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Public-private partnerships in urban solid waste management: A review

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ABSTRACT

This paper is on Public-Private Partnerships (PPP) in Solid waste management. After the bubonic plague in 1994, India tried to improve on its Solid Waste Management. The magnitude of funds required for in this area cannot be financed by the public sector alone. The private sector, therefore, has to play a major role in this sector. This paper followed the following trajectory in the understanding PPP in Solid Waste Management. First, it gives an overview of SWM in India, Second it talks about how the concept changed over time. Third, it gives the rationale for PPP in SWM. Fourth, it also issues and the different kinds of projects under SWM. Finally, it discusses the key considerations and conclusion.

Keywords: *Solid waste management, Public-private partnerships*

1. INTRODUCTION

1.1 What is Solid Waste Management?

Solid waste can be defined as nonliquid material that no longer has any value to the person who is responsible for it. The words rubbish, garbage, trash, or refuse are often used as synonyms when talking about solid waste. In urban areas, solid waste is generated by domestic households, commercial and industrial enterprises, and health care and institutional activities, as well as on the streets. Street refuse contains a mixture of refuse from many sources because streets are used as dumping grounds by all generators of waste. Where sanitation facilities are lacking and a large animal population roams the streets, street refuse contains a lot of human fecal matter and manure. Streets are also often used for extensive dumping of construction and demolition debris—attracting further dumping of solid waste. The term **Municipal Solid Waste** (MSW) refers to solid waste from houses, streets and public places, shops, offices, and hospitals. Management of these types of waste is most often the responsibility of municipal or other governmental authorities. Although solid waste from industrial processes is generally not considered municipal waste, it nevertheless needs to be taken into account when dealing with solid waste because it often ends up in the MSW stream.

1.2 The Solid Waste Management System

A typical waste management system in a low or middle-income country includes the following elements:

- Waste generation and storage
- Segregation, reuse, and recycling at the household level
- Primary waste collection and transport to a transfer station or community bin
- Street sweeping and cleaning of public places
- Management of the transfer station or community bin
- Secondary collection and transport to the waste disposal site
- Waste disposal in landfills
- The collection, transport, and treatment of recyclables at all points on the solid waste pathway (collection, storage, transport, and disposal). In the past, these important elements of waste management were often regarded only from an engineering and technical viewpoint. It is essential to realize that these elements are embedded in the local institutional, socio-cultural, and economic context, which are further influenced by national politics, policies, and legislation as well as national and global and economic factors.

Physical handling of solid waste and recyclables (storage, collection, transport, treatment) & so on are just one SWM activity; it alone cannot fulfill the requirement for sustainable and integrated solutions. Other activities are equally important:

- Making policy, as well as setting and enforcing standards and regulations
- Evaluating data on waste generation and characterization for the purposes of planning and adapting system elements
- Ensuring that workers and planners get training and capacity development
- Carrying out public information and awareness and education programs

- Identifying and implementing financial mechanisms, economic instruments, and cost-recovery systems
- Incorporating formal and informal elements of the private sector as well as community-based activities and nongovernmental organizations (NGOs)

2. SWM IN INDIA: AN OVERVIEW

India produced approximately 48 million people million tons of urban solid waste annually. Current urban waste generation is estimated at .46 kgs per capita per day. This is two to three times more than the rural waste and is increasing at 1.3% per year. The current urban growth rate is estimated at 3.5% has serious implication in terms of waste quantity. In addition as GNP & urban population grow, paper & packaging waste will also increase shifting waste composition. These changes will further stress the already limited financial resources & inadequate waste management systems.

Indian municipalities have overall responsibility for solid waste management (SWM) in their cities. However, most of them are currently unable to fulfill their duty to ensure environmentally sound and sustainable ways of dealing with waste generation, collection, transport, treatment, and disposal. The failure of municipal solid waste management (MSWM) can result in serious health problems and environmental degradation. Because of deficient collection services, uncollected waste—often also mixed with human and animal excreta—is dumped indiscriminately in the streets and in drains, thereby contributing to flooding, breeding of insect and rodent vectors, and spreading of diseases. Furthermore, even the collected waste is disposed of in uncontrolled dumpsites or burned openly, thus contributing to severe environmental impacts including pollution of water resources and air. The problem of SWM in India, when combined with rapid urbanization and unplanned development, is expected to be of such magnitude that significant reasons exist to initiate immediate action for improvement of this appalling situation.

Since the infamous bubonic plague in 1994, India has seen a spate of improvement in solid waste management. Various ministries have formed high-powered committees, there has been increased public awareness & participation manifested in PILs & NGO involvement. Supreme Court issued guidelines & Ministry of Environment & Forest rules outlines procedures for waste segregation, collection, storage, transportation & disposal. The MOEF has also set deadlines for cities to establish suitable waste processing, disposal, and landfill facilities. These requirements have generated demand for technical expertise, equipment, material, and resources.

2.1 Some Facts about Municipal Solid Waste Management in India

The total Indian urban population amounts to approximately 285 million.
There are 4,378 cities and towns in India. Of those cities, according to the 2001 census, 423 are considered class I, meaning that the population exceeds 100,000.
The class I cities alone contribute to more than 72 percent of the total municipal solid waste (MSW) generated in urban areas. Class I cities include 7 mega cities (which have a population of more than 4 million), 28 metro cities (which have a population of more than 1 million), and 388 other towns (which have a population of more than 100,000).

The population growth rate in urban India is high. The percentage of the total population living in urban areas shows a continuous increase. The current world population of 7.3 billion is expected to reach 8.5 billion by 2030.

The Central Public Health and Environmental Engineering Organization (CPHEEO) estimated a per capita waste generation in Indian cities and towns in the range of 0.2 to 0.6 kilograms per day. A World Bank publication (Hanrahan, Srivastava, and Ramakrishna 2006) estimated that in 2000 urban India produced approximately 100,000 metric tons of MSW daily or approximately 35 million metric tons of MSW annually.

Data concerning the physical composition of MSW are shown in the table below. Comparing 1996 with 2005 shows how the physical composition of MSW can change over time along with the changing lifestyle and economic growth of the country. Although the typical urban growth rate has been determined at around 2.5 percent annually (Globalis 2005), the growth of waste generation is outpacing the urban population growth in Indian cities (Singhal and Pandey 2001). Therefore, urban population growth, as well as increasing per capita waste generation, will continue to amplify the waste problem. To prevent future problems, India must take immediate steps to control waste generation, to enhance recycling recovery and reuse, and to ensure better collection and sustainable disposal.

Table 1: Changing concept of SWM

Year	Biodegradable	Paper	Plastic/ Rubber	Metal	Glass	Rags	Other	Inerts
1996	42.21	3.63	0.60	0.49	0.60	-	-	45.13
2005	47.43	8.13	9.22	0.50	1.01	4.49	4.016	25.16

- Earlier, there was a linear system of collection, storage transportation, and disposal
- Indifference towards environmental and health hazards
- Now, viewed from a cyclic perspective
- Emphasis on Resource recovery
- Towards holistic treatment of waste
- Sensitive to environmental and health hazards

Waste management until recently has been treated as a linear system of collection and disposal, creating health and environmental hazards. Until now, the problem of waste has been seen as one of cleaning and disposing of as rubbish. But a closer look at the current and future scenario reveals that waste needs to be treated holistically, recognizing its natural resource roots as well as health impacts. Waste can be wealth, which has the tremendous potential not only for generating livelihoods for the urban poor but can also enrich the earth through composting and recycling rather than spreading pollution as has been the case. Increasing urban migration and a high density of population will make waste management a difficult issue to handle in the near future if a new paradigm for approaching it is not created.

The new paradigm includes a cradle-to-grave approach with responsibility being shared by many stakeholders, including product manufacturers, consumers and communities, the recycling industry, trade, municipalities and the urban poor. The new approach is, therefore, cyclic in nature and holistic in perspective, where sensitivity to environmental & health hazards is weaved in. The table below will give a better picture as of this new paradigm.

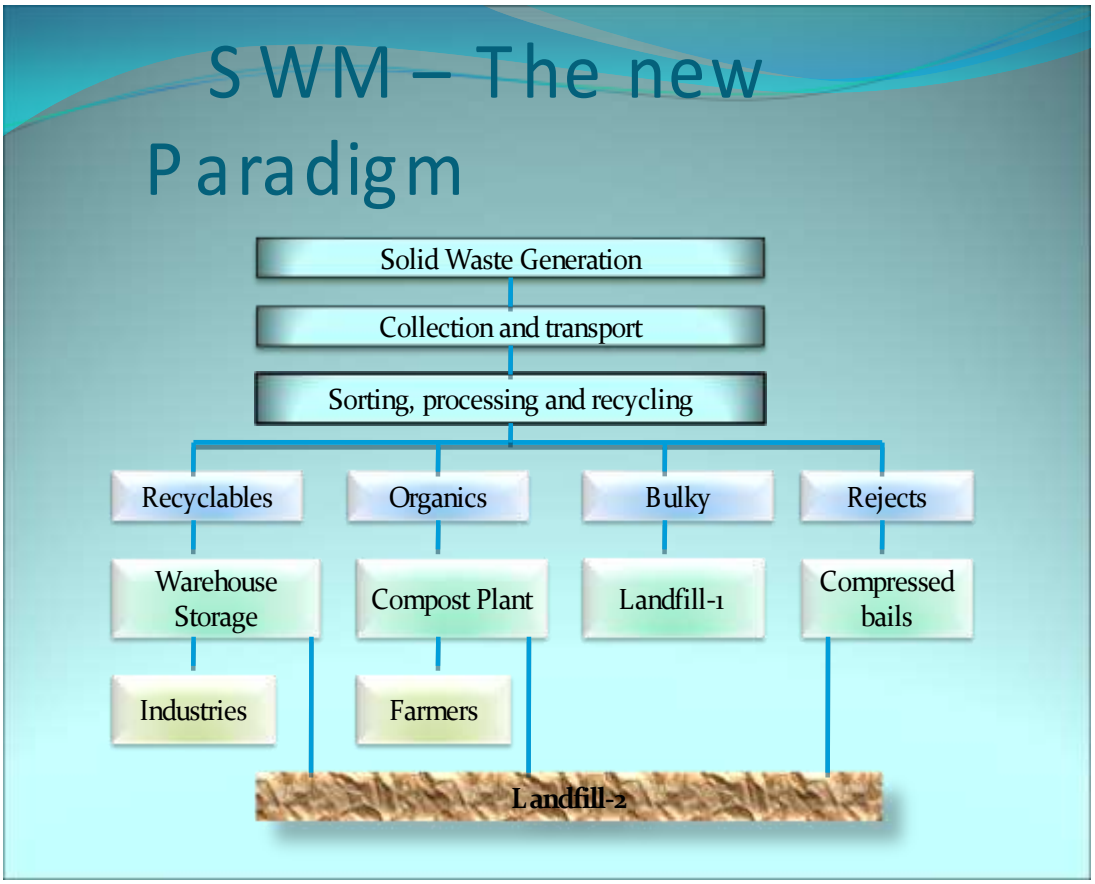

Fig. 1: SWM

2.2 What then is our waste?

Consumption, linked to per capita income, has a strong relationship with waste generation. As per capita income rises, more savings are spent on goods and services, especially when the transition is from a low income to a middle-income level. Urbanization not only concentrates waste but also raises generation rates since rural consumers consume less than urban ones. India will probably see a rise in waste generation from less than 40,000 metric tonnes per year to over 125,000 metric tonnes by the year 2030 (Srishti, 2000). Technologies, which can process organic wastes, have to be a mainstay to any solution. The Supreme Court appointed the Burman Committee (1999), which recommended that composting should be carried out in each municipality. Composting is probably the easiest and most appropriate technology to deal with a majority of our waste, given its organic nature.

However, new and expensive technologies are being pushed to deal with our urban waste problem, ignoring their environmental and social implications. It is particularly true in the case of thermal treatment of waste using technologies such as gasification, incineration, pyrolysis or pellatisation. Indian waste content does not provide enough fuel value (caloric value) for profitable energy production (and is unlikely to do so soon). It needs the addition of auxiliary fuel or energy. Such technologies put communities to risk and are opposed widely. For example, the United States has not been able to install a new incinerator for the past five years, while costs for burning garbage have escalated astronomically with rising environmental standards in Europe.

3. CHALLENGES AHEAD

- Developing countries are being used as dumping grounds for redundant technologies such as incinerators
- Estimated quantitative increases in Municipal waste with rising population & per capita income
- Shifting Waste Composition with rising per capita income
- In view of tighter environmental regulations, the task of municipal bodies becomes more challenging, both in magnitude and complexity

Estimated quantitative increases

As mentioned earlier, India presently produces approx. 48 million tons of urban solid waste, annually. Urban waste generation is 2 to 3 times to that of rural waste generation. The rate of urban waste generation is increasing at the rate of 1.3 % annually. According to an estimate by Shristi, by 2030, the annual solid waste generation is likely to be tripled.

4. WASTE GENERATION & CHARACTERISTICS

Table 2: Status of Municipal Solid Waste Generation in Metro Cities of India

S. No.	Metro city	Municipal Population	Municipal solid waste, (tones/day)	Per capita generated (kg/day)
1	AHMEDABAD	28,76,710	1,683	0.585
2	BANGALORE	41,30,288	2,000	0.484
3	BHOPAL	10,62,771	546	0.514
4	BOMBAY	1,22,88,519	5,355	0.436
5	CALCUTTA	1,06,43,211	3,692	0.347
6	COIMBATORE	8,16,321	350	0.429
7	DELHI	84,19,084	4,000	0.475
8	HYDERABAD	40,98,734	1,566	0.382
9	INDORE	10,91,674	350	0.320
10	JAIPUR	14,58,483	580	0.398
11	KANPUR	18,74,409	1,200	0.640
12	KOCHI	6,70,009	347	0.518
13	LUCKNOW	16,19,115	1,010	0.624
14	LUDHIANA	10,42,740	400	0.384
15	MADRAS	47,52,976	3,124	0.657
16	MADURAI	9,40,989	370	0.393
17	NAGPUR	16,24,752	443	0.273
18	PATNA	9,17,243	330	0.360
19	PUNE	22,44,196	700	0.312
20	SURAT	14,98,817	900	0.600
21	VADODARA	10,31,346	400	0.388
22	VARANASI	10,30,863	412	0.400
23	VISAKHAPATNAM	7,52,037	300	0.399
	Total/Average	6,68,85,287	30,058	0.449

The quantity and composition of MSW vary from place to place and bear a rather consistent correlation with the average standard of living. Extensive field investigations were carried out for quantification, analysis of physical composition, and characterization of MSW in each of the identified cities.

4.1 Characteristics

Typically, domestic waste from industrial countries has a high content of packaging made of paper, plastic, glass, and metal, so the waste has low density. In many developing countries, domestic waste contains a large proportion of inert materials, such as sand, ash, dust, and stones, and has high moisture levels because of the high usage of fresh fruit and vegetables. These factors make the waste very dense (high weight per unit volume). Vehicles and systems that operate well with low-density wastes in industrial countries are not suitable or reliable for heavy wastes. The combination of the extra weight, the abrasiveness of sand, and the corrosiveness caused by the water content can lead to very rapid deterioration of equipment. Waste that contains a high proportion of moisture or is mostly inert material is not suitable for incineration, ruling out one treatment option. Recycling or salvaging operations often reduce the proportion of combustible paper and plastic in waste before it reaches the treatment stage, further reducing its suitability for incineration.

4.2 Why do we need PPP in SWM?

According to India's constitution, SWM falls within the purview of the state government. The activities are local ones and are entrusted to urban local bodies (ULBs) through state legislation. Because these activities are **non-exclusive, nonrival, and essential, the responsibility for providing them lies within the public domain**. ULBs accordingly undertake the task of SWM service delivery. However, many municipal authorities in India provide SWM services very inefficiently. Old and inappropriate vehicles and tools for collection, inadequate transport, and inefficient disposal not only cause unhygienic working conditions and slow down the process but also severely affect the environment. Productivity is very low, resulting in a high unit cost of service. **Collection coverage rates are only 50 to 70 percent. The collected waste is disposed of at open dumping grounds within or outside cities, causing health hazards and environmental degradation.** The poor performance of municipal authorities led to the filing of public interest litigation in the Supreme Court of India. The Supreme Court constituted an expert committee to look into all aspects of SWM and directed all municipal authorities to follow the committee's recommendations. The Ministry of Environment and Forests directed all municipal authorities in the country to take seven essential steps to provide SWM services in an efficient and environmentally acceptable manner. None of the 4,378 municipal authorities in the country has yet implemented all seven steps within the set time frame.

This unsatisfactory situation makes it necessary for the municipal authorities to seriously consider new concepts and approaches for improving services. Private sector participation is an interesting option for boosting performance, whereby the municipal authorities change their role from service provider to the regulator and service facilitator. Different forms of collaboration with the private sector can be envisaged, involving different types of agreements and preconditions of partnership. Enabling improvements through the participation of the private sector depends on the political will for change; clear agreements and contracts; the public authority's ability to regulate the service, monitor performance, and enforce the terms of the agreement; financial capacities; and mutual trust between all partners. Opportunities and Challenges in Private Sector Involvement. The overall objective of involving the private sector is to achieve an improvement in SWM service and to extend coverage to the yet unserved. Delegating tasks and responsibilities to the private sector, however, also entails new challenges for all. All critical factors must be taken into account to prevent misuse or failure of private sector participation. The advantages and disadvantages of involving the private sector strongly depend on the manner in which the tasks and service are contracted out and on the way the daily operational procedures of collaboration between public and private sector are handled and ensured.

4.3 Issues in PPP in SWM

To attract private sector participation and cutting costs of service it is important to have appropriate contract periods. To make the contracts with the private sector effective and bankable their duration & compensation should be sufficient. They should be for a period which is long enough to enable the contractor to repay the loans which he has taken to purchase the equipment or refinance the facilities for the work.

The start of operation must be clearly defined. Putting undue pressure on the contractor to start early quite often leads to improper start and disrepute.

- Adequate preparation time should be provided to the contractor to start the operation.
- Special consideration should be given when certain tools and equipment are to be manufactured or imported and need several clearances.
- In case of large contracts for collection of waste, the insistence should be to start in phases and scale it up over a reasonable period of time for the smooth operations of the contract.

5. TERMS OF PAYMENT

- The most commonly used payment methods are lump sum and unit price.
- In the lump sum contract, the contractor has no risk, gets a fair deal and the risk is reduced.
- In unit price method it is necessary to verify the measurement procedure from time to time and adequately supervise the same
- The concept of "tipping fee" payable by the contracting agencies, of late, is being accepted (integrated treatment landfill at Bangalore, collection & transportation concessions at MCD etc)
- Collection & transportation services are usually paid either based on the quantum of MSW handled or on the number of vehicle trips for transportation.
- Street sweeping contracts are either lump sum based or manpower based.
- Urban local bodies incline to treat MSWM as a profitable operation, have been demanding sharing of revenues/ royalty payments for providing waste, for example, compost plants at Thiruvananthapuram & Mysore and Bio mechanization plant at Lucknow

6. ALLOCATION OF RISKS

- There is a need to define the project appropriately to resolve all the issues and to allocate risks equitably (to the party which is best able to manage the same).
- Lack of clarity or excessive transfer of risks to the private sector may actually lead to lack of participation. Hence, there is a need for contracting agencies to invest in requisite technical, market, financial viability studies to reduce project risks and attract bidders to the project.
- For example, North DumDum in West Bengal. Here the contractor is at a risk if citizens fail to pay the fees and municipalities does not underwrite or assist in cost recovery.

Risk Category	Examples
Operational risk	Delay in construction
	Cost overrun
	Quality and performance failures
	Increasing operation costs
Demand risk	Change in demand
	Cost increase for resources
	Change of tariffs
Financial risk	Delayed or canceled payment
	Fluctuation of foreign exchange rates
	Fluctuation of interest rates
Country risk/ political risk	Expropriation/ breach of contract/ war
	Cancellation of credits
	No refund of profits

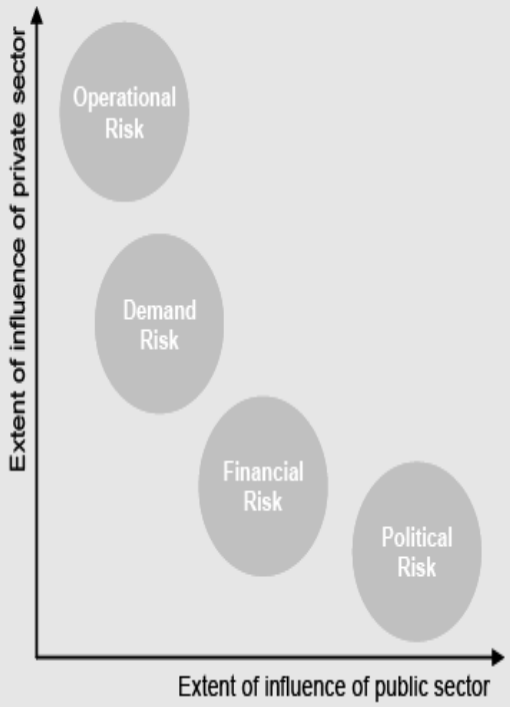

Fig. 2: Risks and potential influence of partners within a public-private partnership

7. LEGAL FRAMEWORK AND INSTITUTIONAL ARRANGEMENT

The Municipal Solid Waste (Management and Handling) Rules 2000

The Municipal Solid Waste (Management and Handling) Rules lay down the steps to be taken by all municipal authorities to ensure management of solid waste according to best practice. Municipal authorities must meet the deadlines laid down in Schedule I of the rules and must follow the compliance criteria and procedure laid down in Schedule II.

Hence, municipal authorities are responsible for implementing provisions of the 2000 rules. They must provide the infrastructure and services with regard to the collection, storage, segregation, transport, treatment, and disposal of MSW. Municipal authorities are requested to obtain authorization (that is, permission or technical clearance) from the state pollution control board or committee to set up waste processing and disposal facilities, and they must deliver annual reports of compliance. The state pollution control boards are directed to process the application of municipal authorities and to issue an authorization to the municipalities within 45 days of the application's submission. The CPCB is responsible for coordinating the implementation of the rules among the state boards. The municipalities were mandated to implement the rules by December 2003, with punishment for municipal authorities that failed to meet the standards prescribed; nevertheless, most municipalities did not meet the deadline.

The urban development departments of the respective state governments are responsible for enforcing the provisions of the rules in metropolitan cities. The district magistrates or deputy commissioners of the concerned districts are responsible for enforcing the provisions within the territorial limits of their jurisdictions.
The state pollution control boards are responsible for monitoring compliance with the standards on groundwater, ambient air, and leachate pollution. They must also monitor compliance with compost quality standards and incineration standards as specified in the rules.

The deadline for implementing Schedule I of the 2000 rules has already passed and compliance is far from effective. Some cities and towns have not even started implementing measures that could lead to compliance with the rules. Enforcement and sanctioning mechanisms remain weak. Other cities and towns have moved somewhat forward, either of their own accords or because of pressure from the Supreme Court, their state government, or their state pollution control board.

Under Schedule II of the rules, municipal authorities have been further directed to set up and implement improved waste management practices and services for waste processing and disposal facilities. They can do so on their own or through an operator of a facility (as described in Schedules III and IV of the rules). Standards for waste processing and disposal facilities are defined in the rules, and municipal authorities are required to meet the specifications and standards specified in Schedules III and IV.

MSWM refers to the entire process chain, comprising seven steps: (1) waste segregation and storage at source, (2) primary collection, (3) street sweeping, (4) secondary waste storage, (5) transport of waste, (6) treatment and recycling options for solid waste, and (7) final disposal. All seven steps are equally important and should be harmonized. Authorities need to consider specialized strategies for different waste generators (households, shops and commercial establishments, industries, hospitals, and so forth) and appropriate measures for the different levels in the SWM chain (household level, neighborhood level, regional level, and so forth). They must also coordinate with the different actors in the management of waste throughout the waste management levels.

Status of Compliance with the 2000 Rules

No consolidated official data are available about the status of compliance of MSW. However, the figure below shows estimated percentages of compliance. Municipal authorities report numerous reasons for noncompliance with the 2000 rules.

Prevalent Deficiencies and Challenges in the SWM System in India

An expert committee appointed by the Supreme Court identified the following deficiencies in the SWM system in India.

- No storage of waste at source
- Partial segregation of recyclable waste
- No system of primary collection of waste at the doorstep
- Irregular street sweeping
- The inappropriate system of secondary storage of waste
- Irregular transport of waste in open vehicles
- No treatment of waste
- Inappropriate disposal of waste at open dumping grounds

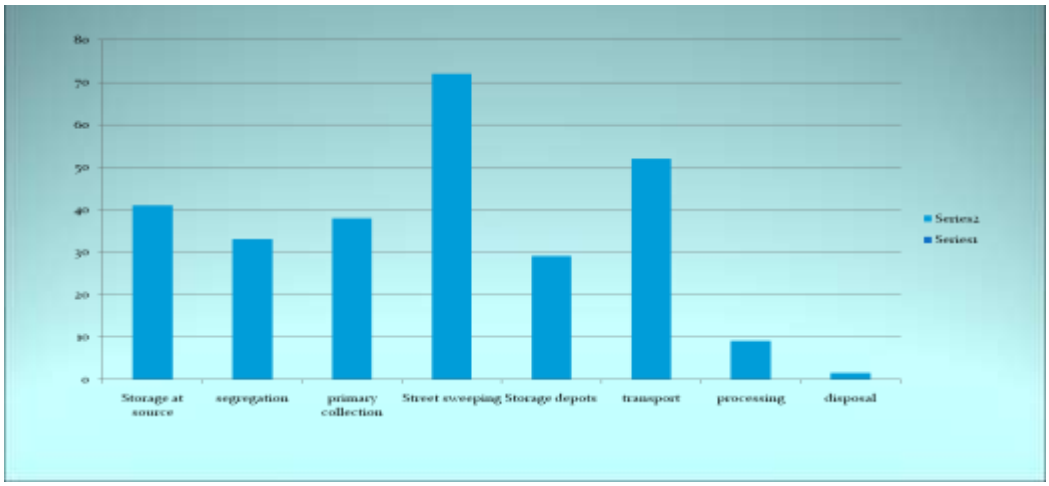

Fig. 3: Compliance with the 2000 rules

Table 3: Reasons for noncompliance with the 2000 rules

Area of compliance	*Reasons for noncompliance*
Storage of waste at source	• Lack of public awareness, motivation, and education • Lack of civic sense and bad habits of people to litter • Lack of cooperation from households, trade, and commerce • Lack of stringent panel provision • Lack of powers to levy spot fines • Lack of litter bins in the city • Long distance between community bins • Resistance to change in attitude
Segregation of recyclable waste	• Lack of wide publicity through electronic and print media • Lack of public awareness and motivation, resulting in poor response from citizens • Lack of citizens' understanding how to use separate bins for storage of recyclables • Lack of sufficient knowledge of benefits of segregation • Lack of cooperation and negative attitude of people • Lack of finances to create awareness • Difficulty of educating slum dwellers • Lack of effective legal remedy

Collection of waste from doorstep	• Lack of awareness and motivation • Unavailability of primary collection vehicles and equipment • Insufficient response from citizens • Lack of financial resources • Difficulty of motivating slum dwellers • Lack of personnel for door-to-door collection • Lack of suitable containers
Daily sweeping of streets	• Excessive leave and absenteeism of sanitary workers • Unavailability of workers on Sundays and public holidays • Kuchha (unpaved) roads • Lack of financial resources
Abolition of open waste storage depots and placement of containers	• Shortage of containers • Lack of financial resources • Lack of planning for waste storage depots • Inaccessible areas and narrow lanes that do not allow sufficient space for containers
Transportation of waste in covered vehicles	• Old vehicles that are difficult to replace
Processing of waste	• Lack of financial resources • Lack of technical know-how • Lack of skilled personnel • Unavailability of appropriate land • Lack of basic facilities to set up treatment plants • Lack of institutional capacity
Disposal of waste at the engineered landfill	• Lack of financial resources • Lack of technical personnel • Lack of technical know-how for scientific disposal of waste • Unavailability of appropriate land • Lack of institutional capacity

Source: Asnani 2004a.

8. REGULATION & MONITORING

This is done through a) Process of authorization b) Reporting

a) The process of Authorization:

The municipal authority or an operator of a facility shall make an application in Form-I, for grant of authorization for setting up waste processing and disposal facility including landfills from the State Board or the Committee in order to comply with the implementation programme laid down in Schedule I. The State Board or the Committee, after the receipt of application from the municipal authority or the operator of a facility in **Form I,** for grant of authorization for setting up waste processing and disposal facility including landfills, shall examine the proposal taking into consideration the views of other agencies like the State Urban Development Department, the Town and Country Planning Department, AirPort or Air Base Authority, the Ground Water Board or any such other agency prior to issuing the authorization.

b) Reporting:

The municipal authority shall furnish its annual report in **Form-II**,-

- to the Secretary-in-charge of the Department of Urban Development of the concerned State or as the case may be of the Union territory, in case of a metropolitan city; or
- to the District Magistrate or the Deputy Commissioner concerned in case of all other towns and cities,

8.1 Annual Reports

- The State Boards and the Committees shall prepare and submit to the Central Pollution Control Board an annual report with regard to the implementation of these rules by the 15th of September every year in **Form-IV**.
- The Central Pollution Control Board shall prepare the consolidated annual review report on the management of municipal solid wastes and forward it to the Central Government along with its recommendations before the 15th of December every year.

8.2 Emerging PPP Arrangements in SWM

Indian cities are introducing PSP in SWM in order to attract funding and new technology and to achieve cost savings and improved efficiency and effectiveness in service delivery. ULBs in India have experimented with the following types of PSP arrangements.

8.3 Contracting for Maintenance, Equipment, & Vehicles

Vehicular Fleet Maintenance and Repair: Local bodies often contract with local garages for minor repairs and maintenance of their waste transportation fleet.

Leasing Vehicles: Leasing is a way to access equipment and vehicles when the opportunity to borrow for capital investment is limited. Typically the lessor provides vehicles as well as fuel and maintenance. Mumbai has leased vehicles for waste transportation for all its 24 wards for more than15 years.

8.4 Service Contracts for Waste Collection and Transportation

More than 50 ULBs have contracted with private firms for waste collection and transportation in selected zones. Typically these contracts are fee-based- the local body pays the private firm a monthly fee for the provision of services. In cities using simpler technologies that require moderate investment, such as Hyderabad, local firms are increasingly entering the business of waste collection and transportation. Metro cities with larger budgets and greater management capacity, such as Chennai and Mumbai, prefer mechanized solutions requiring larger investments that have attracted national and international firms.

8.5 Long-Term Concessions for Resource Recovery Projects

Long-term concessions, such as Build-Own-Operate-Transfer (BOOT) or Build-Own-Operate (BOO) contracts, are a form of agreement being used for revenue-generating components of SWM, such as resource recovery projects. In these arrangements, the private firm finances and owns the solid waste facilities for a period sufficient to depreciate investments and provide a reasonable return to equity investors. The ULB typically grants and enables access to a specified quantity of solid waste. It may also provide land for the facility at a nominal lease. The most popular resource recovery projects are composting and waste-to-energy.

9. WASTE COMPOSTING PROJECTS

Composting involves bacterial decomposition of the organic portion of solid waste. Approximately 35composting projects have been set up in India with PSP in the past five years, most in the states of Maharashtra, Tamil Nadu, Andhra Pradesh, and Kerala. Typically the arrangement has been on a BOO or BOOT structure. The treatment capacity of these facilities ranges from 80 to700 TPD and their combined capacity is about three million tons per year. Some 17 more projects are being finalized. The capital investment required for such facilities (capacity 100 to 700 TPD) typically ranges from Rs. 30 to75 million, and project financing has predominantly been driven by promoter equity. The private firm recoups its investment by selling compost derived from waste processing.

Key risks associated with such projects include demand for compost and sustainability of operations. The quality of compost produced must be closely monitored, since, without waste segregation at the source, compost may become contaminated.

10. WASTE-TO-ENERGY (WTE) PROJECTS

WTE project technologies include incineration, pelletization, and bio-methanation. The viability of these technology options is still being established in India. The incineration plant at Timarpur (Delhi), set up in 1987using Danish technology, failed to operate properly because the waste fed into the plant did not have sufficient calorific value.

In the past, Vijayawada, Baroda, Bangalore, Mumbai, and Kalyan tried to set up pelletization facilities. The pellets, produced by segregating and drying combustibles from waste, would be burned for industrial fuel initially and for power generation ultimately. These projects either stalled in development or were eventually shut down due to poor pellet quality. Last year, the city of Hyderabad set up, on a trial basis, a pelletization plant with a waste handling capacity of 200 TPD.

In recent years, as a result of Ministry of Non-Conventional Energy Sources (MNES) programs, there has been much interest in generating power through bio-methanation of municipal solid waste. Bio-methanation involves bioconversion of organic matter to biogas and humus. This methane-rich biogas is then used to generate power. WTE projects require larger investments and are more complex than composting projects, so ULBs must have the capacity to handle complex PSP arrangements and documentation. Nagpur, Lucknow, Chennai, Mumbai, Bhopal, and Delhi plan to set up such facilities. These jurisdictions generate sufficient waste; typically the minimum required for such facilities is 300 TPD. Project financing, Rs. 400-800 million, is arranged using a mix of promoter equity, loans from financial institutions, suppliers' credit, and government subsidies. Two projects that have reached an advanced stage of development, in Nagpur and Lucknow, are structured on a BOO basis. Construction of the Nagpur (Maharashtra) facility, designed to generate approximately 5.4 megawatts (MW) per day, began in December 1999.

Key risks associated with WTE projects relate to technology. The quantity and quality of available waste are also critical. Financing risks must be suitably addressed with back-to-back agreements (e.g., for energy offtake) in place. Financial institutions also attach great importance to the promoter's qualifications.

Community Contracting

Contracting Cities are increasingly accepting the role of non-government and community-based organizations in urban waste management. Some cities are experimenting with community contracting to complement service provision by the ULB.

11. THE EXPERIENCE SO FAR

11.1 Privatizing MSW Collection and Transportation

Chennai Municipal Corporation, Tamil Nadu

In order to mechanize and modernize its service delivery and management, the Chennai Corporation privatized waste collection and transportation in three zones, about 35 percent of its area. It hired consultants to assist it through the entire process. Following

a competitive bidding process, the Corporation entered into a seven-year agreement in November 1999 with M/S C.G.E.A. Asia Holdings, Singapore. Operations began in March 2000. The private operator is responsible for sweeping, collecting, storing, and transporting waste (garbage, construction, and garden waste), and for creating public awareness. It will deploy more than 1,800employees, 30-35 compacter and hook lift trucks, 170auto rickshaws, 800 modified bicycles, and 5,300mobile garbage bins. It will also modernize two vehicle depots and two transfer stations. The waste to be removed is more than 1,000 tons per day (TPD). The rate for the first year is Rs. 648 per ton, which is to be escalated annually at five percent. This is much lower than the Corporation's own estimated cost of Rs. 1,050 per ton. Most Corporation workers were reassigned to other departments and no worker lost his or her job. The private firm recruited and train edits own workers and supply the uniforms, gloves, caps, shoes, and safety gear. (http://www.chennaicorporation.gov.in/departments/solid-waste-management/index.htm)

11.2 A BOOT Solid Waste Composting Project
Kolhapur Municipal Corporation (KMC), Maharashtra

The composting project was conceptualized in late1996, with the assistance of the FIRE project. The Corporation first enlisted consultants to conduct field measurements and base studies, prepare procurement documents, and support the bidding process. In April 1999, the KMC selected Zoom Developers Ltd. to implement the project, in association with Larsen Engineers. The KMC and Zoom Developers (concessionaire) signed a 30-year, Build-Own-Operate-Transfer (BOOT) contract in September 2000. The Corporation will provide four hectares of land on a long-term lease to the concessionaire, who will design, build, operate, and maintain the waste treatment facility for this period, and mobilize its financing. The facility will handle 160 TPD in the initial year, increasing to 270 TPD in the final year. The KMC will deliver solid waste to the treatment site (a weekly average of 770 tons), for which the concessionaire will compensate it with a fixed annual payment of Rs. 0.48 million (escalated annually at eight percent). The concessionaire will pay the city one rupee per square meter per year for the land lease. The city estimates it will receive Rs. 0.65million in the first year of the facility's operation. The concessionaire, who is responsible for marketing organic fertilizer produced from composting of waste, will retain income from sales.

11.3 Contracting Community Groups
Vijayawada Municipal Corporation, Andhra Pradesh

The Vijayawada Municipal Corporation facilitates the formation of area-based community groups of women and children that are put in charge of sweeping, cleaning, collecting, and transporting garbage, and de-silting drains in their area. The Corporation supports these groups by arranging to finance of sanitation vehicles and implements. Each garbage vehicle unit, consisting of a tractor and a trailer and costing approximately Rs. 0.26 million, is financed by a Corporation subsidy of 50 percent, a bank loan of 45 percent, and the remaining 5 percent by the group. The loan is further secured against guaranteed future income from the rental fee of Rs. 350 per day that the groups pay for each vehicle unit. The Corporation deducts Rs. 150 per day of this amount and repays the bank on behalf of these groups. Each group member is paid Rs. 55 per day. Of this, Rs. 5 goes to a group fund used for uniform jackets, shoes, and implements. As of August 2000, 12 of these groups, including three-night sanitation groups, covered about 20 percent of the town area.

12. PPP IN SWM – KEY CONSIDERATIONS

To attract PPP, local bodies must start by putting their financial house in order. In the absence of user charges, the contract fees come from general revenues. This requires that cities designate income from operating revenues and strengthen their overall resource base.

The next critical issue is linked to labor. Since such a large portion of the municipal staff is engaged in SWM, it is imperative to devise a staffing plan that adequately addresses the apprehensions of these workers. Issues linked with the Contract Labour (Regulation and Abolition) Act of 1970 must also be carefully examined. ULBs must develop in-house financial and managerial capacity to arrange private sector contracts. Monitoring private sector operations is important since the responsibility of ensuring proper service delivery and standard compliance remains with the municipality. Finally, PPP must be introduced within the framework of an overall waste management plan for the city.

13. CONCLUSIONS: SOME CONCERNS IN SWM

It is important that municipal authorities must treat the organic fraction of waste before disposal. Municipal authorities are expected to set up a plan for composting waste or to adopt waste-to-energy technology as may be appropriate. Currently, private entrepreneurs are advocating several technologies for the processing and treatment of organic MSW. Some of the technologies have been used in India in the past, such as microbial composting and vermin composting, whereas some are based on applications used in foreign countries that have yet to be tried in India or that have failed in India. Such applications include incineration for power generation.

Quite often, municipal authorities fail to assess the suitability of new technology to Indian conditions. They may be attracted to technology that is successfully used in industrial countries without evaluating its applicability to India. As a result, they may meet failure later. It is important to avoid this mistake and to properly address the issue of suitability to local conditions, including local technical knowledge, operational capacity, and cost of maintenance. Municipal authorities should also consider seeking expert opinion from outside the municipality. The criteria that are in the table below could be adopted when selecting appropriate waste processing and disposal technologies.

Table 4: Criteria for selection of technology or a variety of technologies

Technical criteria	*Financial criteria*	*Managerial criteria*
• Experience with technology under Indian conditions (references) • Scale of operation • Required land, water, and power • Locally available spare parts • Process aesthetics • Environmental impact	• Investment cost • Operation cost • Financing mechanisms • Market for end product (demand, price)	• Labor requirement • Skills for operation and maintenance • Skills for monitoring and management

Source: Ministry of Urban Development and Poverty Alleviation 2005b.

13.1 Waste recycling

In India has great untapped potential that can benefit Indian society as a whole. Throughout the country, there is a need to upgrade and reorganize the recycling system, to increase the effectiveness of the waste collection and recycling system, and to improve the working conditions for rag pickers. The Supreme Court's expert committee acknowledged this potential in its report and recommended further action toward intensified recycling that takes into consideration all stakeholders. Schedule II of the 2000 rules lay down mandatory directions for waste segregation and processing within municipal management services. Hence, municipalities need to select appropriate processing technologies in the recycling sector.

13.2 Treatment of Organic Waste

Household waste can contain 40 or 50 percent of organic waste. Waste from urban fruit and vegetable markets contain even higher amounts. Because organic waste causes major hygienic and environmental problems in cities and at landfills, the 2000 rules mandate improved management and treatment of this fraction before final disposal. Several treatment options for organic waste are available.

13.3 Composting

In the 2000 rules, composting is defined as a controlled process involving microbial decomposition of organic matter under aerobic conditions. Biodegradable waste is converted to a soil-like substance (compost), which is a valuable soil amendment and fertilizer. India has a well-established composting community with a wealth of experience in composting. However, only a few municipalities have adopted composting as a treatment option in their SWM strategy. Many composting initiatives are not formally linked to the official system and, therefore, struggle with organizational, financial, and institutional problems. Sustainable composting is possible only with the financial or organizational support of municipal authorities. Composting schemes vary in terms of scope, technology, and management.

13.4 Anaerobic digestion

Anaerobic digestion is a process that produces biogas from decomposed waste. The biogas can be used to power electricity generators or to produce heat. The anaerobic digestion process reduces the volume of organic matter from the waste stream, therefore reducing the amount of waste that needs to be put in a landfill or incinerated.

13.5 Incineration and other technologies

Indian waste has a low calorific value—between 700 and 1,000 kilocalories. Therefore, it is not suitable for incineration. Any technology for incineration requires a high calorific value input. Municipal authorities should, therefore, be very careful in assessing this option for disposal of waste. A large incineration plant set up in Delhi in 1986 failed and had to be closed down. However, two power plants using refuse-derived fuel are in operation in Andhra Pradesh at Hyderabad and Vijayawada. Both produce 6.5 megawatts of power, but those plants may be using more agro waste than MSW. The technology should, therefore, be carefully evaluated in the Indian situation. While considering this technological option, municipal authorities should look at the calorific value of the waste and keep in mind the likely reduction in the calorific value on account of segregation of recyclable waste (which has a high calorific value) at the source.

13.6 Treatment of Inorganic Waste

The inorganic fraction of municipal household waste can be divided into recyclable materials and nonrecyclable materials. The earlier recyclable materials are segregated from the solid waste stream, the higher their value and the easier the further processing. The appropriate treatment option for inorganic waste depends on its physical and chemical characteristics as well as on its reuse potential. In India, the predominant treatment option for inorganic waste is recycling through the informal sector. This method has the potential to salvage nearly 20 percent of such waste and for reuse and recycling. **Experiences with incineration (waste-to-energy approaches) are less promising.** The recycling sector is well established in India; however, much is left to do regarding working conditions and environmental protection.

14. REFERENCES

[1] http://siteresources.worldbank.org/ENRLP/Resources/460956-1163449042857/Private_Sector_Participation.pdf

[2] Gupta Sanjay (2004). Rethinking waste management: http://www.indiatogether.org/rethink-environment.

[3] Globalis (2005). South Africa: Urban population, Global.

[4] Hanrahan, David; Srivastava, Sanjay; Ramakrishna, A. Sita. (2006). Improving Management of Municipal Solid Waste in India: Overview and Challenges. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/19463 License: CC BY 3.0 IGO."

[5] Massoud, M. & EI, Fadel, M. (2002). Public-Private Partnerships for Solid Waste Management Services PMID: 12375083 DOI: 10.1007/s00267-002-2715-6. https://www.ncbi.nlm.nih.gov/pubmed/12375083.

[6] Massoud, M. A., [a1]Fadel[b] E. I, Malak, A. Abdel . (2003). Assessment of public Vs private MSW management: a case study. Journal of Environmental Management, 69(1).

[7] Singhal, S. and Pandey, S. (2001) "Solid Waste Management India, Status and Future Direction," TERI Information Monitoring on Environment Science, Vol. 6, No. 1, pp. 1-4.

[8] Srishti (2000). Fifth Srishti survey of medical waste disposal practices in health care units of Delhi. New Delhi.

