM Services

Parameter	Target	Achieved
Direct	100	...
Rejects from processing plants	100	...
Mixed waste	100	...
Landfill gas utilisation	100	...



Complaints Redressed

Parameter	Target	Achieved
Collection related	100	...
User charge	100	...
Health/Environment	100	...
Others	100	...

IV.3 Environmental Monitoring

The Need

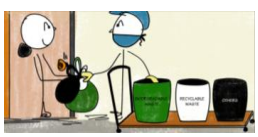
Municipal waste pollutes air, water and soil. Monitoring the environmental impact of SWM activities is very important in due to the high risks associated with exposure to different categories of waste. The minimum acceptable standards for compost is presented in Exhibit 46 below. Exhibit 47 provides an overview of features of good and inferior quality compost.

Exhibit 46: Standards for Compost[xviii]

Parameter	Maximum Acceptable Concentration Parts per Million (ppm)
Mercury	10
Arsenic	20
Cadmium	20
Nickel	100
Chromium	300
Copper	500
Lead	500
Zinc	2500

Exhibit 47: Compost Quality

Criteria	Good Quality	Inferior Quality
Colour	Brown/Black	Varies
Odour	No foul odour	Foul odour
pH	6.5 to 7.5	Below 6 or above 8
C:N Ratio	20:1 or less	>20:1
Moisture	15.0-25.0%	>30 %
Temperature	30 to 40 degree C	>45 degree
Humus	6-8 %	< 4 %
Nitrogen	>1.0 %	<1.0 %
Plant growth	Good	Poor

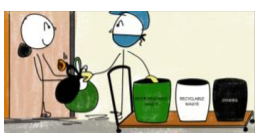


A: Annexure

Model Questionnaire for Demand Assessment

Bibliography

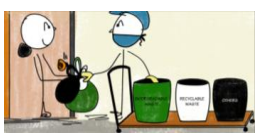
Endnotes



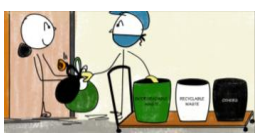
A.1 Annexure

Model Questionnaire for Demand Assessment[xix]

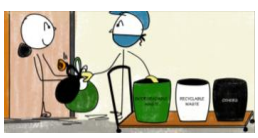
Model Questionnaire	
Assessment of demand and willingness to pay	
Objective	To assess demand, willingness to pay and affordability
Pre-requisites	A pre-feasibility study to determine different service options and the associated advantages, disadvantages, capital and operational costs for each of the options. This information would be necessary to address the concerns of the respondents.
Classification of waste generators	Representative areas to be surveyed are selected. One representation could be a mix of income profile and the quantity of waste that is generated. The classification here will be: 1. High income households 2. Middle income households 3. Low income households Mixed commercial and residential 4. Market areas 5. Industrial 6. Institutions
Who should be surveyed?	The respondent should be the head of a household or head of establishments for other categories. In the absence of the head, a person who is involved in the decision making about financial and other aspects could be interviewed.
What should be the sample size?	For each of the seven categories listed above, the number of respondents could be between 100 and 200. The method of identifying respondents could be based on random (stratified) sampling.



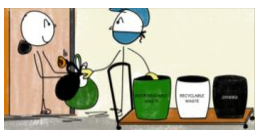
Questionnaire sheet	
A. Identification	*"I would like to ask you some questions that would assist the local government in determining how to improve the solid waste collection service to your neighbourhood. These questions usually take about …… minutes. We are interviewing a sample of …… % of the households and establishments in your neighbourhood, so your input is considered very valuable to this survey. Let me first ask you a few questions to understand more about this house (or establishment) and you."*
Household/Establishment No.	…
Zone/Ward/Street No.	…
Name of the respondent	…
Position of the respondent (in the HH/Establishment)	…
No. of persons (in the HH/Establishment)	…
Economic profile	a) High income b) Middle income c) Low income d) Very low (Slum)
B. Major concerns	Provide a list of options to the respondent a) No waste bins b) Inadequate waste bins c) No door to door collection service d) Irregular door to door collection service e) Foul odour due to waste in the area f) Problem due to waste bin/transfer station/processing plant/dump yard/landfill in the neighbourhood g) Staff behaviour h) User charges related
C. *Existing situation regarding solid waste*	*"I would like to ask you some questions regarding the collection or removal of solid waste from your household or establishment"*
C1	Does your household (or establishment) have a durable metal or plastic container for storing solid waste? a) We use a durable bin b) We use a non-durable waste storage unit (plastic bags, paper bags, carton box, etc.) c) We do not have a bin d) Do not know
C2	Does your household (or establishment) receive a collection service of



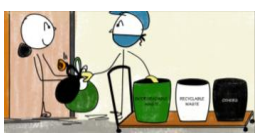
	any type? [it could either provided by the ULB or community/NGO) a) Yes [Ask question in C3] b) No [Go to section D] c) Do not know
C3	How frequently is your container usually taken out to be emptied? a) Daily b) Twice a week c) Thrice a week
C4	Do you have someone in your house/establishment to take the bin out for disposal? a) Yes b) No
C5	Where do you empty the bin? a) On an open pile of waste on the street b) Community bin c) Apartment/Society bin
C6	How far is the place for emptying the bin? (note down the distance in meters or the time taken to reach the bin)
C7	If the bin is emptied by b) and c) as in C5. How often is that waste from that place or bin collected? a) Daily b) Twice a week d) Thrice a week
C8	Who collects the waste from the curb side, communal container, or pile? a) ULB Staff b) Staff of ULB appointed NGO c) Staff of ULB appointed private company d) Others, please specify
C9	What is your opinion of the service that you are receiving for collection of solid waste from your household? a) Very satisfied b) Reasonable satisfied c) Not satisfied at all d) Don't know
C10	If you are not satisfied with the service, would you state your *primary* reason? a) Irregular or non reliable service b) Frequency of collection



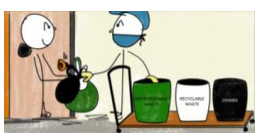
	c) Location of the bin d) Staff behaviour e) Transportation of waste
C11	Do you know where the collected waste is taken for final disposal when it leaves your neighbourhood? a) Yes (ask next question) b) No c) Not concerned
C12	Are you concerned about whether the final disposal is environmentally safe and acceptable? a) Yes b) No c) Not concerned
D. *Description of proposed service options*	*The municipality is preparing a plan to improve the management of MSW in the city and would like to take your feedback to understand your preference. I would like to discuss the options with you. For each of these options, the cost is different. Households and establishments in your neighbourhood will be expected to pay a fee for this improved service. The type of service provided will depend on the fee which you and your neighbours can afford and are willing to pay, as well as your preferences.*
D1	*Would you like to ask any questions about the plans to upgrade the solid waste system?* a) Yes (take the interview further and record the inputs) b) No (thank the respondent for the feedback)
E. Demand assessment	
E1	Which of the collection methods listed below do you prefer given your convenience and cost a) System1– (describe the community bin system) b) System 2 – (describe the curb side collection system) c) System 3 –(The door-to-door collection would be done by a worker using a pushcart) d) System 4 – (A vehicle would come to the neighbourhood on a scheduled basis and provide a door-to-door service. At each building, containers of waste, which have been left at the curb side, would be emptied into the vehicle. The emptied containers would be placed neatly at the curb for residents to bring back into their household (or establishment). Residents would be required to adhere to the schedule and bring their waste to the curb in proper containers before the vehicle arrives) Based on the response of the individual, kindly take the conversation forward using the questions listed below a) Option a [go to question E2] b) Option b [go to question E7]



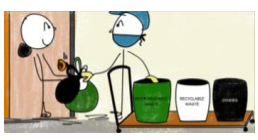
	c) Option c [go to question E10] d) Option d [go to question E13]
E2	*If your preferred collection method (a) were introduced, how far would you be willing to walk to the large communal container?* a) 50 m b) 100 m c) 150 m d) 200 m e) More than 200m
E3	*If your preferred collection method (a) were introduced, would you be willing to have the communal container within 20 meters of your house or establishment)?* a) Yes [go to question E5] b) No [go to question E4]
E4	Please describe your concerns.
E5	*The cost of collection of method (a) is INR.../month. Would you be willing to pay this fee to cover the cost of the waste collection service?* a) Yes [go to question E21] b) No [go to question E6]
E6	*What is the maximum fee per month your household or establishment would be prepared to pay for the collection method that you have chosen method (a)?* (i) INR...per month (ii) Will not pay (iii) Cannot pay
E7	*If your preferred collection method (b) were introduced, are there certain times of day when you would find it most convenient to meet the vehicle when it comes to your block to collect waste? (More than one answer may be checked.)* a) Early morning before 9 AM b) Anytime in the morning c) Anytime in the afternoon d) Anytime during daylight
E8	*The cost of collection method (b) is ..... per person per month if the collection vehicle comes ..... times per week. The fee would be INR... per month. Would you be willing to pay this fee to cover the cost of the collection service?* a) Yes [go to question E21] b) No [go to question E9]



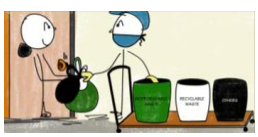
	c) Don't know
E9	*What is the maximum fee per month that your household (or establishment) would be prepared to pay for the collection method that you have chosen method (b)* (i) INR.../month (ii) Won't pay (iii) Cannot pay (iv) Don't know
E10	*If your preferred collection method (c) were introduced, would you be willing to have the community bin within 20 meters of your house or establishment)?* a) Yes b) No c) Don't know
E11	*The cost of collection method (c) is ..... per person per month for collection ..... times per week. Would you be willing to pay this fee to cover the cost of the collection service?* a) Yes [go to question E21] b) No [go to question E12] c) Don't know [go to Question E12]
E12	*What is the maximum fee per month your household or establishment would be prepared to pay for the collection method that you have chosen method (c)?* a) INR.../month [go to question E17] b) Won't pay any fee [go to question E16] c) Can't pay any fee [go to question E16] d) Don't know
E13	*If your preferred collection method (d) were introduced, what type of containers do you think that you and your neighbours should use for putting out your waste at the curb side?* a) Metal dustbin b) Plastic dustbins c) Plastic or nylon bags
E14	*The cost of collection method (d) is INR... per person per month for collection of your waste from the curb side ..... times per week. Would you be willing to pay this fee to cover the cost of your preferred collection method?* a) Yes [go to question E21] b) No [go to question E15] c) Don't know [go to question E15]



E15	*What is the maximum fee per month your household or establishment would be prepared to pay for the collection method that you have chosen method (d)?* a) INR...per month [go to question E17] b) Won't pay any fee [go to question E16] c) Can't pay any fee d) Don't know
E16	*What is the reason that you are unsure or don't want to pay for a collection service?* Please give reason(s).
E17 (For those who stated that they are unsure or don't want to pay for the collection service from government, or are not willing to pay the government enough to cover the full cost of service.)	*Would you be willing to pay the full cost of the collection service if a private company or a community based organisation was providing the service and collecting the fee directly from you?* a) Yes [go to section F] b) No [go to question E18] c) Don't know
E18	*What is your reason for not being willing to pay a fee to cover the full cost of a waste collection service from the government or a private company?* a) Can't afford to pay for the full cost [go to question E20] b) Don't trust that the service will be reliable [go to question E 19] c) Don't consider the service important enough to pay for [go to question E19] d) Believe that general taxes/property tax should cover the cost of this service [go to question E19] e) Others, please explain
E19	*If you are not willing to pay for a collection service and government cannot afford to subsidise it for you, would you support decentralised community based organizations for undertaking MSWM activities. The support could be by* a) Supply of segregated waste b) Labour for management activities like monitoring c) Composting of kitchen waste in your household premises and sale of recyclables to scrap dealers d) Other forms, please specify
E20	*If you cannot afford to pay for the full cost of the collection method that*



	you initially selected, would you consider an alternative method that offers a lower level of service or more effort on your part? Which of the following alternatives would be most acceptable to you? (More than one answer can be checked.) a) Selection of a low cost method b) Walking a longer distance to empty bins c) Less frequent collection of waste d) Participate as a volunteer in community waste management program e) Other cost saving suggestions f) Don't know
E21	*If you have said that you are willing to pay for a collection service, whom would you prefer to provide the service to you?* a) Municipality b) Private company c) NGO d) Don't know
E22	*If you have said that you are willing to pay for a collection service, to whom would you prefer to pay the fee?* a) To municipal staff b) To staff of private company c) To community leader d) Any one e) Don't know



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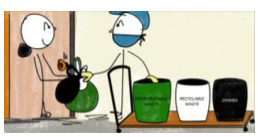
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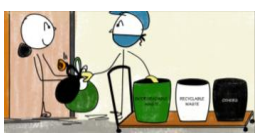
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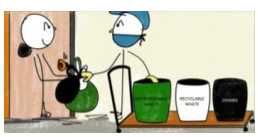
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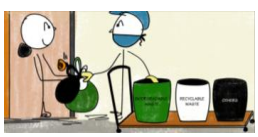
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Endnotes

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[v]Collection and transportation activities together constitute approximately 80–95% of the total budget ofMSW.Source:http://www.unc.edu/courses/2009spring/envr/890/002/readings/SolidWasteIndiaReview2008.pdf
[vi]http://aaqua.persistent.co.in/aaqua/forum/viewthread?thread=23589
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[ix]http://municipalsolidwastepyrolysis.com/
[x]http://www.recycleforgloucestershire.com/recover/what-are-we-doing/downloads/incineration.pdf
[xi]Extended Producers Responsibility (EPR) refers to a scenario where producers would be responsible for the entire life cycle of a product i.e., from design to waste. At present, the Government of India is considering this provision for hazardous electrical and electronic equipments. There is growing debate over proposing EPR for other types of waste also. For details, please refer to "Draft E-waste (Management and Handling) Rules 2010 Ministry of Environment and Forests, GOI.
[xii]http://www.calrecycle.ca.gov/SWFacilities/Fires/LFFiresGuide/default.htm
[xiii]In management of services, the community has a different definition. Here the community does not imply all the citizens who are likely to get affected by the project, but it refers to the groups/bodies that are composed of select members from these citizens. The members of the community group take the responsibility of the services as agreed upon with the ULB and/or private agency and represent the citizens as a whole. There may be contractual agreements between the community groups and the ULB/private agency.
[xiv]A sample questionnaire for undertaking demand and willingness to pay assessment is provided in the annexure.
[xv]Handbook on Sanitation and SWM in Andhra Pradesh: Key learnings from German Cities (2012)
[xvi]http://www.projectsmonitor.com/detailnews.asp?newsid=7670
[xvii] EPC and service contracts are not considered as PPPs but are forms of procuring the services of the private agency
[xviii]http://urbanindia.nic.in/publicinfo/swm/chap14.pdf
[xix]This questionnaire is only indicative in nature and it could be customised to suit local conditions. It has been adapted from Cointreau – Levine S, Coad A and Gopalan P. (2000) 'Guidance Pack: Private Sector Participation in Municipal Solid Waste Management', Swiss Centre for Development Cooperation in Technology and Management, St. Gallen.



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