



Solid Waste Generation and Collection in Pune A Situational Analysis



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Acknowledgements

This is a study with a difference. It was planned and undertaken in close consultation with the actual implementation machinery of the Pune Municipal Corporation. The process of data collection was participatory and data were cross-checked at every level. The findings have been shared with the concerned functionaries in every ward and have in fact been used as the basis for planning improvements.

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Laxmi Narayan and Poornima Chikarmane

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Chapter I Background

Background

The collection, transport and the disposal of garbage are the statutory responsibilities of municipalities in India. The Bombay Provincial Municipal Corporations Act (BPMC) of 1949 applies to the Pune Municipal Corporation. The civic body is expected to provide for public receptacles for garbage, transport of garbage and its final disposal in such manner that is not detrimental in the interests of public health. Citizens are required to deposit garbage in the receptacles provided by the municipalities and placed in public areas. The municipalities are also required to undertake sweeping of public areas such as roads, markets and other open spaces; cleaning of gutters, drains and the sewage channels; and fumigation.

The Municipal Solid Waste Handling Rules notified by the Ministry of Environment and Forests in 2000 require that municipalities:

- institute some system of door-to-door collection of garbage
- institute separate systems of waste collection for hospital and medical waste; abattoir waste; bulk generators such as hotels; and slum and squatter settlements
- promote source segregation and ensure that the recyclables go for recycling
- reduce pressure on landfills and ensure that organic garbage is processed using least-polluting biological methods. The Rules mention that incineration with or without energy recovery including pelletisation can also be used for processing wastes in specific cases.

Reduction, reuse, recycling and resource recovery are the cardinal principles of solid waste management. The Pune Municipal Corporation has taken some initiatives towards the implementation of the above rules since they were notified. These are listed below.

- Promotion of source segregation of waste through the media and printed material
- Door-to-door collection of waste using motorised bell ringing vehicles
- Integration of wastepickers into door-to-door collection of waste on full cost recovery basis by appointing the Kagad Kach Patra Kashtakari Panchayat (Ragpickers Association) as the implementing agency
- Initiating the Chakachak Pune citizens awareness campaign
- Promotion of vermicomposting and bio-methanation plants
- Changes in the building rules making bio-composting mandatory for the issue of a completion certificate to new constructions
- Contracting out the collection of bio-medical waste to Image India on full cost recovery basis

The Pune Municipal Corporation entered into a tripartite Memorandum of Understanding with the All India Institute of Local Self Government, Andhra Pradesh Technology Development & Promotion Council and Infrastructure Leasing and Financial Services on 3rd September 2005 “to develop and implement the project, to utilise municipal solid and partially liquid waste being generated in the limits of PMC,

to produce bio fertiliser, bio gas, refuse derived fuel (RDF), and/or power on a public private partnership basis". (Source: MOU)

The study of waste generation and collection in Pune city was commissioned by the All India Institute of Local Self Government to assess the generation and collection of waste with a view to inform the choice of technology that is most appropriate for processing the waste generated in the city. In the first phase the modes of collection from all wards were studied. The exercise was repeated for only the bulk generators in the second phase. Waste characterisation and analysis of waste composition and chemical analysis of the waste was not part of this study.

Population of Pune

The Pune Urban Agglomeration comprises the municipal corporations of Pune, Pimpri-Chinchwad and the Cantonment Boards of Pune, Dehu and Khadki. This study is limited to the area covered by the Pune Municipal Corporation.

Pune city has grown both in terms of geographical spread as well as population during the last couple of decades. 23 villages from the outskirts of the city have been brought into the jurisdiction of the Pune Municipal Corporation. According to the 2001 census figures, Pune city had 5,55,771 households with a population of 25,38,473 (including 38 merged villages at the time of the census). The estimated population of Pune in 2005 is 30,00,000.

Waste Management Structure of the Pune Municipal Corporation (Figure 1)

Solid waste management falls within the purview of the Department of Health headed by the Medical Officer of Health (MOH) assisted by Deputies, one being responsible for solid waste management.

The Pune Municipal Corporation is divided into the following Administrative units **Zones** (headed by Zonal Commissioners of the rank of Asst. Municipal Commissioner)

Each Zone comprises three or four **Wards** (headed by Ward Officer). The Ward Officer is the cutting edge functionary of the municipal administration and is responsible for administering all ward functions.

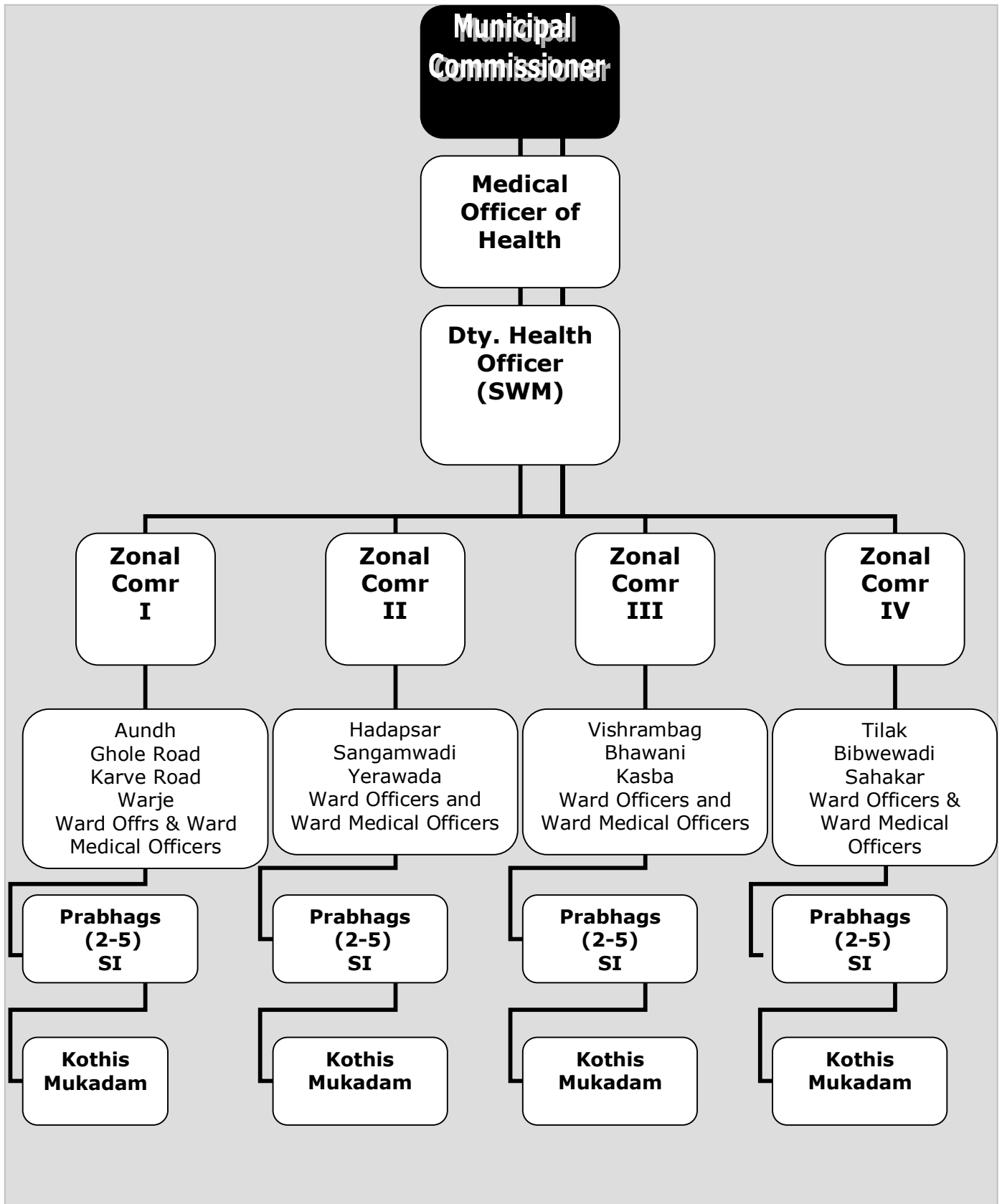
Each Ward is further sub-divided into three to four **prabhags**.

The Prabhags are finally sub-divided into **kothis**. The Kothi is the smallest unit of the ward.

There are totally 4 Zones, 14 wards, 48 prabhags and 152 kothis in Pune.

From 2004-05 the PMC has appointed Ward Medical Officers in each of the 14 wards. The Ward Medical Officers are trained medical professionals who have a variety of public health related duties among which is the management of solid waste within their respective wards. They report to the Dty. MOH (SWM) in so far as this function is concerned.

Figure 1: Waste Management Structure of the Pune Municipal Corporation



Overview of the waste collection system

Waste collection is undertaken by the PMC primarily during the day shift from 6 am to 2 pm. Citizens are expected to segregate waste prior to its collection by the PMC. Domestic waste collection includes primary, secondary and tertiary collection.

Primary waste collection:

The primary collection of waste services about 25 % of the population through the three methods listed below. The remaining population makes its own arrangements to deposit waste in community containers placed on the streets in public areas.

1. Primary collection by PMC ghanatrucks (bell ringing vehicles)

41 ghanatrucks operated by the PMC are expected to collect organic waste daily and recyclable and non-biodegradable waste once a week from the gates of buildings along predetermined routes in select prabhags. The waste is transported to the transfer station in each ward. Wastepickers have been integrated for the daily collection of recyclable and non-biodegradable waste with differing degrees of success depending upon the cooperation of the ward administration in different wards. Alternately, citizens are free to transfer their recyclable and non-biodegradable waste to appropriate recycling units themselves or through their agents.

2. Primary collection by PMC employees using ghanacycles/ push carts

This service is offered by the PMC primarily in inner city areas, not easily accessible to trucks. The mixed waste is carted to the municipal community container.

3. Primary collection by PMC authorised wastepickers on full cost recovery basis Officially started in 2005, the service is provided by PMC authorised wastepickers with cycle rickshaws provided by the PMC. Wastepickers are directly paid a nominal user fee by service users. Recyclable waste is taken for recycling and the non-biodegradable waste is collected separately by the PMC where the provision has been made. Organic waste is deposited in the ghanatrucks where such arrangements have been made or in municipal community bins.

4. Completion certificates for post 2000 constructions are issued subject to provision being made for processing organic waste within the premises. However, processing of organic waste is not really carried out post occupation and the waste is either collected by the ghanatrucks or it is deposited in the community containers.

Secondary waste collection:

Citizens not serviced by any primary collection system are expected to deposit the waste in the municipal community containers, themselves or through their agents. Bulk generators and commercial establishments not serviced by the dedicated collection system also deposit their waste in the community containers. Since community containers are not monitored, most often, mixed waste is deposited in them.

All the waste deposited in the community containers is not collected by the PMC. Prior to the lifting of the containers, about 4000 wastepickers in Pune retrieve paper, plastic, metal and glass scrap from municipal containers for recycling, as a means of livelihood. The study of Scrap Collectors, Scrap Traders and Recycling Enterprises in Pune (International Labour Organisation, 2001) estimated the total collection of scrap to be 144 MT per day.

Community containers are transported to the transfer stations by dumper placer trucks. The waste from dumper placers and ghantatrucks is transferred to Bulk Refuse Carriers (BRC). Secondary waste collection from compactor community containers is also undertaken by compactors. In most cases, the compactors directly transport the garbage to the landfill site.

Tertiary waste collection:

The BRCs transport the waste to the landfill site.

Collection from bulk generators

Hotels, educational institutions, markets and mangal karyalays (marriage halls) are serviced by dedicated PMC vehicles.

Collection of debris

Debris collection is the responsibility of the generator. However, debris dumped outside municipal containers or along the roads is collected by the PMC through tippers or containers requisitioned from the vehicle depot whenever required.

Collection of medical waste

The collection of medical waste has been contracted out to Image India Limited on a cost recovery basis.

Chapter II

Methodology and Process of Data Collection

The study was carried out during the period 1 to 31 October 2005. The study relied on a combination of primary and secondary data sources. Primary data was cross checked with secondary data of the preceding six months wherever it was available. Per capita generation of waste was calculated based on primary data.

The formats for primary data collection were provided by the AILSG. They were simplified based on a discussion between the AILSG, PMC and the KKPKP. Primary data according to the pre-designed format was collected for every mode of waste collection viz. Dumper placer, Ghantatruck, Hotel truck, Compactor and Tipper in every municipal ward within the Pune Municipal Corporation for a period of three days. Weights were recorded for a period of five days. PMC records of the weights at each ramp during these five days were also photocopied and cross checked. All other assessments were carried out for a period of three days, as specified by the AILSG.

Waste generation data were collected for 0.22 % of the total number of households in Pune stratified on the basis of the economic class of the households.

The main categories of data were the source of waste, actual recording of the weight of the waste, volumetric assessment of the waste and visual assessment of the type of waste generated/ collected.

I. Primary data collection regarding per capita garbage generation

For arriving at the per capita generation of garbage, a separate team of 5 surveyors was selected. The population was broadly stratified according to the income group. The study of 0.1 % of households was expected in the terms of reference. However, 1236 of the 5,55,571 households of Pune, (i.e. 0.22%) were studied, disaggregated according to the economic class of households.

HIG bungalows/ rowhouses with area over 2000 sq. feet	181 households
MIG apartment blocks	666 households
LIG slums	389 households

The Surveyors accompanied the garbage collectors in the respective areas and recorded actual time, number of houses, persons in each house, total volume of garbage generated and total weight of the same.

II. Primary data collection of garbage collected by the PMC

All the Ward Medical Officers and Divisional Sanitary Inspectors were oriented about:

- The purpose of the study
- Roles of PMC, AILSG, KKPKP
- Modalities of the study
- Formats for KKPKP and PMC

A Ward Coordinator was assigned to each ward. His/her responsibility was to get the preliminary data regarding number of vehicles and routes, required for the primary data collection and to coordinate the group of surveyors in each ward. All Ward Coordinators were those who were already working intensively on the issue of garbage at the ward level and therefore already aware of basic garbage generation patterns, kinds of garbage, quantity and PMC functioning. Each of them did a trial run on every single kind of garbage vehicle and ramp so that they could accurately correct the mistakes, if any, of the appointed surveyors. Each of them also led the team of surveyors in their respective wards.

Surveyors were selected on the basis of a writing and calculation test. The educational level of the surveyors ranged between class X and post-graduation. Decentralised training programs were held at 14 wards where surveyors and their group coordinators were oriented about the

- Purpose of the study
- Overall garbage scenario
- PMC disposal systems
- Actual roles of surveyor
- Introduction to survey forms

Each surveyor did a trial run on the same vehicle they were to cover/ same task they were to undertake later for the course of the survey during the 3 days. This was to preclude any possibilities of mistakes, delays and miscommunication between the PMC driver, bigaris and themselves. A total of 153 surveyors were trained. 125 surveyors went on trial rounds. Totally 118 surveyors did the actual data collection. Some changes were further made in the survey sheets before and after the trials to ensure that no calculation mistakes would be made. Additionally, the container and compactor bucket lists of all the wards were compiled and given to the PMC as these were not maintained in uniform formats across wards.

Primary data collection was carried out from 21-23 October 2005. Surveyors were deployed on each dedicated collection vehicle namely,

Ghantatrucks,

Hotel vehicles and

Compactors in each ward.

Surveyors were also deployed at each of the ramps

Paud Road (Karve Road, Warje-Karvenagar Wards)

Katraj (Bibwewadi, Sahakar Nagar, Tilak Road Wards)

Ghole Road (Ghole Road Ward)

Koregaon Park (Dhole Patil Ward)

Aundh (Aundh Ward)

Yerawada (Yerawada, Sangamwadi Wards) and

Hadapsar (Hadapsar, Bhawani Peth, Vishrambag, Kasba Peth Wards)

III. Collation of secondary data

The weight of the garbage collected is subject to seasonal variations. During the monsoons and festive seasons there is an increase in the weight of garbage, on account of water retention and increased generation, respectively. Since the primary

data was recorded only for a period of three days and five days during the study, secondary data was used to augment the information.

1. Estimates given by the Ward Medical Officers and Ramp Records

The garbage is collected within the ward and transferred into Bulk Refuse Carriers at different Transfer Stations located across the city. As a practice weights are routinely taken only at the Katraj and Hadapsar ramps where there are weighbridges. Nonetheless, every ward office has some document to estimate the actual daily weight of garbage collected within the ward. This figure is not always based on actual weights. The ward officials in such cases therefore infer the figures.

One method used by some ward offices is to estimate the weight based on the number of containers lifted. The weight criterion used varies between 1 MT and 2 MT per container. It is also based on the actual number of Bulk Refuse Carriers and compactors of garbage going to the landfill site everyday. The BRCs are either weighed or an estimate of their average weights is used. The numbers of tipper, hotel and ghanatruck trips are also added on in some cases. Different ward offices variably use the optimum carrying capacity of each type of vehicle to estimate the weights. The estimations of weights from the different wards range from reasonably high levels of accuracy to very gross estimations. The level of accuracy is therefore marked on the format. These average figures given by the wards have just been used as a backdrop against which the primary data of the three-day survey is actually presented in Table I. The accuracy of the averages cannot be authenticated by anyone.

2. Estimates from 14-16 August 2005

The Pune Municipal Corporation has been treating August 15 and January 26 of each year as zero garbage days for the past few years. Essentially, this means that in the morning there is no uncollected garbage in the street containers across the city. This is carried out with varying levels of efficiency by the different wards. The weights of the garbage collected in each ward from 10-16 August 2005 are also being used as a backdrop against which the data of this study are presented. In many wards the estimations of actual garbage collected, reflect the higher collection in the 2nd week of August. These figures are also presented in Table I. In some wards, collection efficiency is higher than others, even on a regular basis. Presumably in such cases there is no significant difference in the average monthly weights and the weights in the 2nd week of August.

Problems

Scheduling of the study

The study was scheduled in the month of October which comes in the middle of the festive season beginning from the Ganesh festival followed by Dassera and ending at Divali. The garbage generation during this period is therefore considered marginally higher than at other times. However, there is also another contrary opinion that this is actually a lean period of garbage generation as it is the beginning of winter.

Absence of baseline data and the Absence of weigh bridges at every ramp

The PMC does not have a system of weighing the garbage collected daily. This is partly because there are no weighing facilities at each transfer station. There are weighbridges only at the Hadapsar ramp, Katraj ramp and Aundh Octroi post. The secondary data that was available therefore does not provide accurate estimates. Many of the Ward Medical Officers were not conversant with these records and their maintenance.

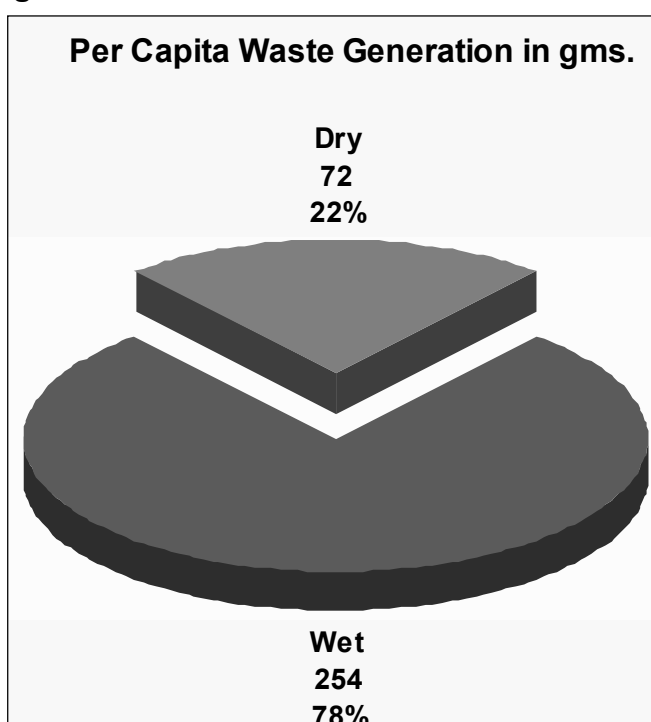
Some ward offices took a lot of time to provide basic data such as the list of societies covered by the ghantatruck and/or the container collection schedule and/ or the location specific list of containers.

Chapter III: Findings

Section I: Per capita generation of waste in Pune

A total of 1236 households and 35 shops were surveyed disaggregated according to economic classes (Table I). All the domestic and commercial waste generated in the city does not enter the municipal waste collection system. It is filtered through various channels. Newspapers, bottles, plastic jars, ferrous metals and corrugated cardboard cartons are generally reused or sold for scrap value by the generators or their domestic workers, drivers, security personnel and other service providers. Further retrieval of plastic, paper, metal and glass scrap is undertaken by Wastepickers/ ragpickers at the street containers.

Figure 2:



Classification of waste

For the purposes of this study waste has been classified into two categories, wet and dry. Wet waste comprises organic waste such as plate waste, vegetable and fruit peels, hair, dust, disposable diapers, wood shavings, sanitary napkins, bones and egg shells. Dry waste includes recyclables such as paper, plastic, metal and glass scrap and non-recyclables such as thermocole, Styrofoam, plaster of paris and battery cells. Construction debris, silt and garden waste are also generated. While garden waste and silt enters the

municipal stream, debris is generally transported separately.

The data did not show a sharp variation in overall per capita garbage generation according to the economic class. However, the proportion of dry garbage was higher among the middle and upper income groups. The data is consistent with the accepted premise that the utilization of packaged products, use and throw products and disposables increases according to the income group.

The data are fairly consistent with the findings of some earlier studies.

Year	Municipal Population (Millions)	MSW (tons/day)	Per capita Waste generation (kg/day)
2003*	2.2	700	0.32
1995**	2.244	695.640	0.31

*Source: NRI India, 2003 cited in Comparative Study on Solid Waste Management in Asia, Asian Institute of Technology, 2004

** Source: ERM India 1995 cited in What a waste: Solid Waste Management in Asia, World Bank, 1999

Figure 3: Per capita generation of waste disaggregated according to type of waste and economic class of generators

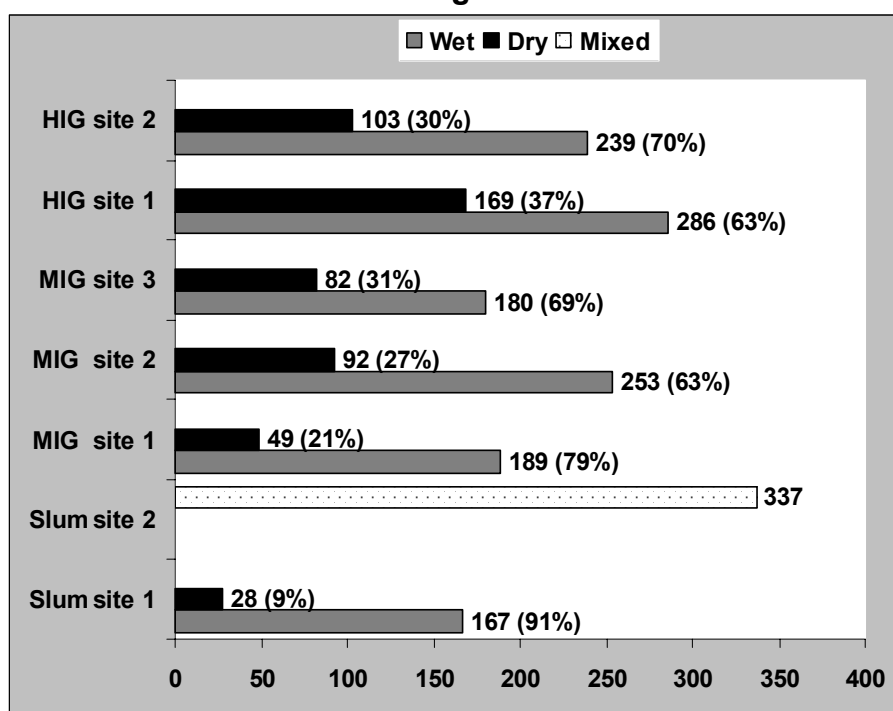


Table I: Per capita generation of waste disaggregated according to economic class of generators

Economic class	Per capita generation of waste			Total
	Biodegradable	Recyclable	Mixed	
Slum site 1	167	28 (9)		306
Slum site 2			337	337
MIG site 1	189	49 (21)		238
MIG site 2	253	92 (27)		345
MIG site 3	180	82 (31)		262
HIG site 1	286	169 (37)		455
HIG site 2	239	103 (30)		342
All classes	254	72 (22)		326

Note: figures in parentheses indicate proportion of recyclable waste to total waste generated

Although the sample of 0.22 % is too small for drawing decisive conclusions nonetheless it can be used as indicative as given below.

According to the 2001 census figures, Pune city had a population of 25,38,473 from 5,55,771 households. The estimated population in 2005 is 30 lakhs (3 Million). If this is taken as the basis the waste actually generated in Pune in 2005 would be 978 MTPD. The proportion of dry waste being 216 MTPD and that of wet waste being 762 MTPD. The actual garbage collected by the PMC is estimated to be 884 MTPD as per the survey i.e.294 gm. per capita per day. This means that about 122 MTPD of recyclable waste is retrieved by Wastepickers and informal garbage collectors. With more effective segregation and door to door collection, the additional 94 MTPD could also be retrieved and further sorted to separate out non-recyclables.

Table IA: Ward wise per capita garbage generation in gms.

Ward	Total Population	Daily garbage generation	Per capita garbage generation in gms
Aundh	282000	63.2	224
Sangamwadi	260000	51.6	198
Yerawada	250000	57.55	230
Warje	160000	37.3	233
Karve Road	124730	70.2	562
Dhole Patil	117000	34.9	298
Ghole Road	160000	55.1	344
Bibwewadi	400000	88.5	221
Tilak Road	350000	67.45	192
Sahakarnagar	325000	63.45	195
Vishrambagwada	252000	76.64	304
Kasba	317450	75.2	236
Bhavani	200000	72.5	362
Hadapsar	250000	55.9	223
Mandai		15	NA
Total	3448180*	884.49	3237

* The total population does not correspond to census figures.

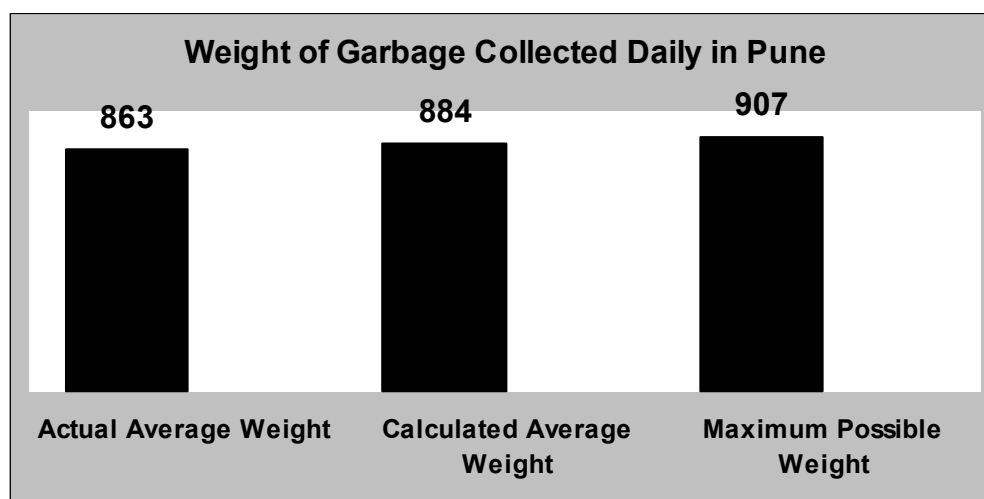
Per capita waste generation data were disaggregated ward wise based on the population estimates provided by the respective Ward Medical Officers. The per capita generation data seem fairly consistent other than for Karve Road ward.

Section II: Overview of Municipal Solid Waste Collection in Pune

Quantity of Garbage Collected Daily

The actual average weight of garbage collected on the survey days was 863 MT. The total calculated average garbage collection in Pune is 884 MTPD (Metric Tonnes Per Day). This has been calculated by taking the average estimates of the collection through all modes i.e. dumper placer, compactor, hotel tipper, ghantatruck tipper, tipper, contracted tractors and private garbage tempos as applicable in each municipal ward.

Figure 4: Weight of garbage collected daily in Pune



The calculated average can be considered more accurate because it has factored in individual vehicles which were sometimes not weighed, despite express instructions from the administration. The failure of the Hadapsar weighbridge at 7.10 a.m. on 23rd October 2005, the third day of the survey and the high variation (of weights of vehicles and numbers of trips completed) in some wards also make this average a more reliable figure. The total variation for the city based on different methods of calculation does not exceed 20 MTPD. The maximum possible weight includes estimated uncollected excess (see para below). The calculated average figure has been used for all analysis because of its greater validity and reliability.

Estimation of Uncollected Excess Waste

The data show that the average daily collection of waste is 884 tonnes. It could generally be assumed that most of the garbage deposited in the containers is collected because if there were a huge gap between garbage deposition and collection of waste, every garbage container would be overflowing at all times which is not the case. However, to estimate the maximum possible difference between deposition and collection of waste we could use the following method.

The quantity of uncollected excess garbage is calculated as follows:

Daily quantity of garbage deposited G in tonnes = Daily collection C (tonnes) + Daily Uncollected excess E (tonnes)

E can be calculated as follows

E = Total quantity of garbage in all public receptacles on a given day Less Actual Daily Collection for the given day

 No. of days over which this excess has built up

Assume that each and every public receptacle of garbage was completely full on the morning of 21st October at the start of the survey (this is practically impossible because many containers had been lifted on 20th night). The total quantum of waste in this case would be 2335 tonnes (Table II).

According to PMC 15th August was Zero Garbage day meaning that all receptacles of garbage in public places were completely emptied. (In case the removal was not complete the excess of generation over collection would be even lesser than that calculated below)

Thus in the above case the total maximum quantity of garbage in public receptacles on 21st October = 2335 tonnes

Actual Daily Collection of Garbage on 21st October=839 tonnes

Minimum No. of days over which it has built up (since 15th August) = 66 days

Therefore E = 2335/66 = 23 tonnes

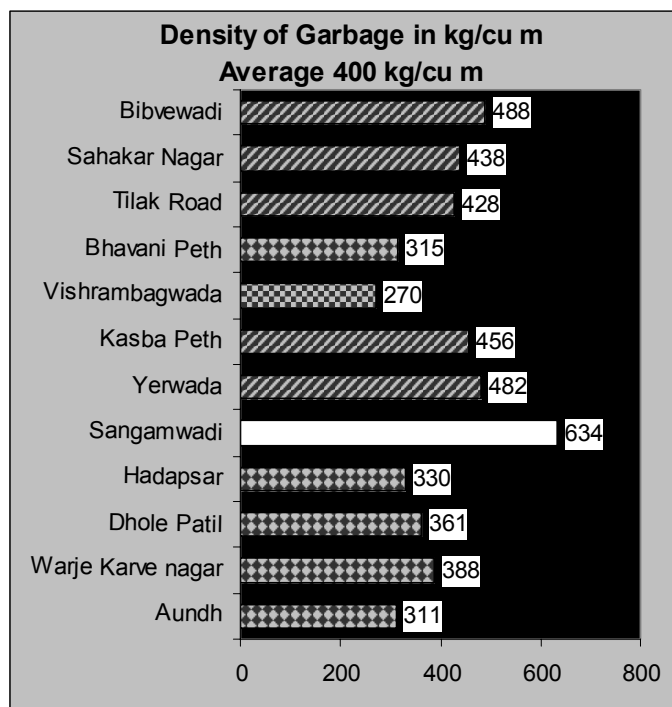
Thus the maximum amount of possible daily excess of uncollected garbage generation would be 23 tonnes

Thus maximum generation of garbage would be 884 + 23 = 907 tonnes.

Type of Waste Collected and Density of Waste

The solid waste collected by the PMC can largely be classified as mixed waste based on visual assessment of every container and vehicle while being emptied. The "mix" consisted mainly of organic waste, silt from road sweepings, garden waste; non-recyclables and low value scrap/ recycling rejects. The visual assessment corroborated the fact that debris and medical waste were absent.

Figure 5: Ward Wise Garbage Density



The average density of garbage in Pune is 400kgs per cu m. The density was calculated based on the average weight of all 100 % filled containers of 3.8 cu size recorded during the survey, disaggregated ward wise.

The highest density was found in Sangamwadi and the lowest in Vishrambag wada wards. Sangamwadi has a large slum population. It is a known and accepted fact that slums generate mainly wet waste. Secondly, the deployment of PMC authorised wastepickers for door-to-door collection is very high in the Sangamwadi ward.

Note: The density of waste from the Ghole Road and Karve Road wards could not be determined because all the containers were not weighed.

The waste deposited in the containers is therefore primarily organic and denser. Vishrambag ward on the other hand is largely commercial area. Although wastepickers do salvage recyclables at the containers, the proportion of dry waste including non-recyclables is likely to be higher reflecting lower density.

Physical-Chemical Characteristics of Waste in Pune (Extracted from HUDCO DPR, 2001)

With regards to the chemical composition, moisture content of solid waste was found to be around 48.40 per cent (table 3.4). The calorific value of Pune waste was 937 kcal/kg. This value is lower than the advised calorific value of 1500 kcal/kg for self-sustaining reaction and the Heating Calorific Value anticipated by CPHEEO. The details of physiochemical analysis of sample are; presented in table 2.5 below:

Table 2.5 Physio-Chemical Characteristics of Solid Waste of PMC

Parameter	Average
Physical Parameters	
1. Organic Matter, %	51.50
2. Paper, %	1.90
3. Rubber, Leather, Synthetics, %	0.40
4. Plastics, %	2.30
5. Clothes, %	1.20
6. Glass, %	1.10
7. Metal, %	0.90
8. Inert Matter, %	40.60
9. Density, kg/m ³	437.00
10. Gross Calorific Value, kcal/kg	937.00
Chemical Analysis	
1. PH	7.50
2. Electrical conductivity, m.mhos/cm	2.80
3. Total water soluble solids, mg/gm	43.63
4. Loss on ignition, %	38.33
5. Moisture, %Organic Carbon, %	48.40
6. Organic Carbon, %	19.20
7. Organic Matter, %	33.10
8. Total Kjeldhal Nitrogen	0.84
9. C/N Ratio	22.85
10. Total phosphorous, mg/gm	18.03
11. Total potassium, mg/gm	18.80
12. Zinc as Zn, mg/gm	0.17
13. Chromium, mg/gm	0.08
14. Cadmium as Cd, mg/gm	0.05
15. Mercury, ppm	ND
All values except moisture content are on dry basis	

Sources Sample Analysis

The chemical analysis also indicates that the organic matter (calculated based on the free carbon available in the sample) to be in the range of 51.60 per cent. Similarly the ratio of carbon to nitrogen, the factor critical for composting was found to be 22.85 below the desirable range of 25 to 40 for composting in view of this the composting process may have to be supplemented by additives such as manure, clean sewage sludge, septage or urea for fair and short time results.

Waste Collection Disaggregated according to Wards and Mode of collection

Figure 6: Ward Wise Daily Quantity of Garbage Collected

In terms of quantities the maximum waste is collected from the Vishrambag and Bibwewadi wards while the lowest quantities are collected from the Warje and Dhole Patil Road Wards.

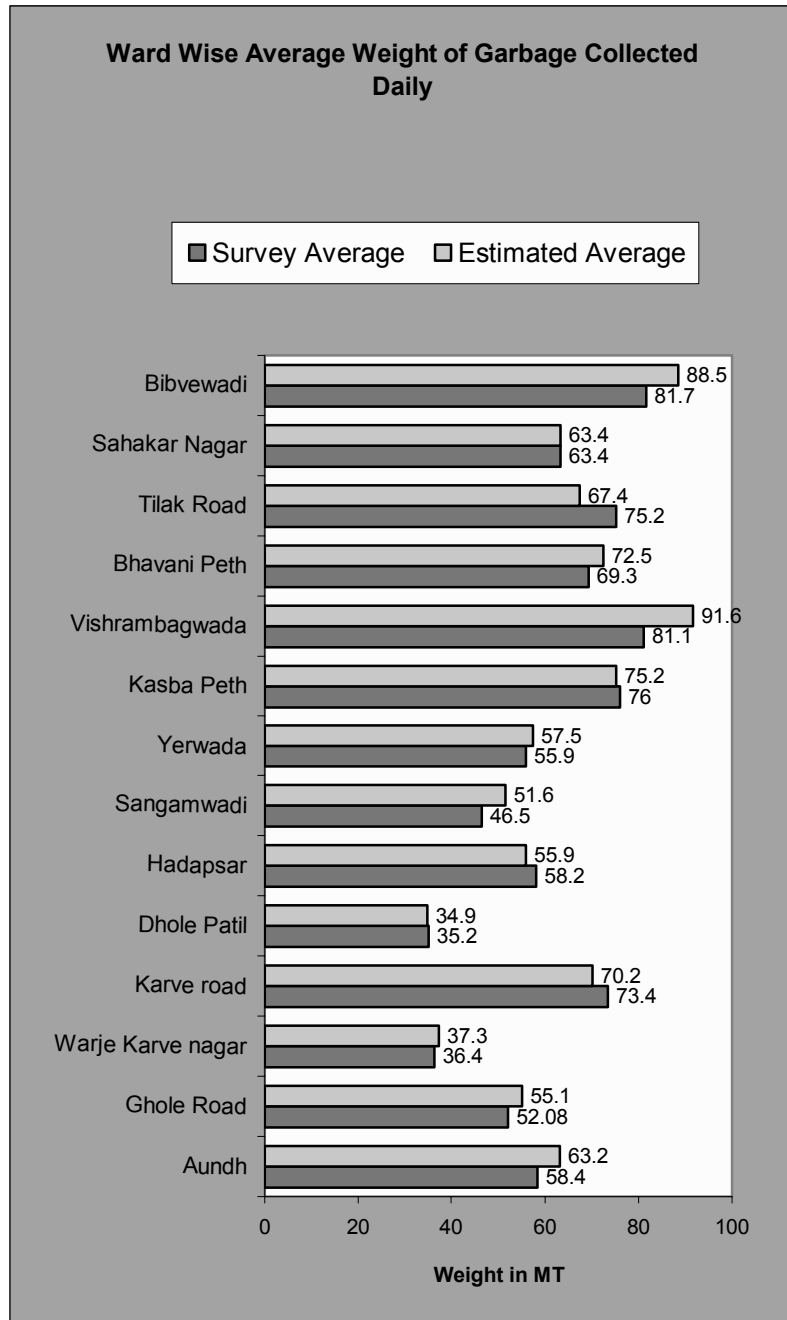
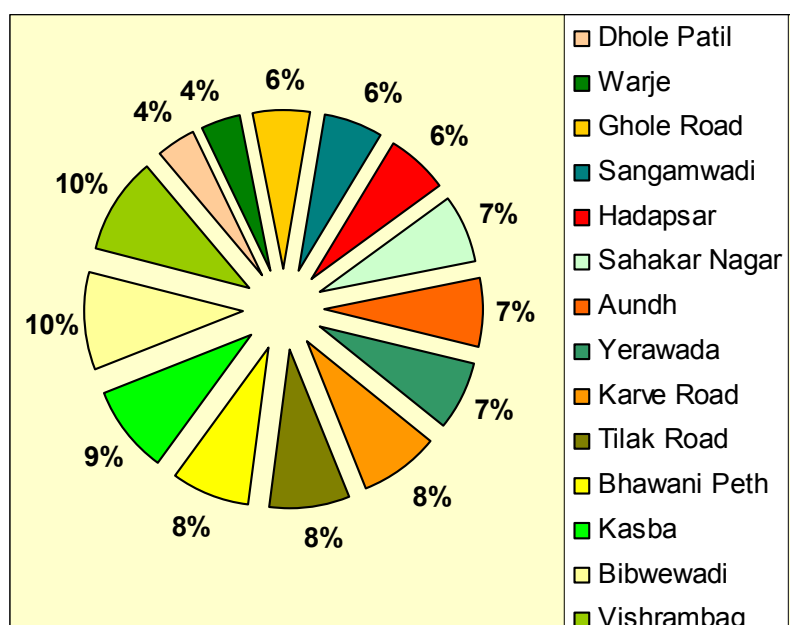


Figure 7: Share of each ward in the garbage pie



According to the Medical Officer of Health, the allocation of garbage collection vehicles is based upon the distance of the ward from the landfill site at Uruli near Hadapsar as well as the quantity of garbage collected daily.

However, further analysis of the data reflects that the allocation of vehicles is disproportionate.

The garbage from compactors in all the wards and some of the hotel trucks is deposited directly at the landfill. The garbage from the ghanatrucks and the dumper placers is usually transferred into Bulk Refuse Carriers at the transfer stations.

Table III A: Vehicle Fleet Capacity of the Pune Municipal Corporation

Type	Numbers	Capacity Cubic metre	Capacity in tons	Price in lakhs	Total Capacity in tons	Total Fleet capacity in double shift
Tipper	8	3.4	1.36	9	10.8	
Tipper	22	6	2.4	12	52.8	
Tipper	6	6	2.4	12	14.4	
Tipper	5	6	2.4	12	12	
Tipper	1	6	2.4	12	2.4	
Tipper	15	3.5	1.36	9	21	
Total	57	30.9	12.3	66	113	226
DP	54	3.8	1.52	9	82.8	
DP	1	3.8	1.52	9	15.2	
DP	22	3.8	1.52	9	33.4	
DP Twin	5	7	3.04	9	15.2	
Total	82	18.4	7.6	36	147	1470
Compactor	1	14	7	35	7	
Compactor	7	14	7	30	49	
Compactor	12	12	6	25	72	
Compactor	4	18	9	30	36	
Total	24	58	29	120	164	328
KT	7	8.5	3.4	14	22.4	
KT	2	8.5	3.4	14	6.4	
Total	9	17	6.8	28	28.8	57.6
BRC	1	8.5	3.4	15	3.2	

BRC	2	8.5	3.4	15	6.4	
BRC	2	8.5	3.4	15	6.4	
BRC	9	8.5	3.4	15	28.8	
BRC	6	8.5	3.4	15	19.2	
BRC	9	14	5.6	16	50.4	
BRC	4	18	7.2	25	28.8	
BRC	4	18	7.2	25	28.8	
BRC	12	18	7.2	25	86.4	
BRC	2	20	8	30	16	
BRC	4	20	8	30	32	
BRC	5	20	8	30	40	
Total	60	171	68.2	256	346	1384

Source: PMC Vehicle depot

The data show that the total fleet size of the vehicles is 232 of which 6 vehicles were inducted in 2006. Primary data indicates that 170 vehicles were actually deployed during the study. The records reflect that an average of 5 breakdowns is reported per day and vehicle repair is centralised. There was no clear explanation about why the number of off road vehicles was as high as 27%. The shortfall was the highest in the case of compactors 9 out of 24.

Table III B: Ward wise fleet utilization

Ward	Daily garbage generation	DP	Compactor	Ghanta gadi	Hotel gadi	Fleet capacity in single shift	Deficit	BRC
Aundh	63.2	4	1	4	1	57.5	5.7	3
Sangamwadi	51.6	3	1	4	1	48	3.6	4
Yerawada	57.55	3	1	3	1	45	12.55	4
Warje	37.3	3	1	2	1	42	-4.7	2
Karve Road	70.2	3	1	2	2	45	25.2	3
Dhole Patil	34.9	3	1	3	2	48	-13.1	3
Ghole Road	55.1	3	1	4	2	51	4.1	3
Bibwewadi	88.5	5	2	6	1	79	9.5	5
Tilak Road	67.45	5	1	3	1	64	3.45	
Sahakarnagar	63.45	3	1	3	1	45	18.45	
Vishrambagwada	76.64	5	1	2	1	61	15.64	
Kasba	75.2	5		4	1	61	14.2	8
Bhavani	72.5	6		5	1	72	0.5	
Hadapsar	55.9	2	2	3	1	42	13.9	
Mandai	15	1		3				
Total	884.49	54	13	52	17	777	107.5	35

Capacity of vehicles in tonnes (Garbage density calculated at 400 kgs/m³)

DP: 1.52 (6 trips per shift)

Compactor: 6

Ghanta gadi: 3

Hotel gadi: 3
BRC: 10 (3 trips per shift)

Whereas Table III A shows the fleet size of the Garbage Transportation Vehicles of the Pune Municipal Corporation, in actual fact fewer number of vehicles were found to be deployed. (Table III B). The data show that if vehicle deployment is undertaken in 2 shifts, as opposed to the single shift at present, and the vehicles are utilised to optimum capacity there is no shortfall. In fact, if the first shift is run efficiently, only a 107 metric tonnes is required to be lifted in the second shift.

Table III C: Ward wise vehicle allocation costs

Ward	Area in sq kms	Daily garbage generation	Dumper Placer	Compactor	Ghanta truck	Hotel veh.	BRC	Total vehicles	Allocation costs in Lakhs
Mandai		15	1		3+1				
Dhole Patil	9.7	35	3	1	3	2+1	3	9+1	107
Warje	14	37	3	1	2	1	2	7	87
Sangamwadi	25	52	3+3	1+1	4	1	4+4	9+4	107
Ghole Road	13	55	3+3	1+1	4	2	3+3	10+1	117
Hadapsar	28	56	2+2	2+2	3+1	1+1		8+6	118
Yerawada	22.9	58	3+3	1 (used as GG)	3+1	1+1	4+4	8+5	97
Aundh	44	63	4+4	1+1	4	1+1	3+3	10+6	116
Sahakarnagar	13	63	3	1+1	3	1		8+1	97
Tilak Road	18	67	5	1+1	3	1		10+1	115
Karve Road	10	70	3	1+1	2	2+1	3	8+2	97
Bhavani	2	73	6+4		5+1	1		12+5	114
Kasba	3.4	75	5+4		4	1	8+4+6	10+4	95
Vishrambagwada	4.7	77	5+4	1+.5	2+2	1+1		9+7.5	105
Bibwewadi	25	89	5+2	2+1	6	1	5	14+3	175
Total	233	884	54+29	13+9.5	52+6	17+6	35+18+6		

Note:

1. Two and three figures in the same column reflect utilisation in each shift
2. Capital cost (source vehicle depot) of types of vehicles
Dumper placer 9 lakhs
Compactor 30 lakhs
Ghanta truck 10 lakhs
Hotel 10 lakhs
BRC 25 lakhs

The vehicle allocation in respect of the ward generating the highest amount of garbage is proportionate. The same does not however apply for many other wards as Table III C indicates.

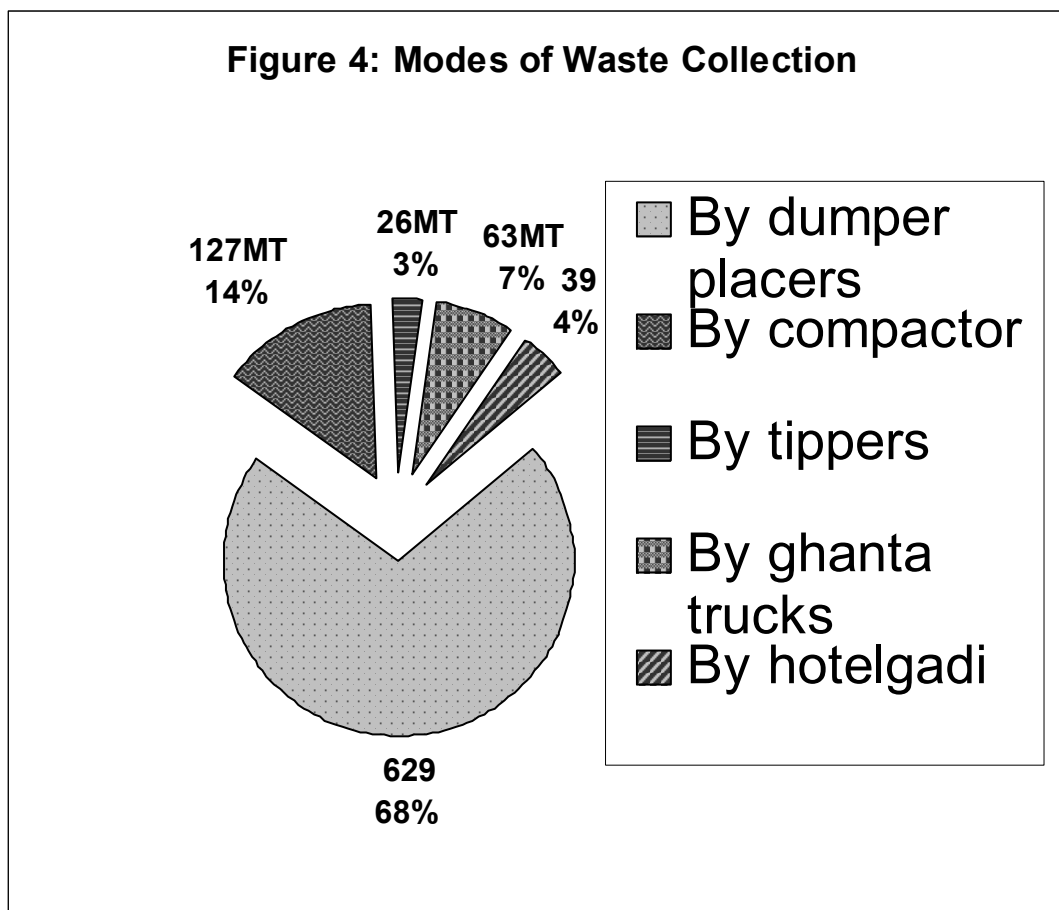
Modes of Waste Collection

Solid waste collection from across all wards is effected in 1 to 3 shifts using 72 dumper placers, 15 compactors, 26 bulk refuse carriers, 16 hotel trucks and 41 ghanta trucks. Tilak Road and Sahakar Nagar wards have also contracted out waste collection to private tractor operators. Private tempos also operate in some wards. The tractors offload at the municipal ramps while private tempos empty into containers.

Door-to-door collection of waste using non-motorised ghanta cycles has also been introduced in the city through the involvement of NGOs on a full cost recovery basis. Some of the ghantacycles are operated by PMC workers themselves while most of them are operated by PMC authorised Wastepickers and other urban poor.

Reduction of containers on the street is being actively promoted by the administration. Nonetheless, the data show that the most favoured means of waste collection continues to be through community bins/ containers placed in public areas using dumper placer vehicles or compactors for transporting the containers or tippers collecting from open bins.

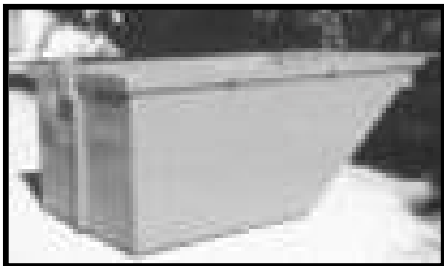
Figure 8: Modes of waste collection in Pune



Container collection accounts for 89 per cent of the waste collected in Pune. Collection through dedicated collection vehicles such as ghantatrucks for households and hotel trucks for hotels accounts for a mere 11 per cent of the total garbage collected (Figure 3).

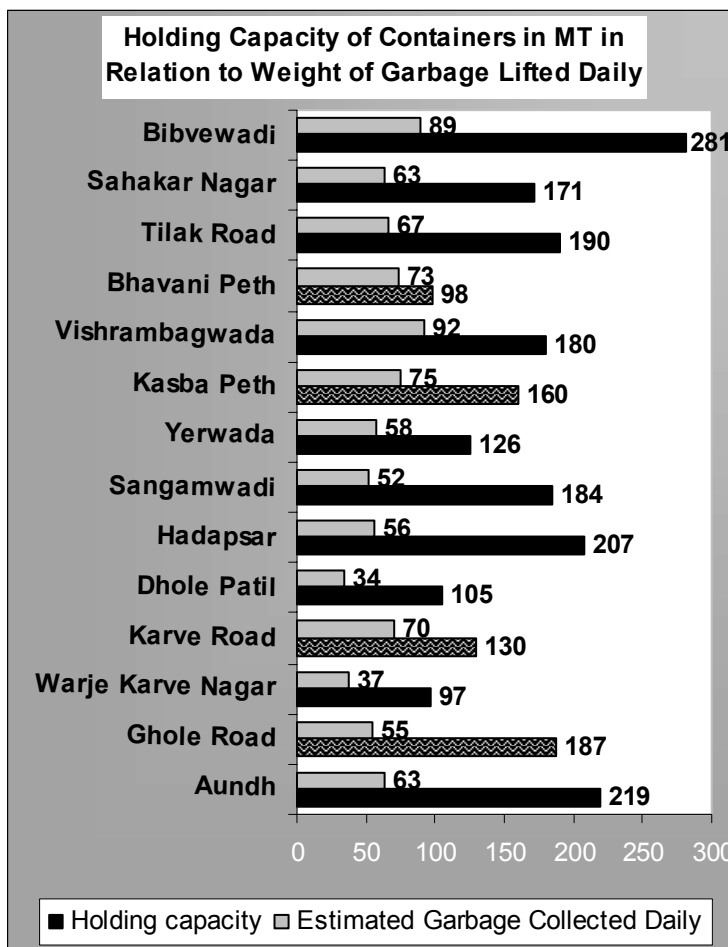
Holding Capacity of Community Containers in Relation to Weight of Garbage Lifted Daily

There are a total of 2066 containers of all types in the city, with a total holding capacity of 2335 MT as compared to the 884 MTPD garbage collected daily. The city has compactor buckets of 3 different sizes (1.1 cu m, 1.5 cu m and 2.2 cu m) as well as the large containers (3.8 cu m) carried by dumper placers. Based on the average density of garbage in the city, the holding capacity of a 3.8 cu m container is 1.5 MT (Table II) while that of a 1.1 cu m compactor bucket is 0.4 MT, a 1.5 cu m compactor bucket is 0.6 MT and a 2.2 cu m compactor bucket is 0.9 MT. The comparison of the holding capacity of containers in each ward and the total quantity of garbage collected is presented in Figure 4.



The number of containers in the ward is influenced by the geographical spread of the ward and quantity of garbage generated daily. Since collection is primarily through community bins, the number of community bins or containers and their holding capacity and accurate placement within the ward becomes critical for preventing overflows.

Figure 9: Ward wise holding capacity of containers



Although, all containers are expected to be lifted daily, vehicle breakdowns, non-availability of drivers, absenteeism of labourers and related exigencies hamper the lifting of all containers on a day-to-day basis.

A comment on the available capacity in each ward has been given in Table II. Overloads were found to be probable in Ghole Road, Karve Road, Bhawani Peth and Kasba Peth wards.

Table IV A: Ward wise population density in relation to holding capacity of containers

Ward	Total Population	Area in sq kms	Population density/sq km	Holding capacity In MT	Ratio of capacity
Bhavani	200000	2	100000	98	1.4
Karve Road	124730	10.38	12016	130	1.9
Kasba	317450	3.37	94198	160	2.1
Yerawada	250000	22.9	10917	126	2.2
Vishrambagwada	252000	4.71	53503	180	2.3
Warje	160000	13.62	11747	97	2.6
Sahakarnagar	325000	13	25000	171	2.7
Tilak Road	350000	18.46	18960	190	2.8
Dhole Patil	117000	9.71	12049	105	3
Bibwewadi	400000	24.5	16326	281	3.2
Ghole Road	160000	12.6	12698	187	3.4
Aundh	282000	44.46	6342	219	3.5
Sangamwadi	260000	25	10400	184	3.6
Hadapsar	250000	28	8928	207	3.7
Mandai					
Total	3448180*	232.71			

* The total population does not correspond to census figures.

Generally there is a correlation between container capacity and the density of population within the wards. Hence, Bhavani peth with the largest population density manages with the least container capacity. On the other hand, Aundh and Hadapsar with lowest population density need to have the largest container capacity. As for the other wards there are those which could reduce their excess containers.

Table IV B: Weight of garbage disaggregated ward-wise from secondary data matched with survey average and estimated average in MTPD

Column No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ward	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Apex Avg	0 gb avg	21	22	23	24	25	Survey Average	Calculated Average
Aundh	53	49	53	65	65	62	57	57.71	62	75	64.2	57.6	49.7	62.1		58.4	63.2
Ghole Road	123	129	118		119	112	70	95.86	70	70						52.08	55.1
Warje								0	35	35	37.6	33	34.8	40.3		36.4	37.3
Karve road	54	56	54	56	55	54	56	55	56		84.3	63.1			72.9	73.4	70.2
Dhole Patil		14	21	22	24	21	21	20.5	22	25	30.2	40.2				35.2	34.9
Hadapsar								0	35	35	58.7	45.7		70.4		58.2	55.9
Sangamwadi	48	48	48	48	48	48	48	48	50	58	68.5	48.3	24.9	44.4		46.5	51.6
Yerwada	32	32	32	32	32	32	32	32	32	26	66	64.3	37.6			55.9	57.5
Kasba Peth	59	66	65	59	60	62	58	61.29	64	80	70.9	83.5		73.6		76	75.2
Vishrambagwada	49	42	56	58	58	76	37	53	45	81	70.9	91.4				81.1	91.6
Bhavani Peth	44	48	48	58	56	70	63	55.29	66	80	66.9	71.8				69.3	72.5
Tilak Road	49	50		50	60	67	63	56.5	63	50	73.5	77				75.2	67.4
Sahakar Nagar		42	51	54	53	60		52	54	61	63.2	59.4	52.8	65.3	76.4	63.4	63.4
Bibvewadi		54	56	55	62	70		59.4	56	82	84.5	96.8	80.9	62.9	83.6	81.7	88.5
TOTAL									710	758						862.8	884.3

Explanation:

The averages given by the Ward officials (WMO/ SI/ Ramp Mukadam/ Kachra Vahatuk Mukadam) have been quoted for the months from March to September (columns 1-7).
The average has been calculated accordingly (Column 8).
Ward Offices present averages at the monthly Apex committee meetings that may or not correspond with the monthly calculated average (Column 9).
Average weight of garbage collected in the Zero garbage week, ie 12th to 14th August 2005, (Column 10).
Actual recorded weights by all forms of collection on Survey dates 21st to 25th October 2005, (columns 11-15).
Average weight of garbage collected during survey, (Column 16).
Calculated average weight of garbage collected in each ward, but factoring specific variations during the study, (Column 17).

Table V: Holding capacity in MT of community bins/ containers disaggregated according to sizes and wards

	Column No	1	2	3	4	5	6	7	8	9
Sr No	Ward Office	3.8 M3	1.1 M3	2.2 M3	1.5 M3	Total	Holding capacity	Average garbage	Estimated capacity	Comments
1	Aundh	111	0	0	88	199	219	63.2	3.5	comfortable
2	Ghole Road	100	40	23	0	163	187	55.1	3	comfortable
3	Warje Karve Nagar	58	25	0	0	83	97	37.3	2.5	comfortable because compact ward
4	Karve Road	70	14	22	0	106	130	70.2	2	overload
5	Dhole Patil	49	0	0	53	102	105	34.9	3	comfortable
6	Hadapsar	77	0	0	153	230	207	55.9	3.5	comfortable
7	Sangamwadi	82	0	0	102	184	184	51.6	3.5	comfortable
8	Yerwada	71	0	0	33	104	126	57.5	2	overload
9	Kasba Peth	91	43	7	0	141	160	75.2	2	overload
10	Vishrambagwada	108	29	7	0	144	180	91.6	2	overload
11	Bhavani Peth	65	0	0	0	65	98	72.5	1.5	highest overload
12	Tilak Road	102	41	18	7	168	190	67.4	3	comfortable
13	Sahakar Nagar	94	0	0	50	144	171	63.4	3	comfortable
14	Bibvewadi	157	0	0	76	233	281	88.5	3	comfortable
	Total	1235	192	77	562	2066		884		
	Capacity in tons	1.5	0.4	0.9	0.6					
	Maximum capacity	1853	77	69	337	2336	2335			

Explanation: Number of containers of each specified size in Cubic Metres in each Ward, (Columns 1-4).

Total number of containers in each Ward (Column 5).

Total Garbage Holding Capacity of all containers in the Ward, calculated according to average Density of Garbage for Pune, 400 kgs/ Cu M, (Column 6).

Average weight of Garbage collected daily in the Ward, (Column 7).

Ratio of Total garbage holding capacity of all containers in Ward to Average Weight of garbage collected in Ward, (Column 6/Column7=Column 8).

Status of containers in ward in case of poor garbage collection due to exigencies.

Table VI: Weight of garbage collected in kg. disaggregated according to ward and mode of collection

Ward	Aundh	Ghole Rd	Karve Rd	Warje	Bibvewadi	Tilak rd	Sahakar nagar	Sangamwadi	Yerwada	Dhole Patil	Kasba	Vishrambag	Bhavani	Hadapsar	Total
By compactor	10000	5800	8800	5000	13500	13500	7500	10500	4200	7000	13900	9240		18400	127340
By ghanita trucks	6700	8900	2700	2100	4450	3150	2100	2700	9600	5700	1300	2400	4850	6700	63350
By tippers	4000	NA	NA	NA	NA	4300	7200	2500	NA	700	5600	1600	NA	NA	25900
By dumper placers	40000	34400	52200	29000	69250	45400	45400	35100	41500	13800	52100	75400	66600	28600	628750
By hotelgadi	2500	6000	6500	1200	1300	1100	1250	800	2250	7700	2300	3000	1050	2200	39150
Total wt	63200	55100	70200	37300	88500	67450	63450	51600	57550	34900	75200	91640	72500	55900	884490

Section III: Waste collection

A. Waste Collection from Bulk Generators through Dedicated Vehicles

The bulk generators of waste comprise hotels, canteens and refectories of educational institutes, marriage halls and markets. The Pune Municipal Corporation has separate tipper truck collection vehicles for bulk generators. Bulk generators are expected to store waste segregated at source in green and black bags for wet and dry waste, respectively. Despite this, mixed waste was found in the hotel truck. At least 5 sample bags in each in each ward were opened to assess the contents. Wet waste contributed to the weight of the truck while the dry waste being more voluminous contributed to the percentage filling of the truck (Figure 3).

Each municipal ward has a list of bulk generators assigned to the collection vehicle. The lists were provided by all the ward offices other than the Bhawani Peth, Ghole Road and Hadapsar ward offices. The hotel vehicles are despatched directly from the PMC vehicle depot and frequently do not report to the respective ward offices. Vishrambag ward covered the highest number of hotels (140) while Bibwewadi covers the least (26) (Figure 4). The coverage as per the list was highest in Yerawada and Karve Road wards, unlisted hotels also being covered in the latter reflecting higher collection in terms of weights and volumes as well. Across wards the hotel vehicles were covering 79 % of the listed hotels.

The data show an attempt to maximise the utilisation of available hotel vehicles in the Dhole Patil Road (also used to collect garden waste) and Karve Road (Warje Karvenagar hotel vehicle also used by Karve Road) wards.

The average time taken for waste collection from hotels ranged between two and a half and nine hours. Most worked for 6 hours or less despite the fact that all the hotels had not been covered and vehicle could accommodate more waste. The time taken for collection is influenced by the size of the establishments and their density within a given area and the geographical spread of the ward.

The number of municipal workers deployed on the ghanta trucks ranged between 2 and 6 excluding the driver, but most often there were 4 workers present.

The estimation of generation by bulk generators in Phase I was as follows.

Mandai daily 10 containers of primarily organic waste	15 MTPD
Hotel waste primarily organic and can be fine segregated	39 MTPD

The deficiencies in the collection from bulk generators were shared with the ward functionaries after the first phase of the study. Subsequently, attempts were made to improve collection from bulk generators. The wards were asked to prepare an exhaustive list of the bulk generators of organic waste including hotels, markets, hospitals, educational institutions and marriage halls (mangal karyalays). These were resurveyed in the second phase in the month of February 2006 and the data are presented in Table VIII and Table IX. The data collected in Phase II indicate an increase of 11 MTPD being collected from bulk generators.

Table VII: Phase II collection from bulk generators

Ward	Listed hotels	List covered	Unlisted covered	Total covered	listed not covered	No of bags	Weight	Hours
Dhole patil	108	15	37	52	80	165	3395	4
Dhole patil		13	7	20		279	3100	6.5
Ghole Rd	86	45	4	49	41	320	6210	3.5
Ghole Rd	61	31	22	53	30	453	5200	4.5
Sahakarnagar	119	38	35	73	81	124	1600	4.5
Tilak Road	88	19	69	26	69	50	900	4
Kasba Peth	80	36	17	53	44	260	3300	6.15
Vishrambag	216	90	30	120	126	228	2300	2.5
Aundh	103	22	15	37	67	261	2000	7.5
Aundh		14	41	55		223	3500	6.15
Karve Road	60	37	11	48	23	297	3500	7
Karve Road	74	42	10	52	32	235	3200	5.45
Warje	50	11	15	26	39	174	1200	5
Hadapsar	120	37	11	47	83	130	2365	2.5
Bibvewadi	220	57	11	68	163	107	3400	4
Yerwada	100	25	13	38	75	143	2460	5
Sangamwadi	99	41	17	58	58	98	1300	4
Bhavani Peth	116	53	25	78	63	78	1140	4
	1700	626	390	953	1074	3625	50070	

Note:

1. The baseline Bulk Generator lists used for the study include 101 **Mangal Karyalayas** which have been appended to the original Ward office Hotel Lists. However only 32 garbage bags were picked from 9 mangal karyalayas. Some wards have clarified that these establishments call up and inform them if waste is generated, whereas others have stated that these establishments do not give them the garbage.
2. Similarly approximately **25 hospitals and 40 hostels** have been appended to the original hotel list. However garbage bags have been collected from only 20 such establishments. Some of these lists possibly include hospitals that are not generating organic garbage.
3. Although it appears that the of the 1700 establishments listed, garbage has not been collected from over 1000, the actual generation of these establishments which are not covered may not be high. This is because
 - a. Firstly almost 150 could be explained by points 1 and 2.
 - b. Many are (approximately 100) small amruttulyas or tea stalls which wards claim do not give garbage daily.
 - c. More than 350 establishments, largely hotels, which are not mentioned in the Ward lists, are actually giving garbage to the vehicle. (As they can only do so if they have prior intimation, it is obvious that they have been giving garbage since some months).
 - d. The actual **lists of Bulk Generators** ward wise provided by the Health dept posed a number of problems. They comprised photocopies of many internal ward lists, along with computerised lists we had compiled for them in the first

- round of the study. Most of these are handwritten, and sometimes illegible. Many have names repeated, either by mistake or because there are more hotels by the same name. Detailed addresses of hotels have not been given for verification. These lists have been prepared largely by Mukadams at the Wards.
- e. If we presume that 400 hotels are still left out we could estimate that another 40% weight could be added to the overall hotel waste collected i.e. 20 tons. (Of the total 61 tons, 50 tons is the weight from hotel garbage. Much of the problems are to do with the original hotel lists.)

4. The weights for 6 vehicles were not taken as the ramp **weighing scale was not functioning**. However weights estimated are accurate as they have been checked along many variables.

Vegetable markets: The bulk generators of garbage include the vegetable markets. However separate systems of collection do not exist for all the garbage generated there. The projected weights of garbage for the same are given in table IX

Table VIII: Phase II Garbage generated in Vegetable markets

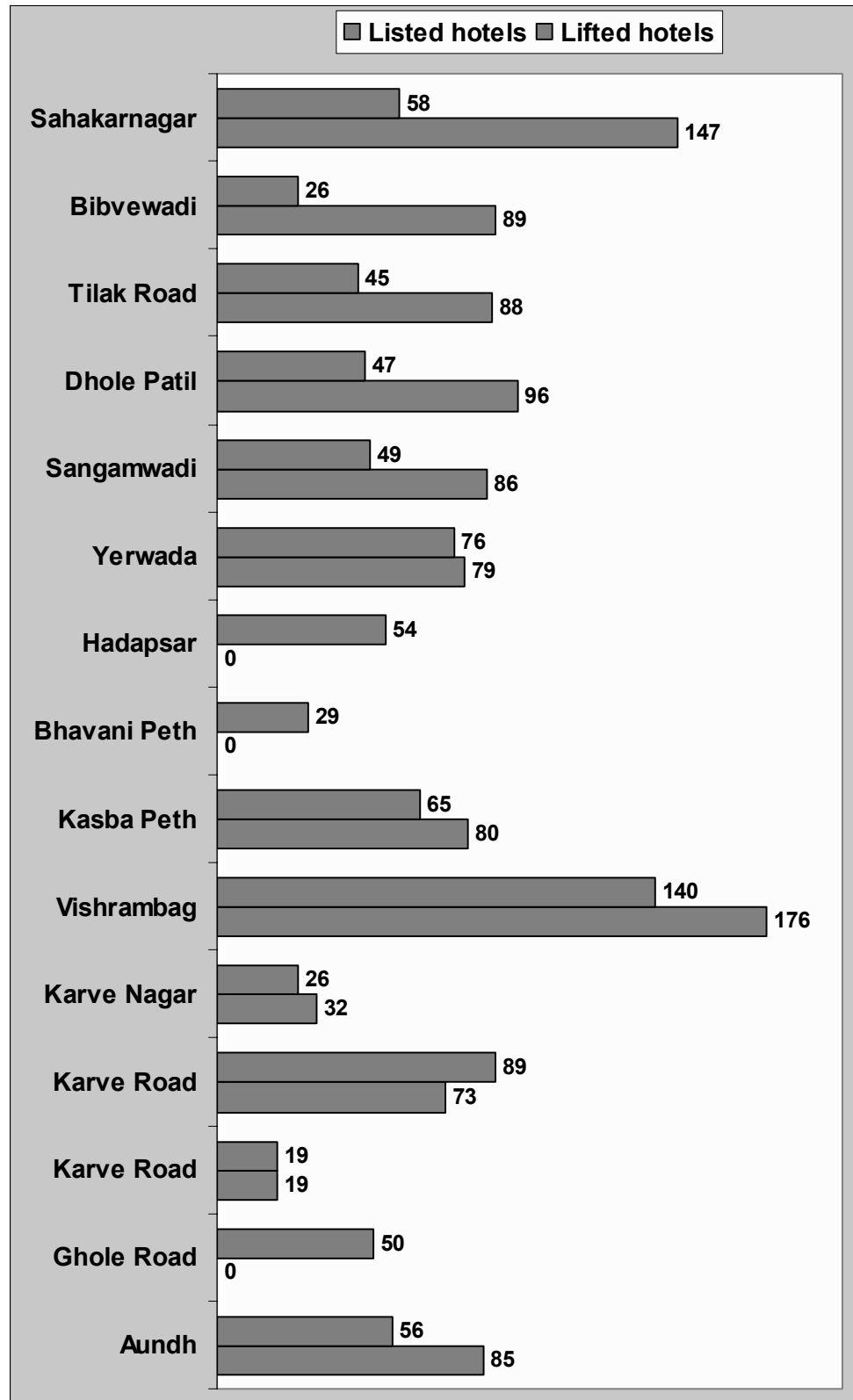
Sr No	Market	Weight in tonnes	Actual weight/ Estimated weight	Separate collection/ No Separate collection
1	Hadapsar	3	Estimated	No Separate Collection
2	Gultekdi	20	Estimated	No Separate Collection
3	Wadgaon Sheri	5	Estimated	No Separate Collection
4	Mahatma Phule	12	Actual	Separate Collection
5	Other Mandais	11	Estimated	No Separate Collection
	Total	51		

Note:

1. The weight of garbage from the **vegetable market** in Phase II is based on secondary data. The weights recorded at the ramp indicate that 11700 kg was collected from the Mahatma Phule Mandai. Estimates of the Gultekdi Market yard and Hadapsar mandai are not available. Whereas Gultekdi is larger than the MP Mandai, Hadapsar mandai is smaller. Apart from this at least 4 of the 14 wards have a vegetable mandai, which should be generating around 1500 kgs of organic garbage daily.
2. The total figures include waste generated by **chicken and mutton markets** spread out in 8 of the 14 wards over the city. Number of such establishments is 73 and number of garbage bags from the same is 83. Although many Chicken and mutton centers are listed, garbage was actually collected on the day of the survey only from 29. Actual weights are not available.
3. Incidentally, the total weights of the garbage of the city, (and ward wise) as per secondary data, were **almost 25%** less than that during the time of the survey in October 2005. However weights of Bulk Generator vehicles have not decreased.

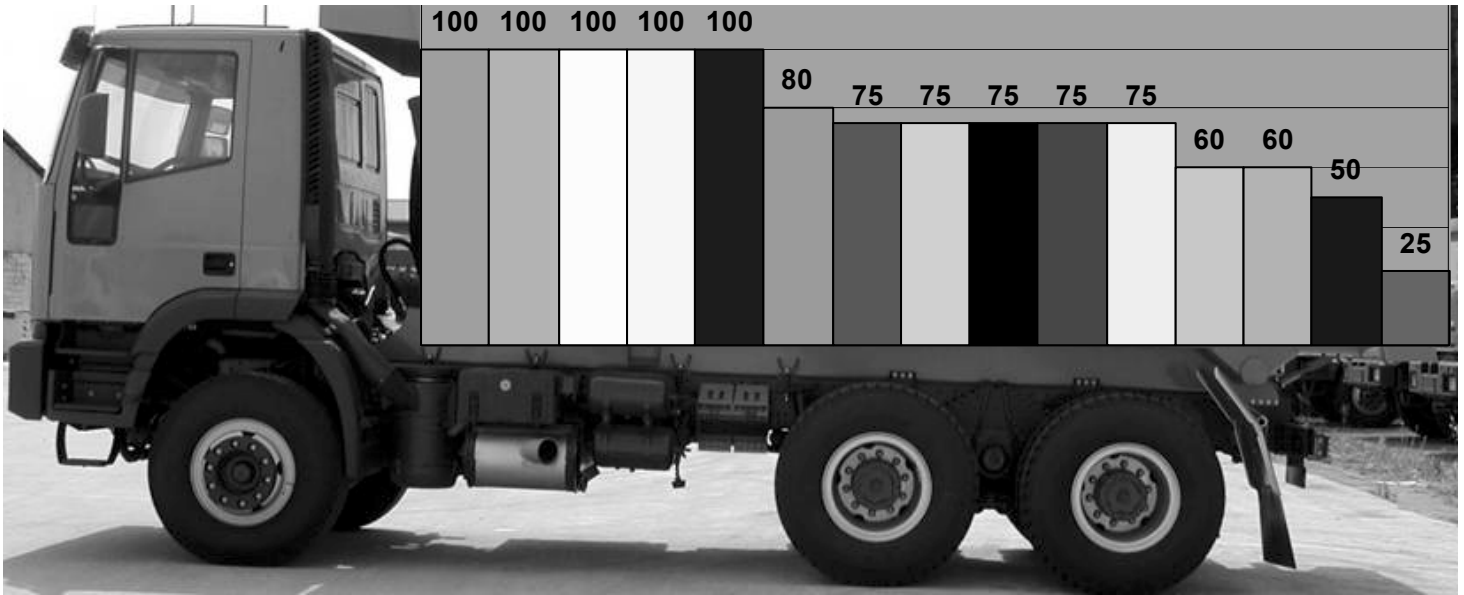
Collection Efficiency of Hotel Vehicles based on Phase I data

Figure 10: Number of Hotels covered for Waste Collection by Hotel Truck in each Ward



Note: List of hotels not provided by Ghole Road, Bhawani Peth and Hadapsar Wards

Figure 11: Percentage Filling of Hotel Truck



LEGEND

- Dhole Patil ■ Ghole Road □ Karve Road □ Karve Road
- Karve Nagar ■ Hadapsar ■ Vishrambag □ Kasba Peth
- Bhavani Peth ■ Aundh □ Yerwada □ Sangamwadi
- Sahakarnagar ■ Bibvewadi ■ Tilak Road

Figure 12: Average Hours of Operation of the Hotel Truck in each Ward

Ward	Average Hours
Aundh	
Ghole Road	3
Karve Road	7
Karve Road	9
Karve Nagar	7
Vishrambag	8
Kasba Peth	5
Bhavani Peth	4
Hadapsar	6
Yerwada	6
Sangamwadi	3
Dhole Patil	7
Tilak Road	4
Bibvewadi	4
Sahakarnagar	4



Figure 13: Number of Workers on Hotel Trucks in Each Ward

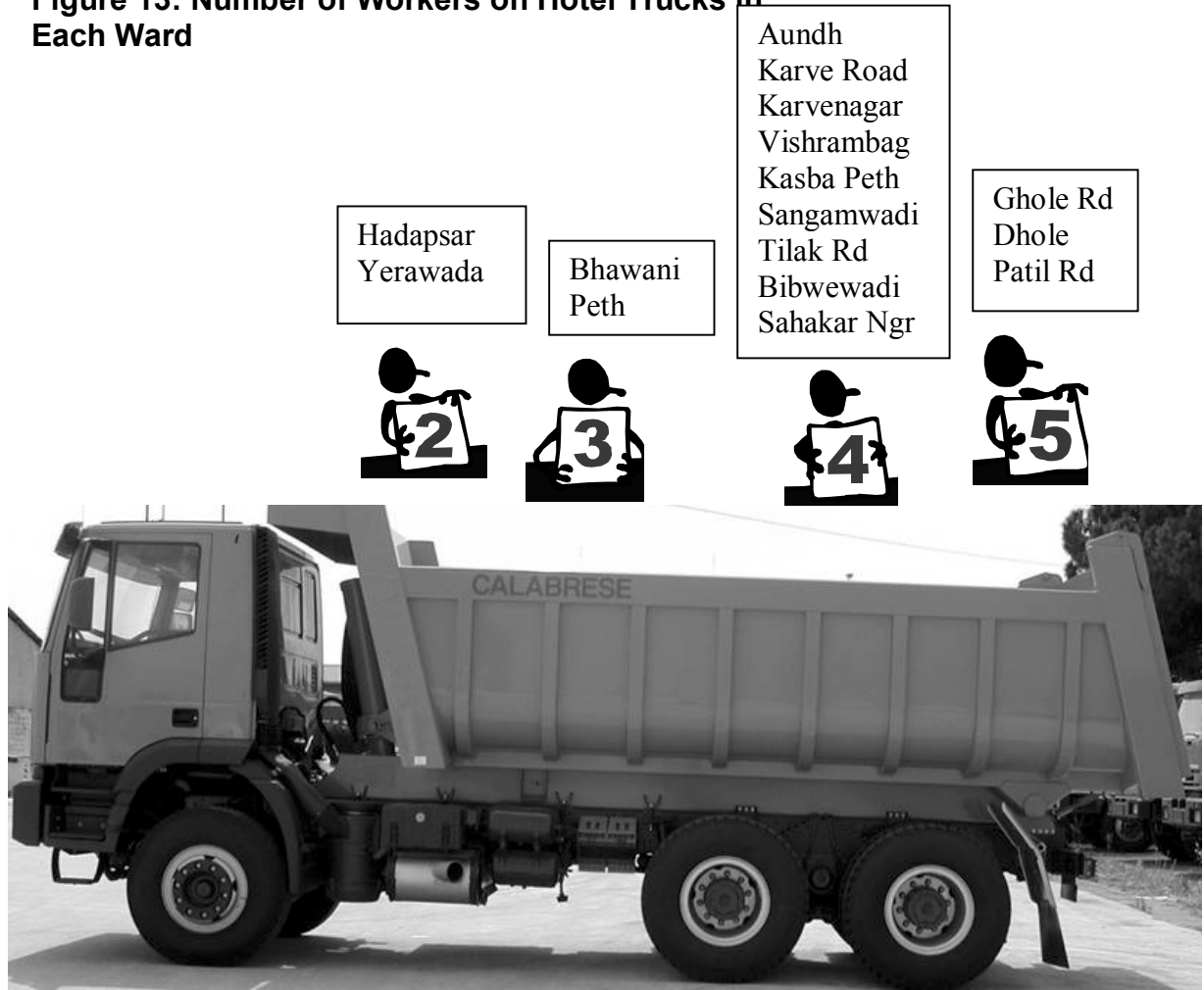
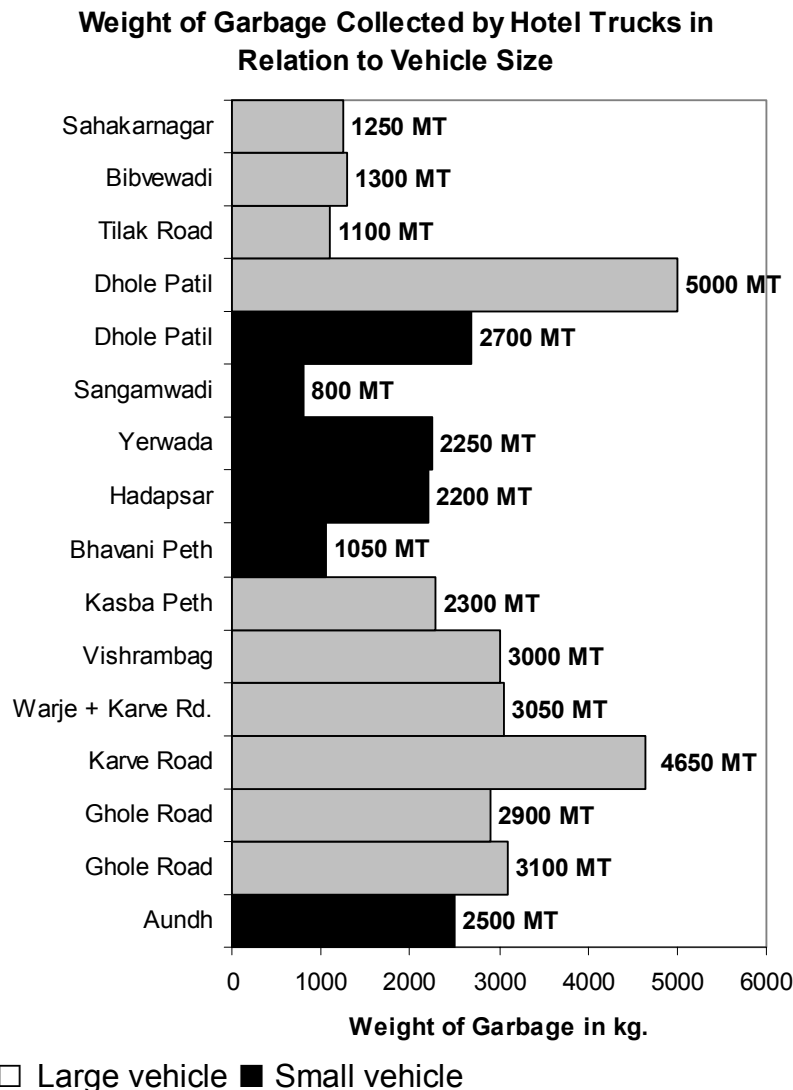


Figure 14:



Utilisation of Hotel Collection Vehicles:

There are two sizes of tippers that are deployed for the collection of hotel waste. The tare weight of the smaller tippers is 3500 kilograms while that of the larger tipper is 5200 kilograms. Presumably the 2 sizes have a maximum carrying capacity of 2500 and 4650 kilograms each (based on the maximum weights lifted in some wards).

In the smaller vehicle size, the Sangamwadi ward lifted the least garbage, averaging 800 kg. per day, filling only 60% of the total volume of the truck, covering only 49 of the 86 listed hotels and deploying four workers and a driver.

The same size of vehicle is optimally used in the Aundh ward, where the hotel vehicle collected 2500 kilograms per day, covering 56 of the 85 listed hotels, deploying four workers and a driver. The bigger vehicle is grossly underutilised in the Tilak Road ward, where it is filled only to 25%, lifting an average weight of a mere 1100 kg. per day, covering only 45 of the listed 88 hotels, with 4 workers and a driver. In sharp contrast, the Karve Road ward, covers 89 hotels (more than the listed 73) and is filled to capacity 100% with 4650 kg. with the same no of workers as in the Tilak Road ward.

Most hotel vehicles operate during the day (6am-2 pm shift) when mobility is restricted by high traffic density.

Estimation of Labour Costs for Hotel Vehicle

Average wages of PMC bigaris (labourers)

Rs.5000 per month X 4 bigaris

Rs.20,000=

Average wages of PMC driver

Rs.8000=

This excludes capital costs and recurring costs of the vehicle, fuel and maintenance. The data show that in effect the Sangamwadi and Tilak road wards spend Rs.20/- per hotel per day just on labour costs. Even with optimum vehicle utilisation, the labour costs in the Aundh and Karve Road wards are almost Rs.10/- per day. However, the PMC gets a bulk quantum of reasonably segregated, largely wet garbage that it could process to its advantage.

Table IX: Comparison of Labour Costs per Hotel Per Day for Hotel trucks of the Same Size Operating at Low and High Efficiency in a Vehicle of the Same Size

Sr. No.	Ward	Vehicle Size	No. of hotels listed	No. of hotels lifted	Wt. of garbage	Vehicle filling	PER unit Labour costs/ Day
1	Sangamwadi	Small	86	49	800kgs	60%	Rs 20
2	Aundh	Small	86	55	2500 kgs	100%	Rs 10
3	Tilak Road	Big	86	45	1100kgs	25%	Rs 20
4	Karve Road	Big	73	89	4650 kgs	100%	Rs 10

Cost efficiency of waste collection from bulk generators

Collection from hotels, mangal karyalays, educational institutions, canteens and refectories is undertaken through dedicated vehicles. Actual Collection was undertaken from 626 (37 %) out of the list of 1700 provided by the PMC. However, in actual fact waste was also lifted from 390 unlisted establishments. The total number of establishments serviced was 953 while 1074 were listed but not serviced.

Total number of establishments:

2090

Total number of listed establishments:

1700

Total number of listed establishments from which garbage was lifted: 626

Total number of listed establishments from which garbage was not lifted: 1074

Total number of unlisted establishments from which garbage was lifted: 390

Each hotel truck averaged 4 workers and one driver and a four hour shift, (11 out of the 18 trucks operational in Phase II, worked for less than 5 hours). In Phase two of the study a total of 18 hotel trucks serviced 953 hotels,

collecting and transporting 50 tons of garbage to the transfer station or landfill site.

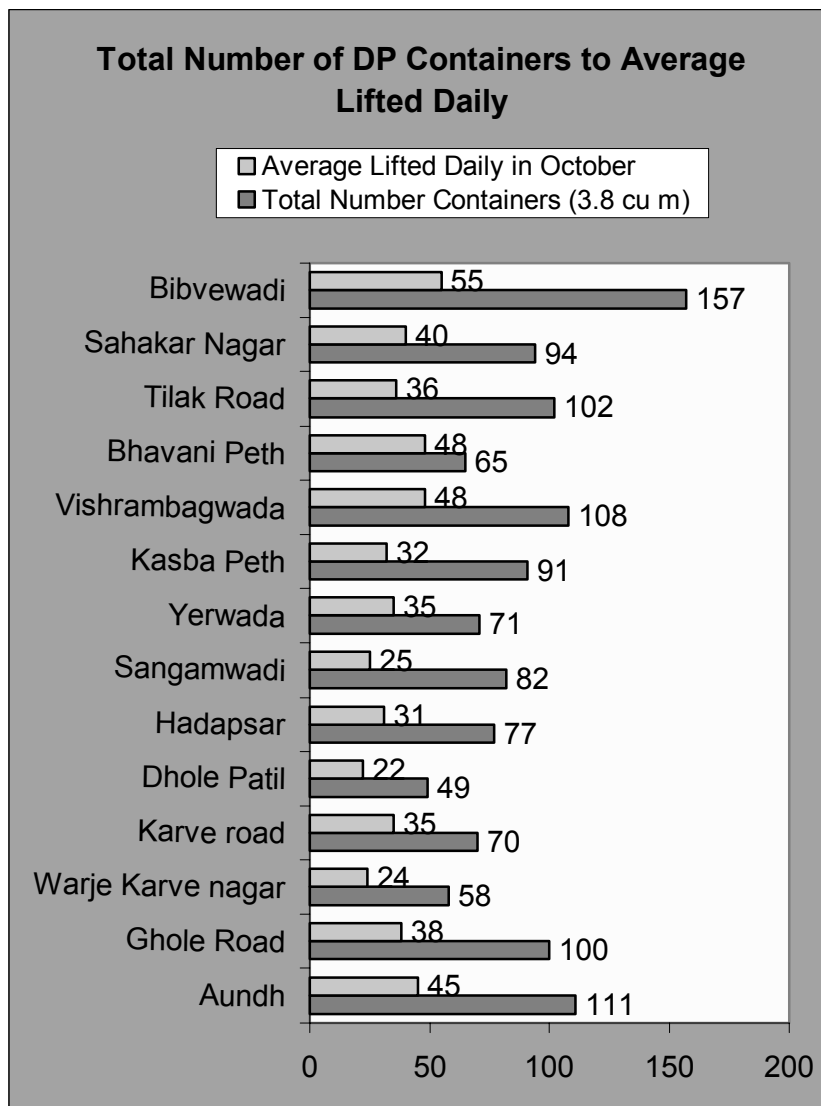
Assuming an average strength of 4 workers and one driver per hotel truck and a capital and fuel cost of Rs.2000/- per day, the monthly operational costs per establishment serviced and the cost per tonne of garbage collected can be worked out as follows:

4 bigaris x Rs.5000/- per month	Rs.20000/-
1 driver x Rs.8000/- per month	Rs.8000/-
Hotel truck costs at Rs.2000/- x 30	Rs.60000/-
Total	Rs.88000/-
Monthly operational cost of hotel truck	Rs.88000/-
Number of hotels covered	53
Average cost per establishment per month	Rs.1660/-
Monthly operational cost of hotel truck	Rs.88000/-
Monthly collection of garbage 2.8 x 30	83 tons
Average cost per tonne of hotel garbage	Rs.1060/-

For such optimum utilisation of the hotel trucks some concerted, coordinated efforts will need to be made centrally and then shared with individual wards.

B. Collection of community bins/containers through dumper placers

Figure 15:

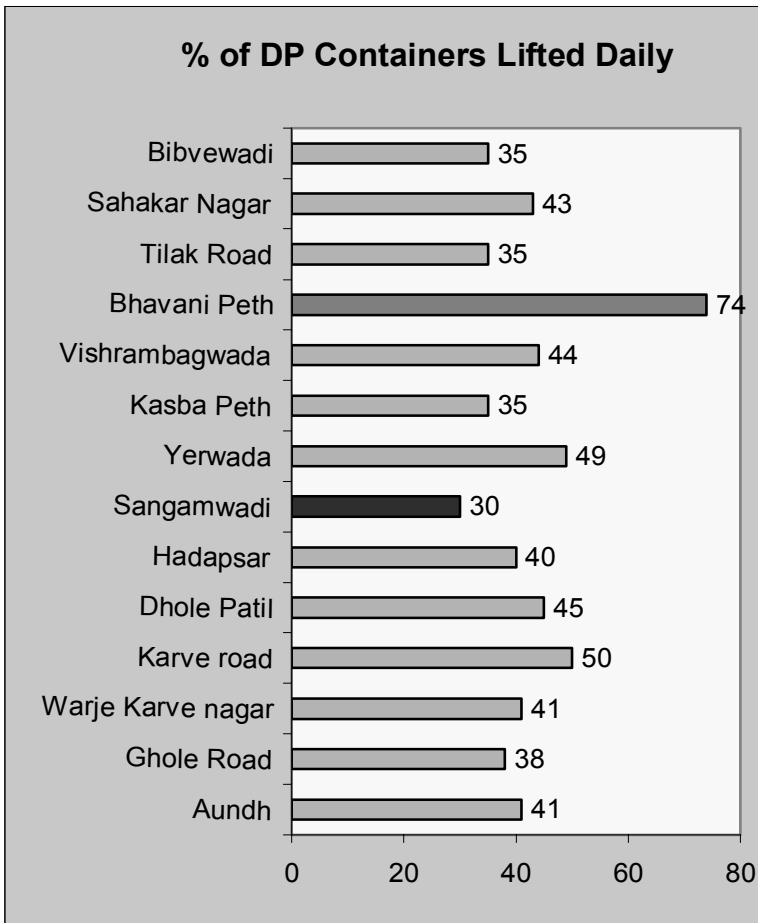


The data show that on an average at least 40 per cent of the total community bins/containers in the city are lifted daily across wards including all shifts. The number of containers lifted daily in relation to the total containers was the highest in the Bhavani Peth ward and the lowest in the Sangamwadi ward. This has to be seen in relation to the filling of containers.

The collection of 3.8 cu m containers filled to capacity was the highest in Kasba Peth and Karve Road and the lowest in Yerawada and Tilak Road. It needs to be recalled here that the Karve Road containers had overflowed for reasons mentioned earlier. The figure may not be the same in normal circumstances.

Each dumper placer is expected to collect at least 15 containers in a single shift.

Figure 16:



Container lifting during survey: Since the bulk of garbage collected in the ward is by the method of Dumper Placers lifting 3.8 M3 containers (74%), it is necessary to compare the numbers of Containers lifted during the Survey period with the Number of Containers lifted on any other day in the month. As the average weight of garbage in a 3.8 M3 container filled to capacity is 1500 kg, a significant variation in the numbers of Containers lifted could distort the average weights derived for the ward.

Some ward officials had also commented that the additional time spent on weighing of individual containers would delay the regular lifting schedule. Average containers lifted in the month of October were therefore compared with the average lifting during the survey days.

Table X : Comparison between the number of containers usually lifted and the number lifted during the survey period

Ward	Comparison
Warje and Kasba Peth	No difference
Ghole road, Sangamwadi, Yerwada, Tilak Road and Sahakar nagar	Marginally less than the number of containers usually lifted i.e. between 6 and 15 containers less
Aundh, Bibvewadi, Hadapsar and Dhole Patil	Lifted less than the usual number
Bhavani Peth, Vishrambag, Karve Road	Lifted up to 5 containers more than usual

The community bins/ containers generally have mixed waste which is segregated by the wastepickers prior to its collection by the PMC. Therefore although visually classified as mixed the organic content of this waste is fairly high.

Table XI: Ward wise collection through dumper placers

Column No	1	2	3	4	5	6	7	8	9	10	11	12	13
Ward	Total 3.8 bins	Avg Dps Oct	% of bins lifted	Avg Dps Survey	Dp 21	Dp 22	Dp 23	Dp 24	Dp 25	Avg Wt 100% full bins	Garbage Density Kgs/M3	<100%full/ 100%full Bins	Comments on DPs lifted during survey
Aundh	111	45	41	32	34	29	33	Na	Na	1181	311	25/75	Less than average
Ghole Road	100	38	38	35	27	54	25	Na	Na	Na	Na	25/75	Marginally less than average
Warje	58	24	41	24	25	22	23	26	Na	1474	388	60/40	Same
Karve road	70	35	50	39	46	32	40	Na	Na	Na	Na	10/90	More than Average
Dhole Patil	49	22	45	10	11	12	8	9	Na	1373	361	40/60	Less than Average
Hadapsar	77	31	40	26	25	21	31	na	26	1255	330	40/60	Less than Average
Sangamwadi	82	25	30	21	24	20	11	20	Na	2410	634	60/40	Marginally less than average
Yerwada	71	35	49	31	32	36	24	Na	Na	1832	482	75/25	Marginally less than Average
Kasba Peth	91	32	35	32	27	37	22	38	27	1731	456	10/90	Same
Vishrambagwada	108	58	44	63	56	64	55	62	70	1025	270	25/75	More than Average
Bhavani Peth	65	48	74	52	53	51	35	56	71	1198	315	25/75	More than average
Tilak Road	102	36	35	31	35	39	23	28	30	1626	428	75/25	Less than Average
Sahakar Nagar	94	40	43	38	35	34	34	39	47	1666	438	40/60	Marginally less than average
Bibvevadi	157	55	35	45	41	52	45	36	49	1856	488	40/60	Less than average

Explanation:

Total No of 3.8 M3 bins in the ward, (Column 1).

Average number of 3.8 containers lifted daily for the month of October, excluding the dates of survey, i.e. 1st to 20th October (Column 2).

Number of 3.8 M3 containers lifted in ratio to the total number of containers in the ward (Column 2/Column 1=Column 3).

Average number of containers lifted during the survey period, i.e. 21st to 25th October (Column 4).

Actual numbers of containers lifted from Day 1 to Day 5 of Survey (Column 5-9).

Average weight of containers filled to capacity on Survey days (Column 10).

Density of Garbage calculated on the basis of weight of 100% full containers, i.e. Column 10/3.8 M3 (Column 11).

Proportion of ¾, ½ and ¼ filled containers lifted to 100% filled containers lifted (Column 12).

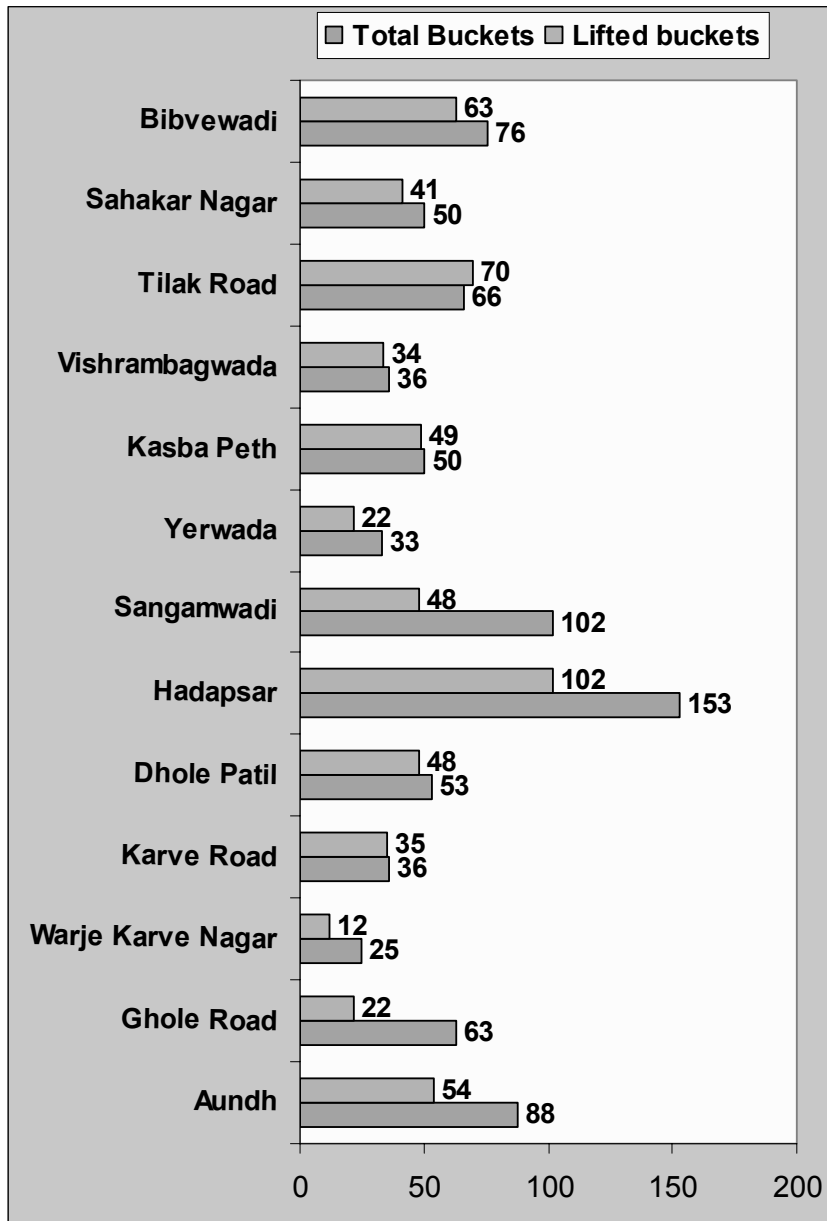
C. Collection of community bins through Compactors

Compactors seem to be an effective mode of collection in some wards because their carrying capacity is much higher in a single trip. However, the compaction was reported to be much less than anticipated in some wards. The breakdowns were also reported to be higher in the case of compactors. The compactors allow for the distribution of smaller containers where the quantity of waste generated may not require the larger containers of 3.8 cu m capacity. The size of the vehicle limits its use in high density areas where the narrow roads do not allow for adequate turning radius. Compactors were used in all wards other than Bhawani Peth.

Most compactors were were utilised for at least two shifts. The duration of the second shift was much less than the scheduled 8 hours in all cases. Between 3 and 9 workers (including the driver) were deployed on the compactors. Since the compactor lifts the bucket mechanically it is not clear as to why the worker deployment on some vehicles was so high (Figure 17).

All compactor buckets are expected to be lifted daily, but in actual fact the data show ward wise differences in the frequency of lifting. Almost all the buckets listed were lifted in the Kasba Peth, Vishrambag and Karve road ward offices while at Tilak Road buckets were also lifted twice in a single day. The Hadapsar compactor was able to make an average of two trips per shift reflecting a total collection of 18 MTPD because of the proximity of the ramp and the landfill site. It therefore does not matter that half filled buckets were also lifted. The data show efficient collection through compactors in a **single trip** in Ghole Road and Warje Karvenagar wards where all buckets were not lifted but most of those lifted were filled to capacity. It is not clear whether this was due to the low filling of buckets or because of inadequate vehicles, in which case the compactor could have been used for an additional shift. In Sahakar Nagar and Bibwewadi wards all the buckets were not lifted although the compactors operated in two and three shifts respectively; the proportion of filled buckets that were lifted was very low; the compactors were not filled to capacity and the duration of the second shift was shorter. The situation was similar in Sangamwadi and Yerawada.

Figure 17: Total Number of compactor buckets listed and lifted daily in each ward including all shifts



All the wards except Bhawani Peth use compactors. Every compactor bucket is expected to be lifted daily and each compactor is expected to lift at least 30-35 buckets in each shift. Only Sahakar Nagar, Bibvewadi and Hadapsar had compactors operating for more than one shift. However, all the listed buckets were not lifted. In Bibvewadi and Sahakar Nagar less than the stipulated number of buckets were lifted. Further, all the listed buckets were not lifted in almost all the wards. The average weight

of garbage carried by the compactors in a single shift was about 5 MT. The wards also reported more frequent breakdowns in the case of compactors as compared to other vehicles. (Figure 10)

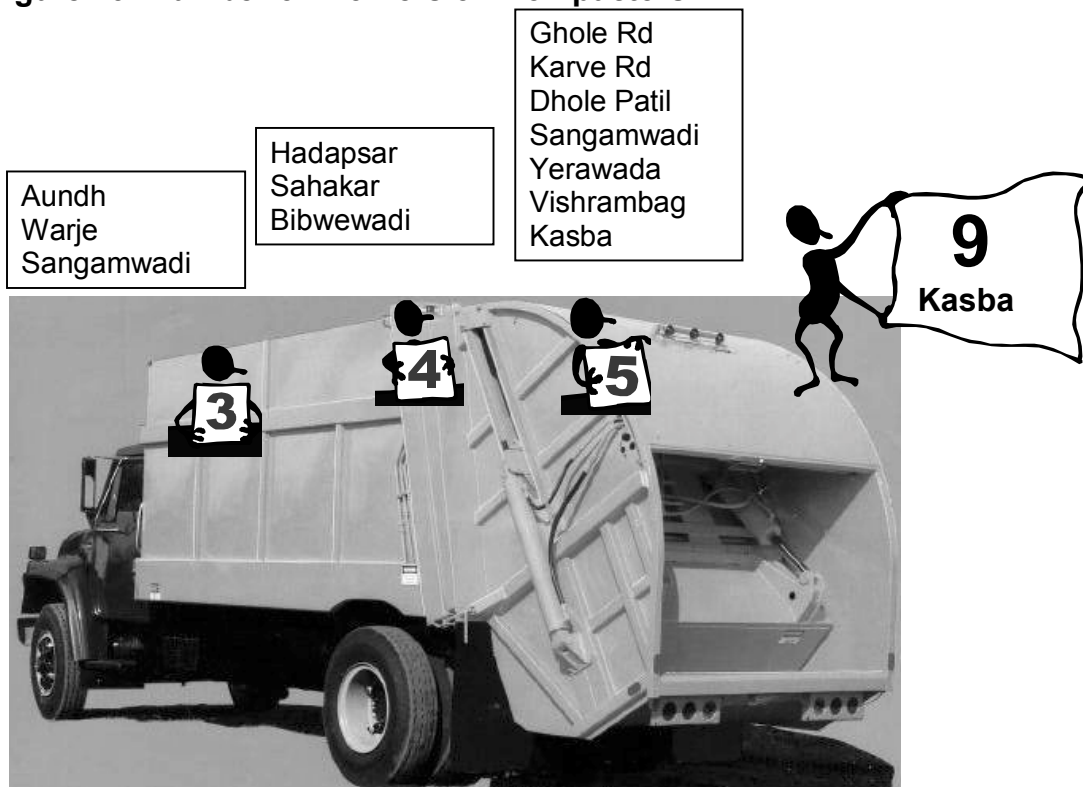
Note: Bhawani Peth ward has no compactor because of the narrow lanes

Figure 18: Capacity Utilisation of Compactors

Ward	Average Waste Carried	Average Shifts	I shift Hrs Wked	II shift Hrs Wked
Aundh	5000	2	4	3
Ghole Road	5800	1	6	NA
Warje Karve Nagar	5000	1	4	NA
Karve Road	4400	2	6	4
Dhole Patil	3500	2	4	4
Hadapsar	9200	2	6	7
Sangamwadi	5250	2	6	6
Yerwada	4200	1	5	2
Kasba Peth	6700	2	6	2
Vishrambagwada	4520	2	5	5
Tilak Road	6750	2	5	3
Sahakar Nagar	3750	2	6	4
Bibwewadi	4500	3	6	4

Note: Bhawani Peth ward has no compactor because of the narrow lanes

Figure 19: Number of Workers on Compactors



D. Door to door collection of waste through ghanatrucks

The Pune Municipal Corporation undertakes door to door collection using a total of 41 ghanatrucks primarily from residential premises. Of these only 6 vehicles were filled to 100 % capacity by volume and 12 were filled to 75 % capacity. Collection efficiency is affected by the number of stops. It is likely to be highest where larger quantities of garbage are collected in fewer stops such as for high rise apartment buildings rather than bungalow societies. The collection efficiency was the lowest in Sahakar Nagar where all the three vehicles were filled to only 50 % of the capacity and the average weight collected per vehicle was 700 kg. The same is the case with Warje-Karvenagar. The hours worked were also much less than expected in Sahakar Nagar. In general too the efficiency of collection through the ghanatrucks needs to be improved considerably. The vehicles in 10 out of 14 wards collected mixed waste. Seeing as these are dedicated collection vehicles, offering an additional service, it would be quite simple for the PMC to enforce source segregation of garbage.

Table XII: Door to door Collection by Ghanatruck

Ward	Route	Stops	Filling	Weight in kg	Workers	Main Type of garbage
Karve Road	GT 1	56	75	1800	3	Mixed
	GT II	33	40	900	2	Mixed
Aundh	GT I	15	75	1400	1	Wet
	GT II	20	100	2100	1	Wet
	GT III	25	100	3200	1	Wet
Warje	GT I	45	50	1350	3	Wet
	GT II	50	50	750	4	Wet
Ghole Road	GT I	90	100	3000	3	Wet
	GT II	70	100	1800	2	Wet
	GT III	50	100	2500	3	Wet
	GT IV	50	100	1600	3	Wet
Tilak Road	GT I	22	75	1250	5	Mixed
	GT II	30	50	1200	5	Mixed
	GT III	15	75	700	2	Mixed
Sahakar Nagar	GT I	15	50	600	4	Mixed
	GT II	15	50	750	4	Mixed
	GT III	15	50	750	1	Mixed
Bibwewadi	GT I	50	75	1250	4	Mixed
	GT II	40	75	2000	3	Mixed
	GT III	50	75	1200	3	Mixed
Vishrambag	GT I	6	75	750	2	Mixed
	GT II	35	75	850	4	Mixed
	GT III	35	75	850	4	Mixed
Hadapsar	GT I	50	50	2000	4	Mixed
	GT II	40	100	1000	5	Mixed
	GT III	62	100	2200	4	Mixed
	GT IV	37	50	1500	3	Mixed
Kasba Peth	GT I	40	75	1300	3	Mixed
Yerawada	GT I	50	100	3500	5	Wet

	GT II	100	50	3200	5	Wet
	GT III	50	100	2000	3	Wet
	GT IV	18	75	900	2	Wet
Sangamwadi	GT I	28	100	1300	2	Mixed
	GT II	90	100	1400	3	Mixed
Dhole Patil	GT I	85	75	2500	3	Mixed
	GT II	100	75	2000	5	Mixed
	GT III	50	75	1200	3	Mixed
Bhawani Peth	GT I	40	50	1000	6	Mixed
	GT II	15	25	1150	6	Mixed
	GT III	50	75	1500	6	Mixed
	GT IV	30	100	1200	6	Mixed
				63400	141	

Note: Type of garbage is based on visual assessment

Cost-efficiency of Ghantatrucks

The abysmally low collection of garbage by the Ghantatrucks in some wards makes it a very expensive method of door-to-door collection for the PMC. The Tippers used as Ghantatrucks are of two sizes with differing carrying capacities. The tare weight of the smaller vehicles is around 3500 kg. while that of the larger vehicles is around 5400 kg. In Yerawada, a compactor is used as a ghantatruck.

Table XIII: Labour Costs per Household Per Month for Ghantatrucks Operating at Low Efficiency

Sr no	Ward Office	Route no	Vehicle size	Avg wt lifted	Filling	No of families covered	Workers + Driver	Labour Costs per Household per month
1	Vishrambag	1	Small	850	50%	850	2+1	Rs.21
2	Vishrambag	2	Small	850	50%	850	4+1	Rs.35
3	Vishrambag	3	Big	700	50%	700	4+1	Rs.43
4	Warje	2	Small	750	50%	750	3+1	Rs.31
5	Sahakarnagar	1	Big	600	50%	600	4+1	Rs.50
6	Sahakarnagar	2	Big	750	50%	750	4+1	Rs.40
7	Sahakarnagar	3	Small	750	50%	750	1+1	Rs.17
8	Tilak Road	1	Small	750	50%	750	4+1	Rs.40

The PMC spends Rs.5 per household per day for door-to door collection of waste in the the Vishrambag, Warje, Sahakar Nagar and Tilak Road wards. This is completely unsustainable in the long term. The ghantatrucks operate in the morning shift (6 am to 2 pm) during peak traffic hours.

The number of municipal workers deployed per ghanta truck in the above wards is also very high in comparison with the weight of garbage collected. In sharp contrast, the Aundh, Yerwada and the Sangamwadi ghanta trucks deploy less

labour and maximise output by enforcing collection of only wet waste. Bhavani peth has a much higher proportion of workers compared to any other ward, because all the spillover garbage from 3.8 containers is also collected in the same tippers, which function as multipurpose vehicles.

Vehicles of the same sizes when optimally utilised, have lifted almost 3000 kg. of garbage in the Yervada and Ghole Road wards. This has been possible because of the insistence on segregation, and rejection of mixed garbage in these areas resulting in higher density of garbage and higher coverage of families by single trips (i.e. 3000 families). The number of households covered has been calculated based on the weight of the garbage; therefore in these wards the coverage of households may be even more than the estimated figure because only wet waste is collected in vehicles. Dry waste is entirely collected by PMC authorised Wastepickers. The weight of garbage generated per household has been calculated on the basis of 330 gm. per capita and an average household size of three. The ghantatrucks operate in middle class localities where the average family size is three persons as per this study. The average garbage generated per family amounts to 1 kg. of which about 22 % is dry waste as per the data. Since only wet waste is collected in Yerawada and Ghole Road wards, at the rate of 750 gm per family, the coverage is likely to be much higher.

Costs of collection of primary collection of garbage by ghanta trucks

In February 2005, the Pune Municipal Corporation adopted a stand that it will collect only segregated wet waste into its stream, as part of the Chakachak drive. This was in an effort to promote and enforce segregation and encourage the integration of wastepickers for the door to door collection of dry, recyclable wastes. Therefore all citizens were expected to segregate garbage in their own homes. The wet garbage was to be disposed off, in the ghanta truck, PMC containers or compost pits. Further, all new constructions, post 2000, are required to dispose off their organic garbage within their premises, in vermipits, compost pits or biogas plants. However, most ghanta trucks in fact service these new constructions, even if they have provided for biogas plants or pits.

The dry garbage could be:

- a. given to authorised wastepickers who could charge a nominal fee between Rs 5/- and Rs15/- per month per family for the same.
- b. sold to retail scrap traders by the household/society.
- c. disposed in specified PMC streams, (i.e. once a week in the ghanta truck or designated sites)

Some amount of publicity was given to the above by way of handbills circulated by the PMC and through meetings organised by the Wards. The Ward administration also decided to enforce segregation at least in cases where the service of primary doorstep collection of garbage (by ghanta truck, PMC cycle rickshaw or Waste pickers' cycle rickshaw) was being provided.

However, save in five cases where concerted efforts were put in by the Ward Medical Officers to enforce the same, ghanta trucks largely continued collecting mixed garbage.

This was because:

- a. Citizens, along certain ghanta truck routes, due to the irregularity and impunctuality of the ghanta trucks were not giving garbage to the trucks at all, leave alone segregated garbage. Most of the routes therefore left out pockets of residences along the route.
- b. PMC bigaris were sometimes not even informed about the measure.
- c. It was in the interests of the PMC bigaris to collect mixed waste and retrieve the recyclables and sell it themselves.
- d. It was difficult for the PMC bigaris to argue everyday with the citizens depositing mixed garbage and reject it.
- e. Most citizens were not segregating garbage, and even if they were, the person bringing it to the gate was frequently mixing it up again.
- f. Citizens almost always tied up the segregated wet garbage in plastic carry bags, and unless wastepickers were appointed for the finer segregation, these bags reached the ghanta truck as wet waste.
- g. The plan to systematically do away with containers along the ghanta truck route, to prevent citizens from disposing mixed garbage there, was not implemented. Hence on the rare occasions when mixed garbage was, in fact, rejected by the ghanta truck, citizens would go and deposit it in the nearby container.
- h. Wastepickers who were appointed on these routes, sometimes did not get their monthly payments and discontinued or became irregular.
- i. Some elected representatives took the stand that the PMC was responsible for collection of wet and dry waste everyday and put pressure on the local ward officials to do so.
- j. As there was no special facility or treatment for segregated organic garbage, it was all reaching the landfill site and getting mixed up with the rest of Pune's mixed garbage.
- k. The time and energy costs of creating awareness regarding the above and enforcing it did not pay off, because apart from the wastepickers no one else benefited directly.

At the time of the study there were only 3 routes where largely wet garbage was coming into the ghanta truck. 41 ghanta trucks collected totally 63 tonnes of largely mixed garbage, on a door to door or gate collection basis from residential areas from all the wards and transported it to the nearest transfer station. The average collection per vehicle was 1500 kgs. (ranging from 700 kgs to 2200 kgs each).

The average per capita for Pune averaged 326 grams, (254 wet, plus 72 dry). Considering an average family size of 4, (ghanta trucks operate in middle/upper middle income group areas), the average daily generation of garbage per family works out to 1.3 kgs. This means that on an average each ghanta truck was servicing 1153 families for mixed garbage collection from the doorstep to the transfer station.

Assuming an average strength of 3 workers and one driver per ghanta truck and a capital and fuel cost of Rs.2000/- per day per ghanta truck, the monthly operational costs per ghanta truck works out to the following:

3 bigaris x Rs.5000/- per month	Rs.15000/-
1 driver x Rs.8000/- per month	Rs.8000/-
Ghanta truck costs at Rs.2000/- x 30	Rs.60000/-
Total	Rs.83000/-

The average mixed garbage collection cost per family per month and per tonne of garbage is computed as follows:

Monthly operational cost of ghanta truck	Rs.83000/-
Number of families covered	1153
Average cost per family per month	Rs.72/-
Monthly operational cost of ghanta truck	Rs.83000/-
Monthly collection of garbage 1.5 x 30	45 tons
Average cost per tonne of mixed garbage	Rs.1844/-

Under the circumstances even at optimum performance, (each ghanta truck collecting 3000 kgs of garbage), the cost per family per month and per tonne of garbage costs will be:

Monthly operational cost of ghanta truck	Rs.83000/-
Projected number of families covered	2307
Projected average cost per fly per month	Rs.36/-
Monthly operational cost of ghanta truck	Rs.83000/-
Projected average monthly collection 3 x 30	90 tons
Projected average cost per tonne of mixed garbage	Rs.922/-

For such optimum utilisation of the ghanta truck some concerted, coordinated efforts will need to be made by ward officials.

However another feasible option, given the circumstances is the integration of wastepickers for primary collection, and the use of ghanta trucks for only secondary collection from fixed feeder points (on an average 10 stops, 300 families being serviced per stop).

If we presume a monthly cost per family of Rs.11/- (to be paid by the PMC to cooperatives of 10-19 wastepickers per kothi), the monthly costs for collection of segregated garbage from doorstep to transfer station works out as follows:

Each ghanta truck can do at least 2 and sometimes 3 trips for collecting segregated organic garbage from 10-15 fixed points along each route. Average of one bigari per truck can be safely reduced as it will be the responsibility of the wastepickers to hand over the garbage to the Ghanta truck. Only wet garbage will be taken in the ghanta truck, and wastepickers will be responsible to ensure segregation and separate transport and disposal of dry waste. Average garbage generation of wet garbage per family is taken as 1 kg, hence 3000 families can be serviced per trip. The total garbage quantum per family collected will therefore go

down; total garbage handled by Ghanta truck will only be the 90 tons of the 97.5 tons generated)

Ghanta truck monthly operational costs	Rs.78000/-
Feeder system recurring labour costs (2.5 shifts)	Rs.82500/-
Total	Rs.160500/-

Per family monthly cost	Rs.21/-
Per tonne cost	Rs.1641/-

Feeder system capital cost	
Cycle rickshaw	Rs.15000/-
Maintenance per annum (5 year life)	Rs.5000/-
Coverage of 300 families	Re.1/- per family

Further the system will ensure:

- a. Compliance with MSW 2000 by ensuring segregation of garbage
- b. Segregated organic garbage which could be used for biogas/vermicomposting
- c. Decent work for informal sector workers

CHAPTER III

Key Findings and Recommendations

Key Findings

Per capita generation

Per capita waste generation is 326 gm. per day, the proportion of wet waste being 78 % of the total. There was no significant variation in the generation of wet waste across economic classes.

Total waste collection

The total estimated waste collected by the PMC is 884 MTPD. The total garbage generated per day calculated on the basis of per capita generation should therefore be about 978 MTPD. However, not all of it enters the municipal collection system because wastepickers and other informal garbage collectors retrieve recyclables.

Type of waste collected

The waste entering the municipal stream has been visually classified as mixed in nature because of the residual presence of non-organic waste. Waste characterisation would provide a more accurate figure. Pune has a separate debris collection mechanism and visual assessment by the surveyors indicated occasional reports of debris. Garden cuttings and silt from road sweepings are present in the waste.

Density of garbage

The average density of garbage was 400 kg/cu.m. The highest density was 634 kg./cu. m. and the lowest was 270kg/cu.m. Density was higher than the average in half the municipal wards. The highest density of waste in the Sangamwadi ward is a consequence of extensive door-to-door collection and resource recovery prior to entry of waste into the municipal system. This is in compliance with MSW Rules 2000, which stipulate waste segregation and door-to-door-collection. As the compliance increases in other wards across the city, the density of waste entering the municipal system is likely to increase. Waste processing technologies that require a lower density of garbage and/ or a specific requirement of recyclables for combustion will not work given the changing characteristics waste.

Waste Collection through containers

Collection from community bins accounts for the bulk of the waste (89 %) collected by the Pune Municipal Corporation. About 40 % of the 3.8 cu m containers are lifted daily while 72 % of the compactor buckets are lifted daily.

Door to door waste collection through ghanta trucks

Door to door collection through 41 ghanta trucks accounts for only about 7 % of the waste collected. 25 % out of 41 trucks collect less than 1 MTPD and 50 % collect between 1 and 2 MTPD. The number of workers per vehicle varies between 1 and 5. Each ghantatruck does a single route and total hours of work are about 5 hours from time of departure from vehicle depot to return to vehicle

depot. At this level of efficiency, the cost on labour alone for the ghanta trucks is between Rs.21 and Rs.50 per household per month.

As per the study organic waste generation per family is about 1 kg. per day. If it is presumed that only wet waste is collected by the ghantatrucks, 63000 households are being serviced. However, that is not the case and mixed waste is being collected and by implication only 48000 households are being serviced. Even if the ghantatrucks were to carry optimum loads of 3 MTPD each would service only 3000 households at a labour cost of Rs.10 per household per month. The ghantatrucks are therefore not the most efficient means of undertaking door-to-door collection of garbage.

Waste collection from bulk generators

Collection from hotels, mangal karyalays, educational institutions, canteens and refectories is undertaken through dedicated vehicles. Actual Collection was undertaken from 626 (37 %) out of the list of 1700 provided by the PMC. However, in actual fact waste was also lifted from 390 unlisted establishments. The total number of establishments serviced was 953 while 1074 were listed but not serviced. There were about 4 workers on most hotel trucks. 11 out of the 18 trucks operational in Phase II, worked for less than 5 hours. The hours of work for all vehicles were calculated from the time of departure from the vehicle depot and return to the vehicle depot. Given varying levels of efficiency, the labour costs of servicing the bulk generators are as high as between Rs.10 and 20 per establishment per day. The total quantity of waste collected from bulk generators is about 50 MTPD.

Waste collection from markets

Waste from the Mahatma Phule Mandai and Gultekdi Market Yard are collected separately. In the case of the latter, the PMC reported that the Agricultural Produce Marketing Committee has contracted the service to compost producers who cart the organic waste to farms outside the city. The Mahatma Phule Mandai generates about 12 MTPD. While the waste from the other markets is not collected separately, the estimated total market waste for the city is 72 MTPD.

Recommendations

Constitution of an Interdisciplinary/ multi-stakeholder Steering Committee on Solid Waste Management

The solid waste management function is currently being handled exclusively by the health department. However, advances in technology and the requirements of the MSW Rules, 2000 extend beyond a public health function to include environmental concerns and engineering. Constitution of a committee and adoption of a more broad based approach would lead to a more integrated approach to the management of solid waste in Pune.

SWM policy and framing of notification and rules in compliance with MSW Rules 2000

The Pune Municipal Corporation needs to develop a Solid Waste Management Policy through a broad based consultative process. Appropriate rules also need to be framed and notified through due process.

Mode of primary collection of domestic and commercial waste

The use of ghanta trucks for door to door collection needs to be discontinued. The MSW Rules require municipalities to organise universal door to door collection of domestic waste. Poverty alleviation is also the statutory responsibility of the municipality. These twin responsibilities could be addressed in a cost efficient accountable environment friendly manner if primary collection (door to door collection of segregated garbage) is undertaken by cooperatives/ organisations of wastepickers/self help groups/ informal service providers using push carts/ ghantacycles. The organic and non recyclable waste could be carted to pre-designated common collection points for secondary collection.

Mode of secondary collection of domestic and commercial waste

The existing ghantatrucks could be used for secondary collection of garbage. Further, progressive planned reduction of containers in areas serviced by ghantatrucks for secondary collection would result in more efficient use of resources.

Closed containers for secondary collection could be provided in areas not serviced by the ghanta trucks. The lifting of these containers could ideally be done at night since mobility will be higher due to lower traffic density.

Mode of collection from bulk generators

Universal collection from bulk generators needs to be undertaken by dedicated vehicles preferably operating at night for increased mobility as explained above. The following measures could be adopted to maximise bulk waste collection. Integration of wastepickers for collection of dry waste to increase the carrying capacity of the vehicle for wet waste enabling it to cover a larger number of establishments

In order to streamline the efficiency of hotel trucks the following points could be considered:

- a. The urgent need to cover all establishments cannot be overemphasised in order to reduce costs.
- b. Size wise vehicle deployment should be made according to the number of establishments in the ward. Alternatively only large vehicles should be used, covering 2 wards each if necessary.
- c. Not more than 3 workers and a driver should be deployed per vehicle.
- d. There is a wide variation in the quantum of garbage coming from hotels, (ranging from 1 bag to up to 100 bags). Differential charges according to garbage generated should be recovered, while taking care to ensure this does not result in dumping of garbage in containers directly by hotels.
- e. Heavy penalties should be imposed on hotels directly dumping garbage in containers.
- f. All garbage should be collected from hotels in the night shift with strict instructions against non-compliance.

Planning and management of personnel and vehicles

- More effective fleet planning and route planning of collection vehicles
- More effective maintenance of vehicles

- More effective deployment of workers to ensure optimum utilisation of the workforce
- Establishing norms for deployment of workers on different kinds of collection vehicles

Management information system

Electronic weigh bridges need to be installed at the Paud Road and Katraj Transfer stations. A system to maintain registers according to a common format at the transfer stations would provide valuable data that could be checked by the Sanitary Inspectors and Divisional Sanitary Inspectors. Seasonal variation can also be monitored in this manner. Although registers do exist, the data are not very well maintained at certain ramps. Computerisation of this data will be very cost effective for the PMC because it will facilitate better planning resulting in less wastage.

Training and capacity building of cutting edge municipal functionaries

The requirements of the MSW Rules and the move towards decentralisation of municipal functions place higher demands on municipal functionaries involved in planning and implementation. Inputs in this area will enable them to undertake micro-planning and to perform their duties more efficiently.

Strengthening of the recycling sector

The MSW 2000 Rules require that all recyclables be recycled. In view of this the Pune Municipal Corporation needs to promote waste segregation and recycling. Some of the measures are listed below.

- Provision of authorised space for retail Cash for Trash centres
- Provision of space for a whole sale scrap market and intermediate processing in an outlying area of the city
- Provision of enclosed scrap sorting sheds in each municipal kothi

Waste processing

Potential for bio-methanation plants

In terms of quantity, presently the waste collection from bulk generators amounts to about 50 MTPD. The waste from the vegetable markets (mandai) accounts for another 72 MTPD. If this were to be supplemented by bio-mass from garden waste and organic waste from the ghanatrucks, a 125 MTD plant for the city either at one location or two locations seems to be a feasible proposition.

One plant could well be located at the abandoned landfill site at Paud Road since the land is still owned by the Pune Municipal Corporation. The location would be easily accessible to Aundh, Karve Road, Ghole Road and Warje Ward Offices.

Potential for composting plants

The MSW Rules 2000 require waste segregation and promotion of recycling. Pune has already recognised and authorised wastepickers for collection of recyclable scrap. Wastepickers have already started primary collection in certain prabhags of all municipal wards. The waste is being segregated prior to collection by the municipality even if source segregation is not done by citizens. Given this, composting of organic waste is a possible option.

Potential for Refuse Derived Fuel plants

As segregation progressively increases, the waste entering the municipal stream is likely to be increasingly organic in nature. In view of this any technology that requires a particular density or presence of combustible recyclable waste will be unsuitable. Waste characterisation and chemical composition were not part of the study in this phase. However, waste characterisation and chemical analysis of waste completely devoid of recyclables must precede any choice of technology.

Annexure I

Experiences and observations during data collection

Involvement of PMC functionaries

There was perceptible enthusiasm among different levels of PMC staff. This was largely due to the importance that the Dty. MOH (SWM) gave to the study. He repeatedly emphasised the relevance of authentic data for planning purposes. Independently some Ward Medical Officers also saw the value of the study to their work. Some wards had assigned shifts to Sanitary Inspectors and placed them at the ramps with their own data sheets to record data. Most Ward Medical Officers visited the ramps to keep track of what was happening. Warje Karvenagar ward office shifted the location of their transfer station for the night shift from Paud Road to Katraj for the 4 day duration just so that they could record the weights. The Sangamwadi ward office worked to full capacity on Sunday 23rd October while the Yerawada ward did a special night shift. The Karve Road and Ghole Road Ward offices started weighing their garbage four days prior to the survey. Consequently the backlog piled up. The Ghole Road Ward Office organised a special night shift to clear the backlog without prior intimation to the survey team. Surveyors had to be rapidly assigned and reassigned on account of these unforeseen changes. Bhavani peth had hotel vehicle and ghanatruck separately assigned after the survey.

Data available with the Ward Offices

Most wards were unable to provide preliminary data regarding the weight of garbage collected daily and the details of the garbage collection vehicles assigned to each of them in the forms provided. Finally, individual empty weights of all the vehicles were taken from the vehicle depot and compared with data available at the ramps. The average weights of vehicles given by the ramps have been used because they were found to be more reliable.

Monitoring at the landfill site during the survey

Monitoring the entry of vehicles at the landfill site became a pointless exercise for the following reasons. Initially assigned to the PMC itself, the task was taken over by the research team upon Dr Pardeshi 's request . Two private vehicles were found to be unauthorisedly dumping garbage at the landfill during the trial. There was no reporting of vehicles during the night. The absence of lights at the site was a major problem. In this context, the entry of vehicles from Katraj and Hadapsar into the landfill from separate entry points made monitoring extremely difficult.

Weigh-bridges

Interestingly, there was a sharp difference in the weights recorded for the same vehicle at different weigh-bridges on the same day. The dates of the survey were changed from 17-19 to 21-23 October because of the failure of the Hadapsar weigh bridge. The weigh-bridge failed again at 7.10 am on the 23rd and remained inoperational thereafter during data collection.

Intimidation of surveyors by municipal workers

As anticipated, municipal workers on the vehicles tried to bully and intimidate the surveyors to record data as per their instructions. Although the surveyors had been prepared for this during the training, in one ward no actual weights were taken but the surveyor was made to record weights according to earlier data. In two other wards the surveyors were deliberately not picked up by the hotel vehicle and compactor despite explicit instructions issued by the ward officials. The vehicles had to be traced along the route in order for the surveyors to board. The surveyors on two hotel vehicles were also compelled to include names of hotels from which garbage was not picked up. In one ward the driver parked the compactor at the road side after getting a telephone call and reappeared after a four hour gap. There was also pressure on the surveyors to record mixed waste as wet waste. These attempts were foiled by the Ward Co-ordinator when the vehicles reported to the ramps.

On the other hand, there was also camaraderie between the surveyors and municipal workers on some vehicles. Municipal workers offered to deliver files for one surveyor to assist him prepare for an examination the next day.

Surveyors

The surveyors were drawn from among educated slum women and youth and students with educational level ranging from class X to post-graduation. They were highly enthusiastic and keen on working on the problem and could be mobilised for campaigning in future. 50 % of the surveyors were from the Janwadi Mahila Sanghatna.

The tasks of three surveyors from the same family had to be reassigned because their grandmother died on the second day of the survey.

Changes in survey dates

Changes in survey dates due to weigh-bridge malfunctioning led to an increase in cost as many surveyors were not free on next 3 days. Training and trials had to be repeated in 10 out of 14 wards.

Annexure II: Schedule of Activities

Date	Activity
22-09-05 and 30-09-05	Planning meeting with AILSG and Dty. MOH (SWM), PMC to finalise the data collection formats and the modus operandi for data collection
30-9-05	Introductory session with Ward Medical Officers and Dty. MOH (SWM)
3-10-05 to 19-10-05	Collection of preliminary data required for KKPKP survey from each of the 14 ward offices of the PMC
6-10-05	Orientation of WMOs and Dty. MOH (SWM) and KKPKP ward coordinators Distribution of final PMC formats given by AILSG
17-10-05	Finalisation meeting with WMOs and Dty. MOH (SWM)
8-10-05 to 18-10-05	Surveyors Interviews
10-10-05-18-10-05	Ward-wise orientation of surveyors
7-10-05	Verification of ward wise garbage collection for 6 mths using secondary data
14-10-05	Plan finalisation meeting with WMOs, PMC, KKPKP, AILSG
14-10-05 to 20-10-05	Test run with surveyors
15-10-05 to 20-20-05	Check of the test run
21-10-05 to 23-10-05	Collection of primary data on dedicated collection vehicles
25-10-05 to 30-10-05	Analysis and Report Writing
31-10-05	Submission of Preliminary Findings
15-11-05	Submission of Report

Annexure III
Terms of reference of the study

Sub: Study for Integrated Solid Waste Management Facility for Pune Municipal Corporation.

This is in reference to the meetings on the 22.09.2005 at AILLSG, Mumbai and 30.09.2005 at the Pune Municipal Corporation Office as well as the telephonic conversation on the 03.10.2005. As discussed and agreed previously, KKPKP shall work with the AILLSG to carry out a study on status of solid waste management in Pune Municipal Corporation.

In order to have a complete understanding of the existing system of solid waste management in the city of Pune, it is important to perform a micro and macro level study. It has been agreed that Dr. R.R. Pardeshi, Chief Health Officer (Medical), P.M.C. will provide the Basic data required in the survey formats provided to them. A set of formats is also being provided to the KKPKP based on which the survey shall be carried out.

It is expected that the PMC will provide:

1. City profile
 2. Status of compliance of MSW rules in the city
 3. Ward- wise data collection by the field staff, on the quantity of road sweepings being collected presently. (To be done on the day of the KKPKP survey i.e. 17th, 18th, 19th of October.)
 4. Information of the waste collection routes/ vehicles (their type, capacity and route details) to be given to KKPKP. This will include
 - a) The daily collection and transportation programme for the door to door collection vehicles
 - b) The daily collection and transportation programme for the bulk generators
 - c) The daily collection and transportation programme for community bins.While giving the route information those routes which operate in more than one ward should be clearly indicated.
 5. PMC will monitor the vehicles reporting at each transfer station to gather the data on the weight carried in by each vehicle trip. (To be done on the day of the KKPKP survey i.e. 17th, 18th, 19th of October.)
 6. They will also gather data on the weight carried by all vehicles out of the transfer stations to the landfill sites. (To be done on the day of the KKPKP survey i.e. 17th, 18th, 19th of October.)
- The PMC shall give administrative instructions to the transport department to allow the surveyors to accompany the vehicles. Permission for surveyors to be allowed at the weighing stations will also be needed.

It is expected that KKPKP will provide:

1. A list of surveyors with the routes assigned to them to be given to PMC, for coordination and obtaining the permission for each of them, to accompany the

- vehicle as well as be allowed at the weighing stations.
2. Ward/route wise waste collection figures in terms of volume and weight.
 3. Volumetric quantification of waste received from containers
 4. In case of the door to door collection the information shall be collected on the stoppage basis.
 5. In case of bulk generators (hotels, commercial complexes, non-residential setups), the exact property and the quantity of waste received from each needs to be noted.
 6. Surveyors to be deployed on each vehicle as well as at the transfer stations at the weigh bridges and jakat nakas (for noting the weight) on three consecutive days. (17th, 18th, 19th of October.)
 7. A compilation of the bulk waste generation and its characteristics will be needed.
 8. A study of the per capita waste generation by residential generators considering a sample of 0.1% households.

The dates for the survey have now been finalized as 17th, 18th and 19th of October, 2005, taking into consideration the discrepancies in the values due to the Navaratri festival, load shedding on Thursdays and 16th being a Sunday.

You are requested to please complete the preparatory work for this survey along the above lines and inform the action taken by 13.10.2005. I will attend a meeting to review the preparations for the survey and training of the surveyors and the municipal officials on 14.10.2005

The finalized formats for both PMC and KKPKP are enclosed herein.
With regards,

A.K.Jain

Annexure IV

Comments: Comparative analysis of Primary and Secondary data

High Accuracy Secondary data: (less than 5 MT difference) Aundh, Bhavani Peth, Warje, Tilak road, Sangamwadi

Average Accuracy Secondary data: (upto 10 MT difference) Karve Road, Dhole Patil, Kasba Peth, Sahakarnagar

Low Accuracy Secondary data: (more than 10 MT difference) Ghole Road, Hadapsar, Yerwada, Vishrambagwada, Bibvewadi

Figures for Aundh, Warje, Tilak Road, Sahakarnagar, Sangamwadi, Yerwada, Kasba Peth and Bhavani Peth

Very accurate because they have been cross matched along several parameters. BRC weight corresponds to weights of individual vehicles emptied into them, Backlog garbage in BRCs on first and last days have been factored in, Percentage of Filling of vehicles and weight of garbage corresponds.

Figures for Bibvewadi, Vishrambag, Hadapsar and Dhole Patil are much higher than their earlier estimates.

Accurate, difference is possibly because the Ward has not been considering some of their vehicle weights earlier.

Figures for Ghole Road and Karve Road

Need verification, because individual vehicle weights of containers and some BRCs were not taken, and BRC weights are differently recorded at ramps and Transfer Station.

MIS

Record keeping details annexure

Secondary data:

Aundh ward office maintains the best records of ongoing collection of garbage.

Dhole Patil Ward office also has very good records, but probably do not include the weights of hotel vehicles and ramp.

Vishram bag, Hadapsar, Kasba Peth and Bhavani peth (at the Hadapsar Ramp) and Bibvewadi, Tilak road and Sahakarnagar ward offices, (at the Katraj Ramp) have some accurate data although it is not compiled uniformly well by all the ward offices. (Probably again certain vehicles' weights like hotel gadis and compactors have not been included in some of their estimates). Hence, Tilak road, Kasba Peth Bhavani Peth and Sahakarnagar estimates are not totally inaccurate, whereas the estimates given by Vishrambag, Hadapsar and Bibvewadi ward vary greatly from the survey findings.

Warje and Karve Road estimates were shared with us, but there was no corresponding break up according to different vehicles.

Yerwada and Sangamwadi do not have an accurate break up of vehicles wise weights of garbage, and their extrapolations differ in accuracy, Sangamwadi featuring much higher than Yerwada.

Ghole Road secondary data had the most gross figures, unreasonably extrapolated, and probably rather inaccurate. It is difficult to comment on their accuracy because even after the survey, there are no clear averages available as all their vehicles were not weighed.

Primary Data Accuracy Estimates

The average estimates derived based on the average weight of garbage collected ward wise, also can be rated according to differing levels of accuracy, due to the efforts taken (or otherwise) by the respective wards.

The average figures of Aundh, Dhole Patil, Warje, Sangamwadi, Yerwada, Sahakar nagar, Tilak Road and Bibviewadi are very accurate.

The figures of Hadapsar, Vishrambag, Kasba Peth and Bhavani peth are likely to be accurate, although they are only for a two day period.

The figures of Karve road and Ghole Road need to be rechecked (particularly Ghole Road), as individual Containers were not weighed. All estimates have been arrived by extrapolating based on averages as even all the BRCs were not weighed.

Comments on data Annexure

- Aundh had a good data base, the maintenance of ward level records was good, all the staff was very cooperative and every vehicle was weighed during the survey. The same holds true for Warje-Karvenagar, Tilak Road, Sahakar Nagar and Bibwewadi. The estimates generated for these 5 wards can therefore be considered very accurate. A few discrepancies may arise because the compactors and hotel vehilces that went directly to Hadapsar ramp on the third day could not be weighed.
- The figures for Kasba Peth and Bhavani Peth ward offices figures are fairly accurate although they pertain to only two days because of the failure of the Hadapsar weighbridge
- Bibwewadi probably generates more than projected by them prior to the study, because the two dumper placers (lifting around 10 containers), that go directly to the Hadapsar ramp may not have been taken into account. Besides the number of containers lifted in Bibwewadi during the study were fewer than the average number lifted otherwise.
- The estimated average given by Dhole Patil Road ward was less than the study estimate because they probably did not consider their compactor and hotel vehicles which collect a great deal of garbage, in their estimates. The container collection in this ward during the study was less than average but the weights were nonetheless much higher.
- The survey data for Karve Road was distorted because they started weighing the containers four days prior to the survey. The containers overflowed leading to complaints, due to which they were forced to augment their collection during the survey days. Although all their compactors, ghanta and hotel vehicles were weighed, individual weighing of containers was not possible, and estimates of the same have been arrived based on the weights of the Bulk Refuse Carriers, (not all of which ere weighed). Hence, Karve Road probably generates more than what they estimated but less than what the data show because their containers were excessively overloaded on the first day of the survey.
- Similarly, Ghole Road ward also started weighing the containers prior to the survey dates. As a result they had an overlaod, and the subsequent complaints from citizens made the quick lifting of containers a high priority. A special night shift was organised by the

ward to cope with the overload. During the survey many of their BRCs were not weighed making it difficult to cross check data. The recording of figures at the ramp was also found to be problematic. Hence, the figures for Ghole Road may have to be maintained and checked again at the ramp.

- Vishrambag ward shows a much higher collection than estimated by the ward prior to the study. It is possible that the ward does not consider the weight of the garbage generated in the Mahatma Phule Mandai which is sent and recorded separately at the Hadapsar ramp. Since technically the mandai falls in Vishrambag, the study includes it in the totals for Vishrambag ward. Mandai waste accounts for almost 15 MTPD.
- Hadapsar ward shows higher collection than projected by the ward office. The collection by compactors and ghantatrucks is very high. The ward optimizes the use of its vehicles and utilizes its proximity to the ramp as well as the landfill to its advantage.
- The figures for Yerawada and Sangamwadi can be taken as accurate. The figure for Yerawada is higher than projected possibly because the ward does not consider the hotel and ghantatruck waste which goes directly to the Hadapsar ramp. Sangamwadi's earlier estimates of garbage weight seem to be rather accurate.
- Overall the collection machinery was on high alert during the period of primary data collection. This is reflected in the collection across most wards.
- The data reflect lower weights on Sundays because the collection is generally less on Sundays. Municipal sweepers have a holiday on Sundays so there are no street sweepings. Some ghantatrucks also do not operate on Sundays. Other conservancy staff also has their weekly off. The ramps do not function to full capacity. Yerawada operates a special night shift on Saturdays to compensate. While Sangamwadi worked on Sunday during the study period.

