9th WEDC Conference: Sanitation and water for development in Africa: HARARE: 1983

URBAN SOLID WASTE: APPROPRIATE TECHNOLOGY

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1. INTRODUCTION

The Solid Waste Management services can absorb upto 1% of the G.N.P. and is one of the most expensive city services. At 3 to 6 workers per 1000 population, solid waste workers may represent about 1 to 2% of the total national work force in the developing countries. In order to optimise return from this huge public expenditure, every country must evolve an indigenous technology for Solid Waste Management based on the quantity and character of the wastes, the level of national income, wage rates, equipment manufacturing capacity, energy costs and various social and cultural factors typical to the community. A careful analysis of the present status of solid waste management in the cities and towns in India would lead one to the inevitable conclusion that better sanitation standards could still be achieved in most of the third world cities and towns by prudent and well planned allocation of available resources through the application of appropriate technology. The All India Institute of Hygiene and Public Health is presently carrying out a pilot study sponsored by the Calcutta Metropolitan Development Authority and financed by the World Bank on various technical and managerial aspects of municipal solid waste management and the experience of the project team strengthens the above view points.

2. EXISTING STATUS OF SOLID WASTE MANAGEMENT IN SMALL AND MEDIUM TOWNS IN INDIA

The collection and disposal of refuse within an urban area has been, traditionally the responsibility of local self Government Bodies. These bodies, except in the cases of a few large Metropolitan Cities, do not have adequate managerial and technical manpower at their disposal to plan and operate the Solid Waste Management programme at the desired level. Most municipalities spend a sizable portion of their annual budget for Solid Waste Management and for the maintenance of surface drains. But in absence of adequate planning and management and as a result of inappropriate technology, much of the municipal expenditure and efforts in this direction have gone waste. In a sample survey conducted by the All India Institute of Hygiene and Public Health in 34 municipal towns with varying levels of urbanisation and socio-economic circumstances, population varying between 20,000 to 3,50,000 and density of population varying between 5000/sq.KM. to 30,000/Sq. KM, it was observed, -

(i) In more than 60% of the municipalities surveyed, less than 40% of the solid wastes are collected daily. Against an average generation of 400 to 500 gms/capita/day average. Collection is mostly less than 200 gm/capita/day.

(ii) In absence of any house to house collection system and adequate no. of community containers, collection is from open on-road dumps. These dumps are invaded by scavangers and animals which scatter the wastes, the rats have access to food, and fly larva migrate and pupate in the vicinity. Leachate from decomposing and putrifying garbage percolates into soil and nearby water sources. Resultant contamination of food, water and soil has caused frequent epidemics of cholera, jaundice, typhoid and other pest borne diseases.

(iii) Uncollected solid waste finds its way into the open drains meant for rain and sullage water, thus blocking flow and creating water logging. This has created acute mosquito problems in most municipal towns. Moreover removal of solid waste from these unlined open drains results in wastage of much labour.

(iv) The handling process involves collection from the street into ill-designed hand carts which again dumps them on the ground to be picked up by rakes and baskets and put into trucks. This results in wastage of labour and waiting time for vehicles apart from the great health risk that the workers and public at large are exposed to.

(v) More than 80% of the collected solid waste in municipal towns are disposed off by filling up private lands scattered all over the town in most uncontrolled hap-hazard and insanitary manner which is a potential health risk for the community. Municipalities possess less than 0.32 hectares of land for every 10,000 persons for disposal of solid waste as well as night-soil.

The above observations though based on a sample survey in 34 municipal towns in India, by and large reflects the general level of Solid Waste Management in many of the Asian and African towns, which could be attributed primarily to the failure of the authorities to develop a Solid Waste Management System appropriate to the socio-economic circumstances of the community and its available financial resources. Expenditure on Solid Waste Management varies between Rs.8/- to Rs.20/- per capita per annum in India (£1=18 at 1981 level). Man-power employed varies between 3 to 6 persons per 1000 population. The quality of services provided in most urban areas, particularly in small and medium towns, in terms of quantity of solid waste collected and environmental protection provided to the community, does not justify this expenditure.

3. PILOT STUDIES

3.1. Project Objective

(a) Development of a fully/partly containerised collection and transportation service which would not allow the waste matters to touch the ground during the collection and transportation process.

(b) Technical and financial feasibility of simple labour intensive, low cost yet hygienic methods of solid waste disposal and resource recovery.

3.2. Pilot Project Areas

Six municipal wards, in two municipal towns, with varying socio-economic circumstances and different levels of urbanisation were chosen as the pilot areas where alternate methods were studied. They covered a total population of about 50,000.

3.3. Alternatives in Methods and Materials.

3.3.1. Collection and transportation System:

(a) House to House collection by light weight mannually tipping auto-vehicle ($2M^3$/1.2T) and 12/18 litre plastic/G.I.domestic bins were supplied to each family.

(b) The same system as in (a) with pedal-tricycles, carrying 4/6/8 nos. of 50/ 100 litres G.I. containers.

(c) Same system as in (b), but collection from community containers, provided for every 10/20 houses.

(d) Collection from community containers by pedal tricycles and direct transfer into $4M^3$ skips in primary transfer stations. The skip is hauled by 35 H.P. tractors to disposal grounds.

(e) Same system as in (d) but with house to house collection.

3.3.2. Disposal techniques

(a) Mannually operated sanitary land filling.

(b) Mannually operated aerobic (Windrow method) composting.

Each system was first optimised through the optimal combination of men and materials, before their comparative evaluation. Each system were run for daily as well as alternate day collection. Criteria for evaluating system-efficiency were cost, environmental protection and public acceptance.

Mode of operations tried in different areas and optimal design parameters for them are shown in Table-1.

3.4. Findings of the Study.

In table-2, and 3 and 4 a comparison of pilot project systems is made with the existing systems in various categories of towns in India, in respect of manpower requirement, O & M Cost, vehicle and fuel requirement and quality of service as indicated by per capita waste collection per day, frequency of collection etc. It could be seen that under the pilot project systems, average O & M cost is considerably less than what is presently being spent in most Indian cities and towns. At the same time the level of services in terms of per capita refuse collection per day is much higher. Table 3 clearly demonstrates that the existing system of solid waste management in the municipalities is counter productive and wasteful in respect

Table-1: Pilot Operations

Pilot Area Characteristics	Mode of operation		Optimal Design parameters
	Collection & Transportation	Disposal	
P-I. Population Density /10,000/KM^2 Disposal site /3KM Semi Urban; Average income level /Rs.2500 per capita per annum	As in (a) under 3.3.1.	Mannually operated sanitary landfilling	12/18 litres plastic/ G.I. buckets as domestic container per family per annum One dumper per 5000 people. Two crew collection.
P-II. -Do-	As in (b) under 3.3.1.	-Do-	-Do- One tri-cycle (600 litres) per 1200 people.
P-III. -Do-	As in (c) under 3.3.1.	-Do-	One Community Container/ 10 houses. One tri-cycle per 1500 people.
P-IV. Population Density >20,000/KM^2 Disposal site 8KM Highly urbanised. Average income level. /Rs. 3500 per capita per annum.	As in (d) under 3.3.1.	Mannually operated wind-row composting	One Community-Container/ 20 houses. One tri-cycle per 2500 people. One Primary Transfer Station per 15000 people. One tractor-4 skips set/ 45000 people.
P-V. -Do-	As in (e) under 3.3.1.	-Do-	12/18 litres plastic/G.I. buckets as domestic containers. One tricycle per 2000 people. One Primary Transfer Station per 10,000 people. One Tractor-4 skips set/30000 people.

Table-2: O & COSTS

	Level of Service	O & M.Cost Rs. per capita per annum.
Calcutta Corporation	500 gm/capita/day collection. Roadside open storage and Double Handling, Daily collection. Uncontrolled disposal.	Rs. 20.00
34 Municipal Towns in Greater Calcutta	200 gm/c/d. Irregular collection. Roadside open storage and Double Handling uncontrolled disposal.	Rs. 6.00 to Rs. 10.00
Pilot - I	250 to 350 gm/c/d. daily collection. No double Handling. Sanitary Disposal	Rs. 6.00(Rs.4.00
Pilot - II	- Do -	Rs. 7.00(Rs.4.50)
Pilot - III	150 to 200 gm/c/d	Rs. 6.00(Rs.4.00)
Pilot - IV	300 to 400 gm/c/d - Do -	Rs. 4.50(Rs.3.00)
Pilot - V	350 to 450 gm/c/d - Do -	Rs. 5.50(Rs.3.50)

*Figures in bracket indicate O & M cost for alternate day collection.

Table-3: VEHICLE, FUEL AND STAFF REQUIREMENT

	No. of vehicles needed (Per million people)	Fuel consumption per annum (Per million people)	Oil consumption per annum (Per million people)	Staff requirement (Per 1000 people)
Existing System	100 Trucks	1,25,000	1500	3 to 7
Pilot Project System	40 Tractors and 100 trailors /skips.	50,000	600	1 to 1.2

of utilisation of man-power. Method studies also revealed that for towns with density of population less than 10000 persons/Sq.KM, house to house collection with pedal tri-cycle would be more effective. For towns with pop-ulation density more than 20,000/Sq. KM, collection from community contain-ers would ensure almost the same level of collection but at a much lower cost.

Pilot studies on low-cost disposal techniques revealed that,

(i) Small mannually operated sani-tary land filling sites, could be operated fairly satisfactorily by cut and cover method upto 15 tons of refuse per day(Population 40,000). The O & M cost for such operations was found to be much lower that what many municipalities spend on crude dumping.

(ii) Mannually operated wind-row compost plants could be operated efficiently upto 30 T per day capacity i.e. upto a population of 60,000. At this level the transportation cost of refuse and compost would also be minimal. O & M cost would be about Rs.20 per ton of solid waste as against Rs.50 per ton in larger mechanical plants. Inorganic rejects (which could be 30 to 50%) could be recycled for private land filling within the town without caus-ing much health hazards. Chemical quality of finished compost-manures from mannually operated plants, with nutrient (NPK) content of about 20 Kg. per ton and carbon to Nitrogen ratio being 15 to 20, are comparable with that from the mechanical plants.

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References:

1. "Pilot Studies on Solid Waste Management in Municipal towns"(con-ducted by AIIH & PH, Sponsored by CMDA/World Bank).

2. "A Status report on refuse and night-soil disposal in municipalities under CMD", Report prepared by AIIH & PH, 1976-79.