NSWAI ENVIS

Newsletter

NATIONAL SOLID WASTE ASSOCIATION OF INDIA

ENVIRONMENTAL INFORMATION SYSTEM CENTRE

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Urban Municipal Solid Waste Management

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Maharashtra is the most urbanized state with the population of 967.52 lakhs, out of which 410.20 lakhs (42%) dwell in cities. Of the total population, 258.68 lakhs reside in Municipal Corporation Cities and 131.16 lakhs live in "A" class cities.

Maharashtra has six revenue divisions. Of these Konkan division is the most urbanized division of the state with 75.05 % population living in its cities and towns. This is followed by Pune (37.52 %), Nagpur (37.42%), Nashik (28.16 %), Amravati (26.53%) and Aurangabad (24.58%) in the descending order.

There are 40 Class I cities in Maharashtra with Municipal Corporation in 22 cities and A Class Municipal Councils in the remaining 18. The data of the population in 1991 and 2001, decadal growth and the per capita and total w aste generation for these cities are given in Table 1.

Table 1 and 2 show that percentage decadal growth varies from7.9 to199.9. About 72 % of these cities have grown by 11- 70 % in terms of population. However 17 % of these cities have more than doubled in population in the decade of 1991-2001.

The per capita daily waste generated in these cities varies from 149 to 630 grams. The average of the per capita waste generated works out to 339 g $c^{-1}d^{-1}$ (Table 1). But the over all per capita daily waste generated obtained by the total waste per day divided by the total population works out to 465 g $c^{-1}d^{-1}$. Table 3 gives the distribution of these cities in varying per capita waste generation. The distribution shows that about 72 % of the cities produce 200 – 500 g $c^{-1}d^{-1}$. About 32 % of cities produce 200 – 300 g $c^{-1}d^{-1}$, and 27 % produce 300 – 400 g $c^{-1}d^{-1}$.

The linear regression line of population versus per capita waste generation for the 40 cities can be expressed as:

$$y = 2.87 x + 315.9; \quad r = 0.43$$

Where,
y is per capita daily waste generated in grams,
x is population of the city in 2001, in lakhs.

A similar regression line reported by us for Maharashtra in 2004 for 22 cities was (NSWAI – ENVIS newsletter, Feb 2004):

$$y = 1.69 x + 362.9; \quad r = 0.2$$

The line obtained for 16 cities of Maharashtra in 2003 (NSWAI- ENVIS news letter June 2003) is as follows:

$$y = 2.72 x + 282; \quad r = 0.74$$

The nature of the regression lines doubtless is very similar. The slope varies from 1.69 to 2.87 and the intercept (minimum waste produced per capita per day) value varies from 282 to 363. This is strikingly good. The regression coefficient values vary from 0.2 to 0.74. That is the relations are not directly proportional with good degree of agreement.

Table 1. Decadal growth and per capita generation of waste in 40 Class I cities of Maharashtra

Name of the city /town	Total populationas per 1991 census	Total populationas per 2001 census	% Decadal increase in population	Total waste per day (MT)	Per capita waste generated (grams per person per day)
AMRAVATI DIVISION					
Achalpur	96229	107304	11.5	25	233
Akola	327946	399978	22.0	120	300
Amravati	421576	547370	29.8	150	274
Yavatmal	108563	120763	11.2	25	198.7
AURANGABAD DIVISION					
Aurangabad	59100	1000000	69.2	300	300
Beed	112434	138091	22.8	25	185
Jalna	174986	235635	34.7	45	149
Latur	191407	299828	56.6	120	400
Nanded-Waghala	309316	430000	39.0	149	347
Parbhani	190255	259170	36.2	54	309
KONKAN DIVISION					
Ambarnath	127745	203795	59.5	72	390
Bhiwandi-Nizampur	378000	598000	58.2	305	530
Kalyan-Dombivli	800000	1166149	45.8	550	471
Mira-Bhayander	173372	520000	199.9	230	495
Mumbai	9920000	11914398	20.1	7500	630
Nalasopara	62314	184664	196.3	60	325
Navghar-Manickpur	56000	116700	108.4	35	300
Navi-Mumbai	318447	703947	121.1	400	568
Panvel	58986	104031	76.4	18	173
Thane	795833	1285396	61.5	650	505
Ulhasnagar	369077	472943	28.1	236	499
Virar	57600	118945	106.5	50	420
NAGPUR DIVISION					
Chandrapur	226205	297612	31.6	100	336
Gondia	109470	120000	9.6	40	333
Nagpur	1624757	2040175	25.6	700	343
Wardha	102974	111070	7.9	50	450
NASHIK DIVISION					
Ahmednagar	181339	307455	69.5	65	240
Bhusawal	145203	172366	18.7	52	297
Dhule	278315	341662	22.8	66	193
Jalgaon	242000	368000	52.1	220	597
Malegaon	342595	409190	62.0	230	216
Nashik	656925	1064000	62.0	230	216
PUNE DIVISION					
Barsi	87143	104786	20.2	30	300
Ichalkarnji	214950	257600	19.8	65	252
Kolhapur	406370	485183	19.4	165	350
Pimpri-Chinchwad	517083	1006453	94.6	310	300
Pune	1566651	2540000	62.1	1000	390
Sangli-Miraj-Kupwad	351917	436639	24.1	160	210
Satara	95116	108043	13.6	35	300
Solapur	620846	873009	40.6	350	390
Total for all Class I cities of Maharashtra	23410363	31970350	36.6	14874	Average value of Waste 339

Table 2. Decadal growth and the number of cities of Maharashtra

% decadal growth	Number of cities	Percentage of total 40 cities
up to 10	2	5
11 – 70	29	72.5
71 – 100	2	5
101 – 200	7	17.5
Total	40	100

Table 3. Per capita waste generation: frequency distribution in cities of Maharashtra

Daily per capita waste generation - gm	Number of cities	Percentage of total 40 cities
101 – 200	6	15
201- 300	13	32.5
301 – 400	11	5
401 – 500	5	12.5
501 – 600	4	10.0
> 600	1	2.5
Total	40	100

Collection and transportation of Municipal Solid Waste in Class I cities of Maharashtra:

Financial Aspects.

The Solid Waste Management Cell (SWM Cell) of the All India Institute of Local Self – Government (AIILSG) has put up six models to arrive at the financial implications for collection and transportation of MSW. This is a laudable effort and keeps in view the already existing systems of collection and transportation in these cities. Models are based on primary collection system or a composite system with variations in the models in terms of waste quantity, characteristics and topography of a city. Primary collection is the house-to-house/ property-to-property collection of waste in segregated form. i.e., biodegradable and recyclable. In case of a composite system of primary and secondary collection, waste collected at door step is transferred to the community bins and bulk transportation of waste from community collection units to centralized/decentralized processing cites. The unit cost of equipment and vehicles used has been estimated after taking into consideration the equipment and vehicles is used for collecting debris and green waste.

Cost components of different models:

1. One time capital expenditure on vehicles and equipment.
2. Per year running cost (annualized capital cost including depreciation over the equipment's vehicle's life time.
3. Operational and maintenance cost.
4. Manpower cost
5. Miscellaneous cost

Items 2 to 5 are used to calculate per tonne cost.

Models:

Within the framework explained above, six models have been suggested as follows:

1. Model I – Combination of Tricycle and Tractor Trailer- 30 % of house-to- house collection by Tricycle + 70 % of house- to house collection by Tractor Trailer. Waste from Tricycle transferred to Tractor Trailer so that 100% waste collected house to house is carried by Tractor Trailer to disposal ground.
2. Model II- Combination of Tricycle and Tractor Container Carrier – 30 % of house to house collection by Tricycle + 70 % of house to house collection by Tractor Container Carrier. Waste from Tricycle transferred to Tractor Container Carrier so that 100% waste collected house to house is carried by Tractor Container Carrier to disposal ground.

Table 4. Capital and per tonne cost of collection and transportation of MSW in 39 cities of Maharashtra.

Model	Range of cost Rs. Capital	Per tonne	Average	Total cost Rs. in crores
I	0.25 cr – 14.64 cr.	593.6 – 696.61	619.48	108.83
II	0.22 cr – 13.1 cr.	578.81 – 680.97	602.02	96.88
III	0.29 cr – 15.75 cr.	766.83 – 1031.79	971.2	111.98
IV	0.32 cr – 18.7 cr.	408..0 – 493.6	430.0	133.85
V	0.15 cr – 7.31 cr.	712.56 – 785.17	728.7	55.53
VI	0.31 cr – 8.89 cr.	303.44 – 850.72	442.7	70.35

3. Model III- Auto Rickshaw- 100% waste collected by Auto Rickshaw house to house and taken directly to disposal ground.

4. Model IV- Combination of Auto Rickshaw and Refuse Compactor- 30 % of house collection by Auto Rickshaw + 70 % house to house collection by Refuse Compactor. Waste from Auto Rickshaw transferred to Refuse Compactor so that 100% waste collected house to house is carried by Refuse Compactor to disposal ground.

5. Model V – Tricycle – 100% primary collection of waste by Tricycle. Waste from primary collection transferred to Skip Container which is mounted on skip loaders to carry the waste to the disposal ground.

6. Model VI – Combination of Auto Rickshaw and Tractor Container Carrier – 30 % of house to house collection by Auto Rickshaw + 65% of house to house collection by Tractor Container Carrier. Waste from Auto Rickshaw as well as Tractor Container Carrier (100% waste collected house to house) is carried to disposal ground.

Cost implications:

The six models for 39 cities have been worked out and the one time capital cost and running per tonne cost for each model and for each of the 39 cities is given in a table. The summary of this data is given in Table 4.

Capital cost for all the models varies from rupees to 0.15 crore to 18.75 crore. The per tonne cost varies from rupees 303 to 1031. From the point of view of the total cost, model V is least expensive and model IV is the most expensive. The optimum mix of the capital cost and per tonne cost appears to be either model V or model VI. The cost variation per tonne is not very high in models I to V. In case of model VI, there is a large variation in per tonne cost. It varies from 303 – 850 rupees per tonne. Following this, the variation is wide in model III, variation being from 767 to 1030 rupees per tonne. In all other models, variation is limited to 100 rupees per tonne. (See figure 1). Capital cost is the minimum for model V, followed by model VI.

The selection of a model depends upon the needs and the budget provision of the urban local body. It will be prudent to choose a model with prudence keeping in mind the future developments in a city.

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