STRATEGIES FOR IMPROVEMENT OF URBAN SOLID WASTE MANAGEMENT IN INDIA

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Abstract *This paper discusses the various strategies involved in the management of urban solid waste in India. Following factors have been highlighted (i) work norms for workers (ii) proper maintenance of vehicles and optimisation of transportation routes (iii) design and standardisation of incinerators for hospital and industrial waster (iv) sanitary landfillings (v) community development and training programs. It is also stressed that the present available bye laws are very old and in-adequate and need to be replaced by more comprehensive enactment.*

INTRODUCTION

Wastes generated in solid state as a result of various human activities are commonly termed as ' Solid Wastes'. Solid Waste Management involves managing various activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid wastes in an environmentally compatible manner adopting principles of economy, aesthetics, energy and conservation. Solid Waste Management in urban areas is the responsibility of the concerned civic agencies who spend on an average 5-25% of their budget on this activity (Bhide and Sundaresan, 1983), which works out to about Rs. 50-150 per capita per year. This does not include the money spent by industries, on managing industrial solid wastes. Due to the low priority accorded to this activity, the financial allocation and attention given to solid waste management is considerably less resulting in inadequate services. This paper reviews the existing practises in India, points out areas where improvements are needed and identifies an action plan for the same.

MANAGEMENT

Solid waste management mainly involves management of activities which are engineering oriented such as collection, transportation and operation of processing and disposal facilities. For obtaining best results, proper professional leadership needs to be provided. In majority (90%) of Indian urban centres, Health Officer is assigned to manage this activity (CPHERI, 1973) who is not able to provide required attention to this additional responsibility. He takes the assistance of the engineering department for provision and maintenance of the transport vehicles. Poor services in Solid Waster Management are often a result of lack of intersectoral co-ordination.

Collection and disposal of municipal solid waste is mainly labour intensive. Table 1 gives the manpower provision for this activity per million population served. It can be seen that in 75% of the towns, 1000-3000 workers are provided per million residents served. However, the cleanliness and promptness of services are not directly proportional to the number of workers provided and good results are obtained only when an effective organisation and management is provided.

Table1 Manpower provision for solid waste management

No. of workers/million residents	% of cities (out of 43)
1000-2000	47.5
2000-3000	27.5
3000-4000	18.5
4000-5000	7.5

WASTE CHARACTERISTICS

Knowledge of physical and chemical characteristics of waste materials is useful for ascertaining the frequency of removal of waste from generation point as also the problems likely to be encountered during its collection and transportation. The data is also important while designing the transportation equipment and in the selection and design of the processing and disposal methods. The data collected from 43 Indian cities indicated that due to the common practice of using fresh vegetables and fruits, the waste contains a high organic fraction necessitating frequent collection and removal of solid waste from the collection points (Table 2).

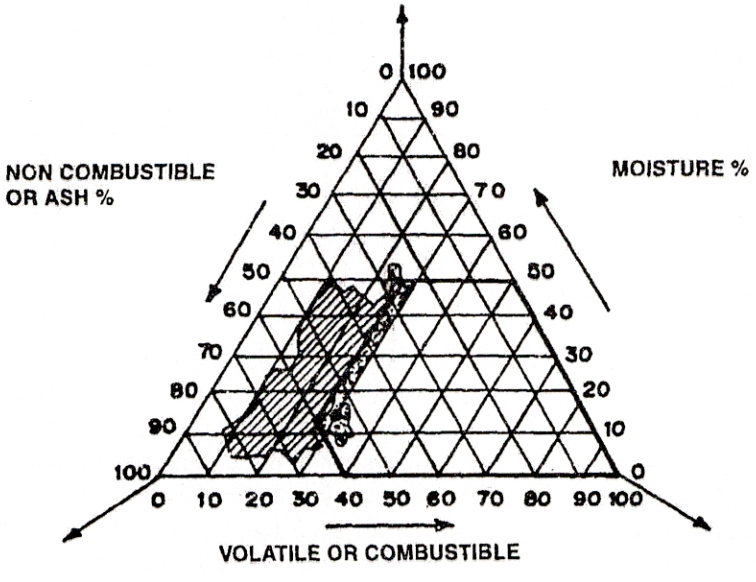
The solid waste in India contains an appreciable quality of ash and fine earth. This is mainly due to the practice of adding street sweepings, drain silt and construction and demolition debris to the community waste bins. As the proportion of asphalt and concrete pavement increases, the percentage of ash and earth content tends to decrease (CPHERI, 1973). The high ash and earth content tends to give a higher density value of 330-560 kg/m^3. As paper, glass and plastic are commonly recycled, only that fraction which is in an unrecoverable form remains in the waste.

Table 2 Chemical characteristics of Indian urban solid waste

Characteristics	Range %
Paper^{+}	3-7
Plastics^{+}	0.5-0.9
Metals^{+}	0.3-0.9
Glass^{+}	0.3-0.9
Ash and fine earth^{+}	30-55
Total compostable matter^{+}	30-55
N^{++} (Total)	0.5-0.65
P^{++} as P_2O_5	0.5-0.85
K^{++} as K_2O	0.5-0.80
LCV^{++} in Kcal/kg	800-1050

$^{+}$On wet weight basis; $^{++}$On dry weight basis

The calorific value on dry inert free basis varies between 800-1050 Kcal/kg[2]. The 'Three Component Diagram' (Fig. 1) indicates that a self-sustaining combustion cannot be obtained and auxiliary fuel will be required. Thus, incineration is expected to be a very expensive and uneconomical method.



Zone in which self- sustaining combustion reaction can be obtained.

Zone in which values from 33 Indian cities lie.

Zone in which values from some Indian cities lie giving a self - sustaining combustion reaction.

Fig. 1 Three Component Diagram

Per Capita Waste

The quantity of waste from various cities was accurately measured by NEERI. The quantity of waste produced is lesser than that in developed countries and is normally observed to vary between 0.2-0.4 kg/capita/day[2] (CPHERI, 1973). Values up to 0.5 kg/capita/day are observed in metropolitan cities (Table 3). While the total Indian urban population was recorded as 217.16 million in 1991, the total quantity of MSW from urban areas is estimated to be 20.71 million tonnes/year.

Table 3 Quantity of municipal solid waste in India urban centres

Population range (in million)	Number of urban centres	Total population (in million)	Average per capita value (kg/capita/day)	Quantity (tonne/day)
<0.1	328	68.300	0.21	14343.00
0.1-0.5	255	56.914	0.21	11952.00
0.5-1.0	31	21.729	0.25	5432.00
1.0-2.0	14	17.184	0.27	4640.00
2.0-5.0	6	20.597	0.35	7209.00
>5.0	3	26.306	0.50	13153.00

COLLECTION OF WASTE

Collection from Premises

In India, community bin system is used and it is the responsibility of the owner or his employee to deposit the waste in the community bins located at street corners.

House to house collection system is not commonly used, except in some parts of Bombay and Kolkata. In commercial areas of many towns, the collection staff moves at specific times with large sized handcarts and the waste from adjoining premises is collected. The industries arrange for collection of waste within their premises.

Street Cleansing

This work is carried out manually by workers working in groups, who are assigned specific areas known as 'Beats'. The road is swept and the sweeping taken to a convenient point. It is then transferred to handcart by another worker. The collected material is deposited in the community bin located at street corners. The short handled broom suffers from a number of drawbacks and needs to be replaced by long handled broom (Bhide and Sudaresan, 1983). Two and three wheeled handcarts having capacities ranging between 50 to 100 litres are commonly used. Handcarts with a number of replaceable containers have recently been introduced which are expected to gain wider acceptance (NEERI, 1982).

Community Bin System

This is the most widely used system where in storage bins are provided at frequent intervals on the road side and the bins are owned and maintained by civic authorities. A variety of bins are in use in different cities. The simplest and most common type consists of a RCC pipe section (1 m dia, 1 m high) open at both ends. As these are quite heavy and do not have resale value, they are rarely stolen. The G.I. community bins (circular or rectangular) which were previously used, though quite convenient, get stolen. Wherever the quantity of waste collected is large,

masonary bins are constructed. These have usually two or more openings for the worker to enter to deposit and remove the waste. In big cities, bins in the form of enclosed rooms having two or more openings are often constructed. In different cities these are known by various names such as Chamber, Dalao, etc. (Bhide and Sundaresan, 1980). In some cases, a parked trailer of a vehicle is used as a bin while in some cases, a large sized bin which can be directly lifted and transported by a truck prime mover is also used (Bhide and Sundaresan, 1983). The collected waste is taken away to processing/disposal site as often as possible depending on the need and availability of vehicles.

TRANSPORTATION OF WASTE

Transfer of Waste from Bin to Transport Vehicle

This is normally carried out manually by the labourers (4-6 in number), who transfer material from bins to the vehicles using baskets. After the bin is emptied, the vehicle, along with the labourers, moves to the next bin and so on, till fully loaded. Majority of vehicles are now equipped with tipping gear and hence these workers need not travel to processing/disposal site and can be dropped after filling the vehicle at another bin. In such cases where the bin is lifted and taken to disposal site directly, this additional handling step is avoided.

Transport Vehicles

These are usually departmentally owned and, only in a few cases contractor's vehicles are used. Though different vehicles ranging from bullock carts to compactor vehicles are in use in Indian cities, majority of the towns use normal 5-7 tonne trucks for such transportation work. These vehicle when new are used for other purpose and assigned fir waste transport when old.

Recently, a number of vehicles such as container carrier system and dumper placer system have been introduced where in the containers of the vehicles are themselves used as community bins. A vehicle with an empty container on reaching the collection point, unloads the empty container, lifts the container filled with solid waste and transports it to the disposal site. Compactor vehicles are not economical to use for high density Indian municipal solid waste and are able to provide a compaction ratio of only 1.25 to 1.5. As their capital costs is high and as they require extensive maintenance they are uneconomical and hence not commonly used.

PROCESSING OF WASTE

Out of the various processing methods, composting in pits by using Bangalore Method is commonly used in small towns and cities.

In the case of larger towns and cities due to non-availability of adequate space, manual composting is not used. About 10 mechanical compost plants were

constructed during 1975-80 using different flow-sheets. An evaluation of these plants indicated that over mechanisation, lack of consumer acceptability of the compost, and absence of compost, consumers in the vicinity were the main reasons for their failure (NEERI, 1981). Fig. 2 shows the type of mechanical composting plant recommended by NEERI for Indian conditions.

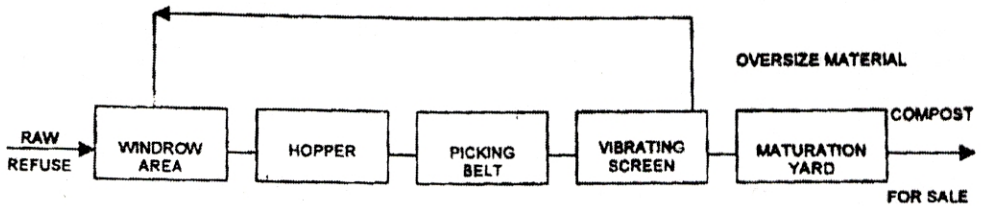


Fig. 2 Mechanical composting plant recommended by NEERI for Indian conditions.

Incineration of waste from hospitals is necessary but rarely practiced. The lackadaisical attitude and general apathy towards incineration of infectious hospital waste needs urgent correction. Incineration of industrial solid waste is commonly observed. But majority of these units are not properly designed and operated. It is necessary to arrive at proper design criteria (Muley et al., 1983) for incineration of waste from hospitals and industries.

DISPOSAL OF WASTE

Land disposal is the commonest method used, and in some cases, marshy lands are also being filled up and reclaimed. Most of the towns operate at least one land disposal site, though, in some metropolitan cities, multiple sites are used. Unfortunately, majority of the landfill sites are only dumps where the waste is used to fill low lying areas and no specific precautions are taken with the result that pollution of surface and ground water by leachates commonly occurs.

LEGISLATION

Public Health an Sanitation falls within the purview of State Laws. Collection and disposal of solid wastes is of local nature and is entrusted to local civic authorities and forms its obligatory duty.

Local civic authorities in some states like U.P., Punjab, Bihar, Tamil Nadu and West Bengal are governed by old laws and regulations passed in 1916, 1911, 1922, 1920, and 1932 respectively which deal with collection and transport of the waste. These old regulations deal with domestic and, to some extent, trade waste only cursorily. They do not provide sufficient powers to civic authorities for prosecution of offenders with the result that enforcement becomes ineffective.

It is, therefore, necessary to frame regulations which are more specific, take into account the future developments and cover specifically all the different aspects

of solid waste management. A comprehensive law can help improve the situation tremendously as illustrated by the case of Singapore.

PROJECTED SCENARIO

The 217 million urban population in 1991 is expected to increase to 395 million in 2011. Consequently the present waste quantities are expected to increase from 20.17 to 56.33 million tonnes in 2011 (Table 4).

Table 4 Quantity of municipal solid waste from urban areas

S.No.	Year	Total Urban Population	Quantity (in million tonnes/year)
1	1991	217	20.71
2	2001	295	39.28
3	2011	395	56.33

The waste composition is expected to change only marginally, with an increase in paper and plastic content and decrease in ash and earth content. Due to rapid urbanisation, prevailing land used regulations and competing demands for available land, acquisition of additional land filling sites will be difficult unless the sites are selected during the planning stage itself.

PROBLEMS ASSOCIATED WITH THE SYSTEM

On critical analysis of the existing practices, the following main issues emerge and need to be tackled on a priority basis:

- Fragmented management
- Ineffective Bye-laws
- Rapidly increasing areas to be served and quantity of wastes
- Inadequate resources
- Societal and management apathy
- Use of inappropriate technology
- Low efficiency of the system

ACTION PLAN

Unitary Control A nodal ministry responsible for identifying and implementing priority items and for providing necessary financial and other resources should be identified. The activity at municipal level should be carried out by an independent department with necessary organisational and financial support.

Update Byelaws Byelaws which make specific provisions for levying of user charges, its recovery and penalty for non-compliance and non payment be farmed and adopted.

Provision of Adequate Resources The present allocation of funds is made mostly on adhoc basis and is not related to the requirement. Adequate funds should be provided so as to enable provision of necessary level of service. A new revenue instrument of a dedicated solid waste management tax (different from the existing inadequate conservancy tax) be created which should be gradually introduced. An element of cross subsidy to the weaker sections of the society should be build in this system.

Citizens Participation A sustained programme involving citizens, NGOs and other organisations should be implemented to obtain citizens operation. citizens forums should be formed in every ward.

Adoption of Appropriate Technology The equipment and vehicle should be designed and manufactured to suit the local conditions. Collection equipment which avoids multiple handling of the waste by containerising it should be adopted. New processing and disposal technology should be adopted only after pilot testing and detailed techno economic evaluation.

Strengthening of Professional Training Suitably trained manpower will be required to optimally utilise the various equipments and vehicles. A trained cadre of personnel should be provided at all levels.

Improvement in Efficiency The efficiency of the system will improve if properly designed equipment is used and maintained by suitably trained manpower. The downtime to vehicles should be reduced by a scheduled preventive maintenance programme and replacement of spare parts at appropriate times.

SUMMARY

Municipal agencies spend a significant portion of their budget on Solid Waste Management. For obtaining better results, allocation of funds should be increased and a rationalised tariff structure should be introduced.

The waste characteristics indicate the necessity of more frequent collection and transportation of the waste. Work norms for workers at various levels need to be laid down. Continuous monitoring of work is necessary to ensure improved performance. Presently, satisfactory performance is not obtained mainly due to use of improper vehicles on ill planned routes. It is, therefore, necessary to use suitable vehicles and optimise the transportation routes.

Composting is the processing method commonly used in India. Incineration is rarely used due to the high capital and operating cost. Design of incinerators for hospital and industrial waste needs to be standardized.

Wastes are mostly disposed of by dumping in low lying areas which can cause a number of problems. Sanitary landfilling techniques need to be practiced to avoid these problems.

The laws and bye-laws are very old and inadequate and need to be replaced by more comprehensive enactments. Community participation be improved by

involving the citizens in decision making at local level and by a sustained compaign for public awareness. Training programmes should be run for staff at all levels to ensure better operation of the system.

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