HSMI, HUDCO SPONSORED RESEARCH STUDY

Draft Report

STUDY ON PRIMARY COLLECTION OF SOLID WASTE MANAGEMENT IN BANGALORE

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ABBREVIATIONS

BBMP	Bruhat Bangalore Mahanagara Palike
CBO	Community Based Organization
CBC	Clean Bangalore Centre
CoC	Corporation of Chennai
DWCC	Dry Waste Collection Centre
GoI	Government of India
GoK	Government of Karnataka
gpcd	grams per capita per day
MoEF	Ministry of Environment and Forest
MoUD	Ministry of Urban Development
MSWM	Municipal Solid Waste Management
MT	Metric tonnes
nGOG	No Garbage on Ground
NGO	Non-governmental organization
O&M	Operation and Management
RDF	Refuse Derived Fuel
RWA	Resident Welfare Association
SHG	Self Help Group
TPD	Tones per day
tpy	Tonnes per year

EXECUTIVE SUMMARY

BACKGROUND

With growing urbanization the challenges of managing the cities is increasing. One such challenge knocking at the door of Indian cities is managing large quantities of the Municipal Solid Waste generated every day. Currently this service is exclusively a municipal service which is often provided by the Health Department of an urban local body (ULB). Following the guidelines of Solid Waste (Management & Handling) Rules 2000, some of the larger ULBs have created specific SWM Departments which are staffed by Environmental Engineers.

Like many other cities, Bangalore is also facing issuing in disposal of larger quantities of waste produced every day. The severity of the issue became more evident in year 2012 when garbage piles started to build alongside streets and footpaths continuously for days together. During the period the city changed from 'Garden City' to 'Garbage City.' This was due to the closure order of Mavallipura landfill site on 11th July 2012 from the Karnataka State Pollution Control Board (KSPCB). Subsequently, another agitation at Mandur landfill site has begun calling for its closure based on the issues pertaining to the earlier landfill site.

This issue of SWM has highlighted the biggest constraint of space in the city. Land is a scarce resource and finding adequate land in a city like Bangalore for disposing of garbage is likely to become even more difficult in the coming years. Adding to this, is the unavoidable truth that population and consumerism is all set to grow exponentially. By 2030, the average MSW in the city is expected to rise by five times and locating more landfills would be nearly impossible.[5] It is therefore, important to understand the current practices, the status of the initiatives taken up for collection and disposal and benchmarking with the best practices in other cities.

In this context, it is necessary to reduce the waste reaching the final disposal in large quantities. Hence there is a need to study current practice of primary collection system of solid waste management in Bangalore and suggest ways to achieve the objective of waste reduction.

[5] H N Chanakya, T V Ramachandra and Shwetmala, 2005, Towards a Sustainable Waste Management system for Bangalore

PROFILE OF THE CITY

Bangalore, the capital of Karnataka State, is one of India's fast developing city with an average annual growth rate of 3.25 % and population of 8.4 million (census 2011). It has an area of 800 sq km and is situated at an altitude of 920 m above mean sea level. It is the third most populous city in India. The city is divided into 8 zones that are further divided into 198 wards.

ABOUT THE STUDY

The study on Primary Collection of Solid Waste in Bangalore is supported by HSMI (HUDCO) and is conducted by Indian Institute of Management Bangalore (IIMB) along with Centre for Sustainable Development (CSD).

The expected outcomes from the study are:

- A comprehensive report on the status of SWM in the selected wards including processes of generation and collection of solid wastes and citizens' behaviour
- A model system for primary collection of solid waste.

The objectives of the research study are:

1. To assess the quantum and the composition of MSW in selected wards of Bangalore.
2. To undertake due diligence of the primary collection systems of MSW in selected wards, and identify the key issues and gaps hindering the collection process. This would include studying various practices tried by different groups.
3. To study the behaviour of the citizen and identify their concerns and issues in storage, segregation and disposal of solid wastes.
4. To recommend model collection system and best practices to be followed during the collection system. Also, to suggest a suitable strategy for influencing behaviour of citizens.

METHODOLOGY

The study has the following steps:

- **Review of literature**

  Literature on SWM studies, research papers, articles with reference to solid waste in Indian cities and Bangalore, in particular, were studied. Best practices in solid waste management in other Indian and International cities were studied. Also some of the best practices (at a small scale) in Bangalore were reviewed.

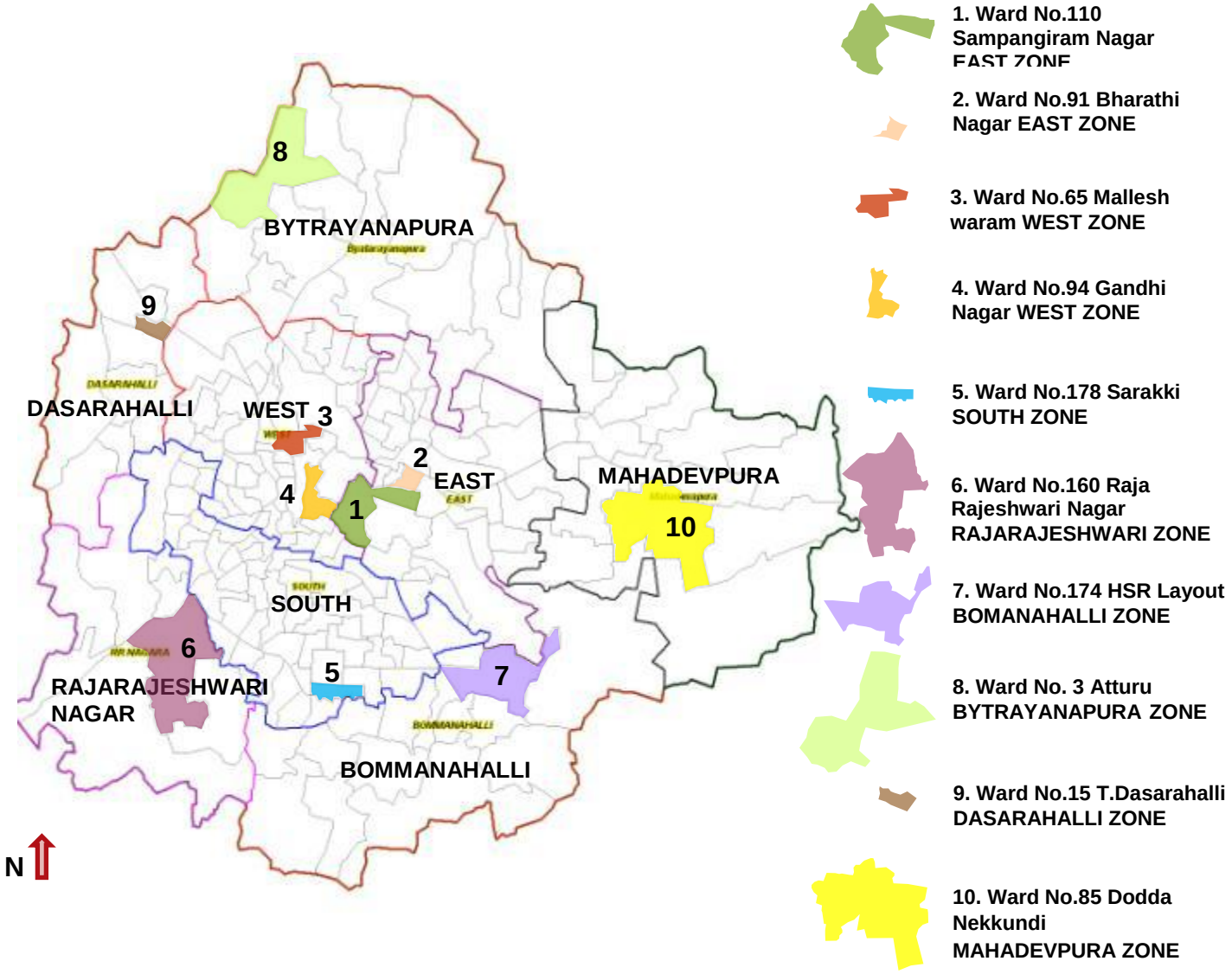
- **Selection of Study Area**

Out of 198 wards, it was proposed that 5% of wards i.e., 10 wards would be chosen in the first phase of the study. The selection of wards was done considering different strata of citizens, institutions, locations, etc. There are total 8 zones under BBMP jurisdiction. One ward per zone was selected through random sampling method in order to get the status of solid waste management for the entire city. Out of the remaining two wards, one ward was selected from old areas of the city where there is maximum floating population, high density commercial areas and haphazard/unplanned dense development and the other ward was selected based on the best practices currently adopted in segregation, storage and disposal of waste.

Care was taken to select those wards where the following categories of waste generators existed:

Residential population; Slums / Areas around slums; Commercial Establishments (Hoteliers / marriage halls / convention centres/ shopping malls); Markets (Vegetables, fruits, meat); Institutions (Hospitals, Schools, Colleges, etc.) and; Industries (including IT Parks).

The ward selected from old areas of the city is Ward no. 110 Sampangiram Nagar and the ward selected based on the best practices adopted is Ward No. 65 Kadu Malleshwaram. The selection of Ward no.65 was based on the discussions with the BBMP officials, few NGOs and field visits made to the ward. The wards selected are indicated in the map below:



- **Process Mapping**

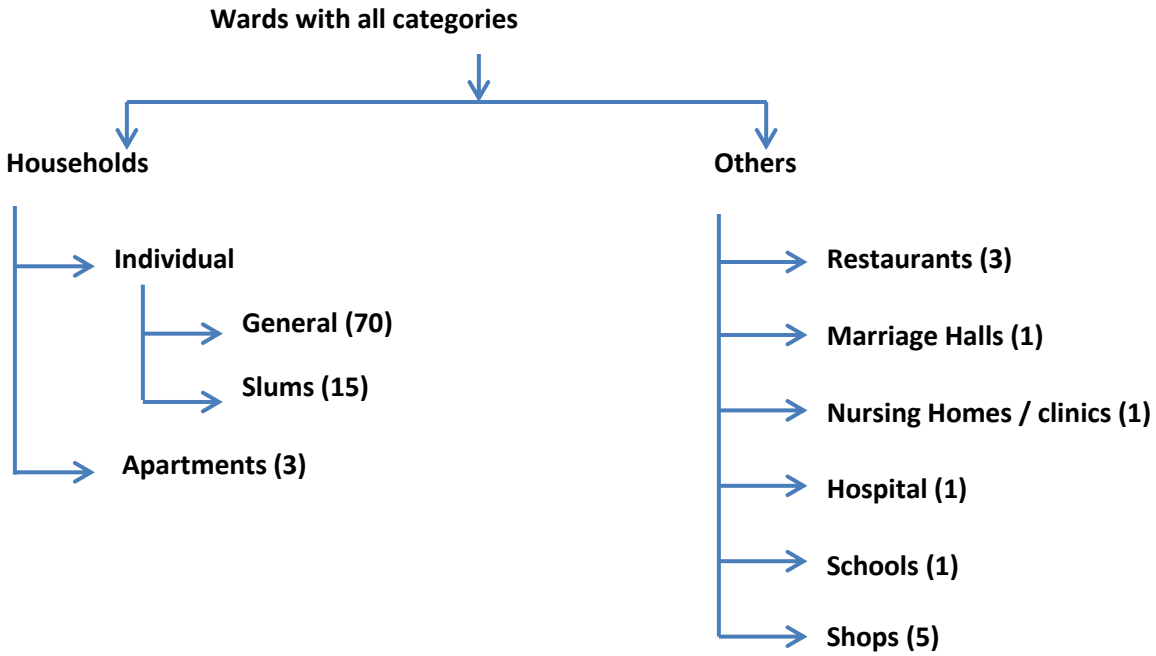
  Understanding and mapping the processes involved right from generation of MSW from various domains to storage, segregation, door-to-door collection, transportation, treatment and disposal of MSW. Process flow charts for all the selected wards are studied and analysis of areas where the performance is poor is identified and explained.

- **Citizen's Survey**

  The citizen's survey was conducted to achieve the two objectives of understanding the primary collection systems of MSW in selected wards and identifying the key issues and gaps in the

collection process and; to study the citizen's behavior and identify their concerns in storage, segregation and disposal of solid waste.

A sample of 1000 households was surveyed from the selected wards, 100 samples from each ward. The method of sampling was stratified random sampling. The following were the categories of samples along with the distribution of the survey:



- **Determining the quantum and composition of waste**

In order to achieve the quantum and composition of waste, a study conducted by Infrastructure Development Corporation of Karnataka (iDeCK) in 2008 on Integrated MSW Strategy for Bangalore City was referred. The study was carried in 8 zones of Bangalore and the selected households contained the various categories, i.e., HIG, MIG, LIG and slum area. The sample waste generated was collected from 128 households for 7 days (896 samples). The composition of waste in the study was derived by taking the waste generated by the selected households as the sample for the study.

The data from the study was used to arrive at the organic and inorganic quantities of waste generated at household level.

- **Discussion with other stakeholders**

  The other method to achieve Objective 3 is to discuss waste management practices adopted by involving various categories of waste generators like hoteliers/ marriage halls/ convention centres, markets/shop owners, hospitals, educational institutes, builders (construction waste), contractors, etc. This method is ideally suited to understand the behaviour and attitude of bulk waste generators towards maintaining a solid waste free environment for the city.

ABOUT WASTE GENERATION & MANAGEMENTIN BANGALORE

The total Municipal Solid Waste has increased from 650 tpd (1988) to 1450 tpd (2000) and about 3600 (2010) tons per day (tpd)[6]. The total waste generated in 2012 is 4650 tpd[7]. The following is the percentage of waste generated from various categories:

- Households - 54% percent of the total waste;
- Markets & function halls - 20% ;
- Commercial establishment & institutions - 17% and;
- Others - 9%

The current practice of solid waste management at BBMP is, about 70% of the MSW (Municipal Solid waste) activity starting from primary collection to disposal has been outsourced & 30% is managed by BBMP.

Primary Collection[8]

- The primary collection is performed using pushcarts & auto tippers
- Around 11,000 pushcarts & 650 auto tippers are used for Door -to-Door collection
- Around 4,300 Pourakarmikas (Sweepers) of BBMP & 10,000 Pourakarmikas from contractors used for Door to Door collection & sweeping activities.

[6] H N Chanakya, T V Ramachandra and Shwetmala, 2005, Towards a Sustainable Waste Management system for Bangalore

[7] BBMP, Department of Environmental Cell, 2012, Policy on Integrated Solid Waste Management

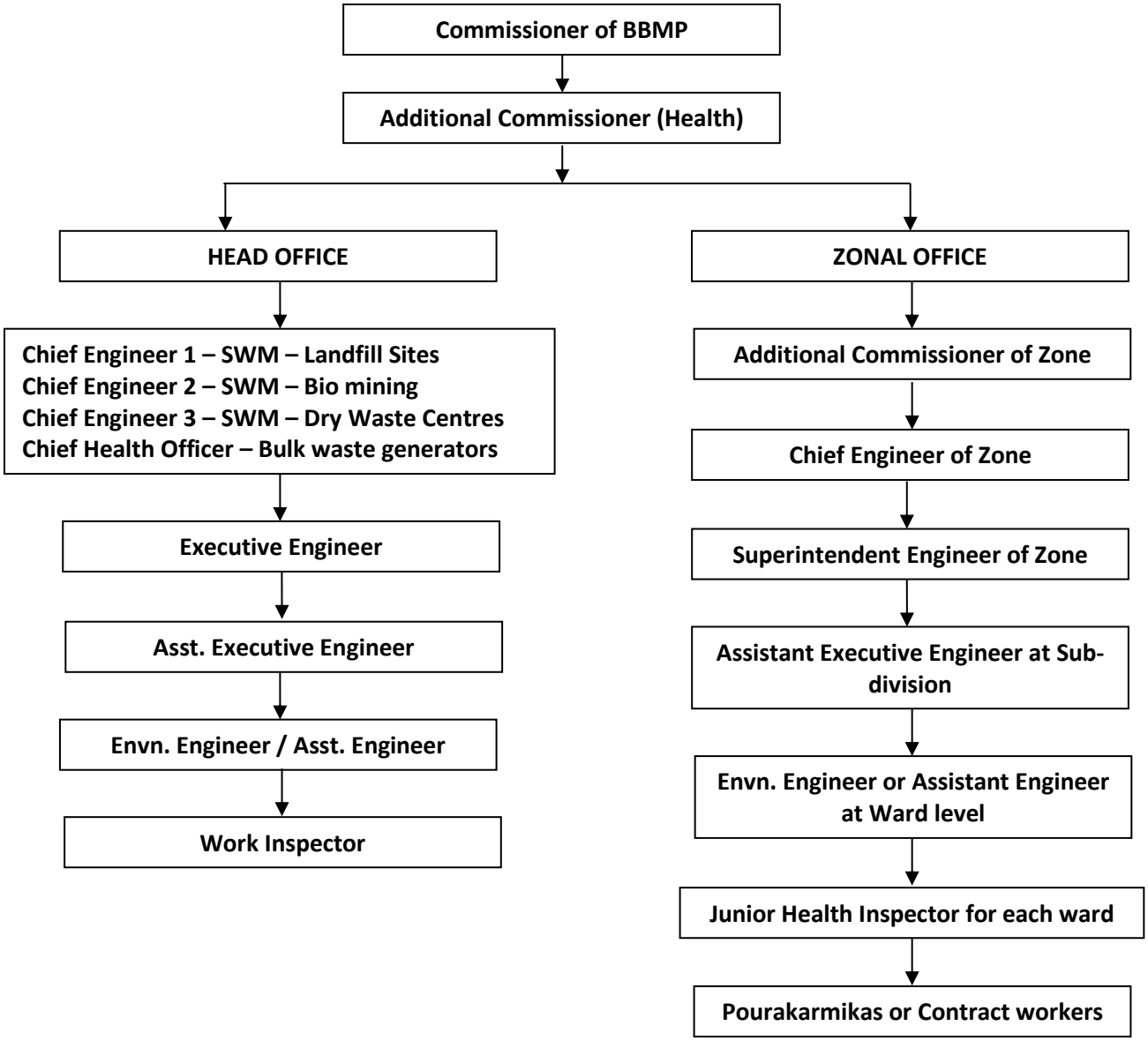
[8] Secondary data from BBMP

Secondary Collection & Transportation[9]

- There are about 600 MSW transportation vehicles including Compactors, Tipper Lorries, Dumper placers & Mechanical Sweepers both BBMP and contractors
- The waste collected from the households is brought to a common point i.e., secondary collection points (vacant sites, road sides, etc.) from where it is shifted to the compactors & tipper lorries for transportation to the treatment / disposal sites.

CURRENT ADMINISTRATIVE STRUCTURE FOR MSWM IN BBMP

The chart below shows the administrative structure of SWM in BBMP.



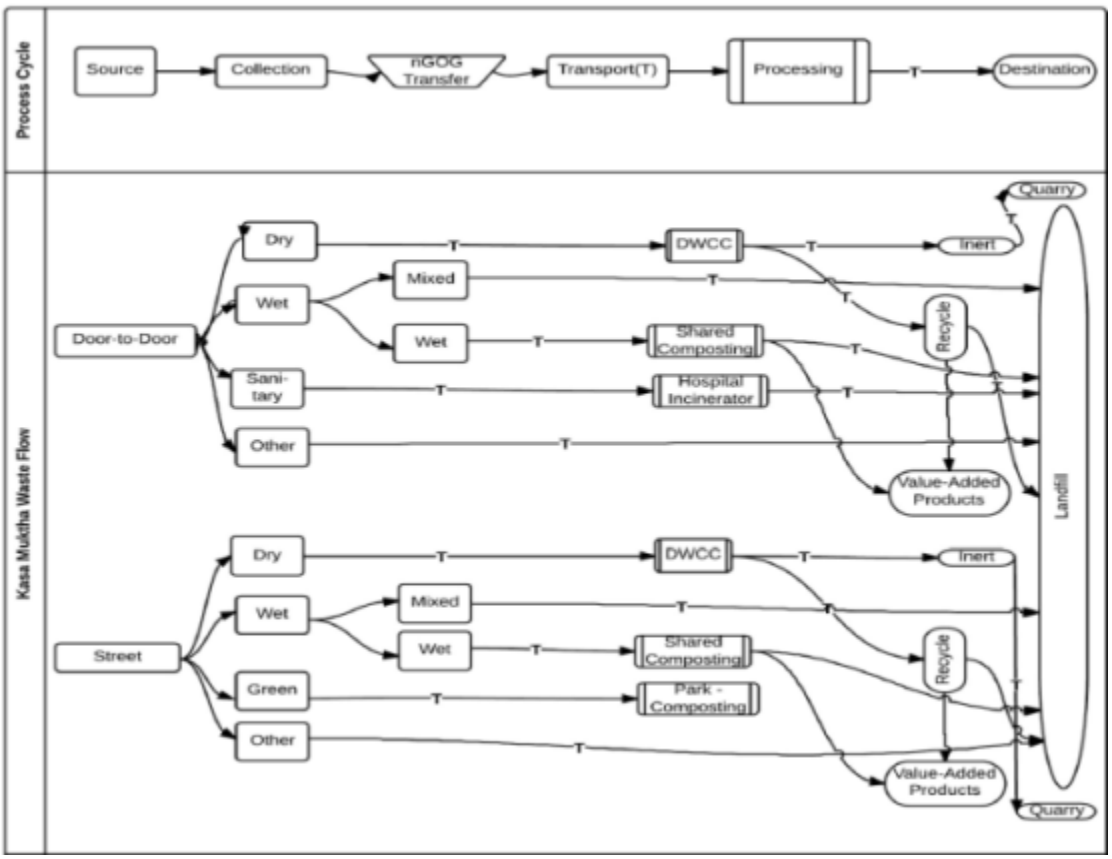
[9] Secondary data from BBMP

CONTRACT AGREEMENT - SALIENT FEATURES

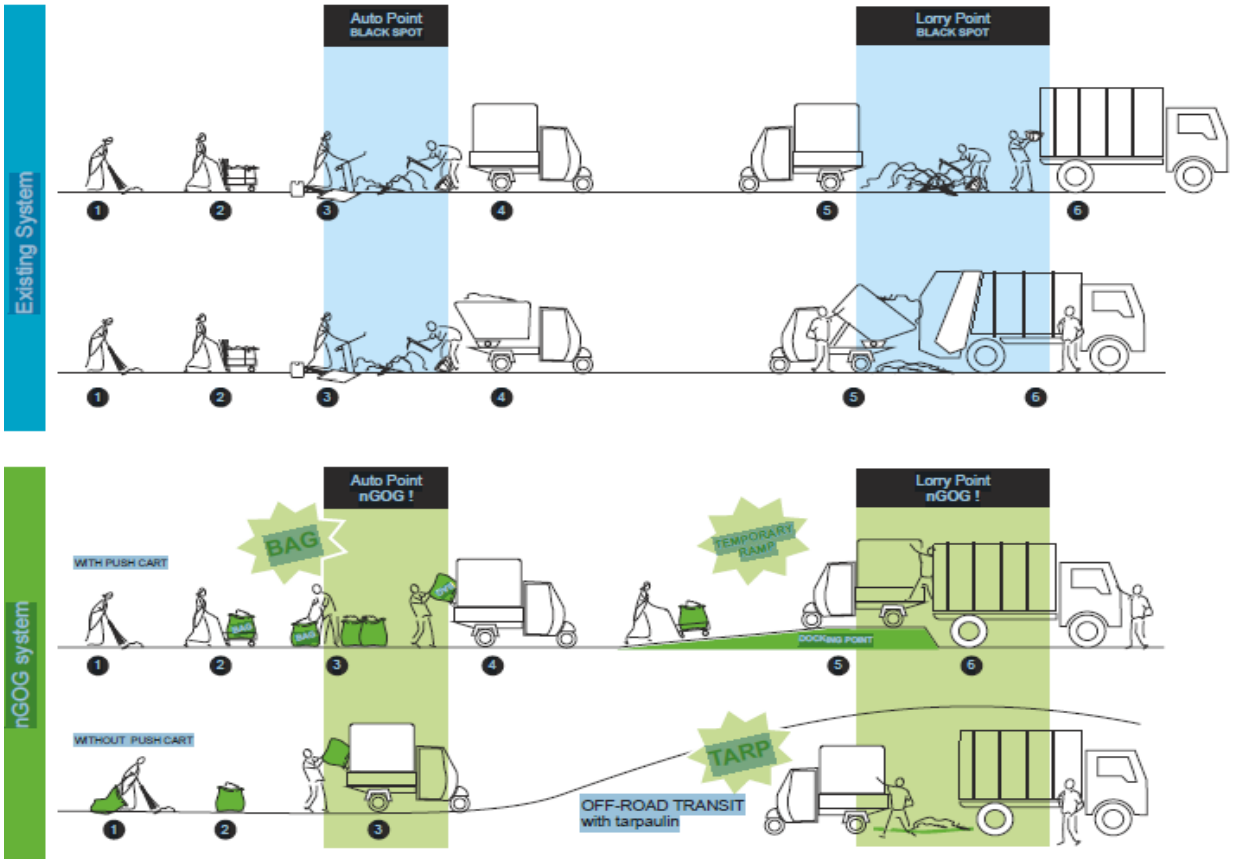
BBMP manages 30% of waste in the city and the management of 70% is assigned to the private contractors. There are around 91 contract packages. (Each package consists of 2-3 wards). The maximum period of contract is 3 years. The following are the activities assigned to the private contractors:

- Door-to-door collection of segregated Municipal Solid Waste (MSW) - wet waste, dry waste and sanitary waste separately on daily basis and dry waste exclusively on two days a week basis.
- Clearing of street litterbins is also part of this contract and the successful bidder is responsible for timely clearing of the street litter bins and transporting the same to the designated location.
- Sweeping of roads, streets, footpath and pavements, removing of MSW from open tertiary road side drains and shoulder drain, uprooting of vegetation and transportation of the same to designated locations.

Collection of Municipal Solid Waste from the bulk waste generators is not a part of this service contract. The flow of waste proposed in the contract agreement is:



In the present system the waste is transferred to the ground and then transported to another vehicle for transportation. It is proposed that no waste should touch the ground and should be directly transported to bigger vehicles.



The following scope of work suggests the importance of segregation of waste as part of the service contract:

- Collection of Wet MSW on daily basis
- Collection of the dry waste twice in a week from each household and transported to the designated Dry Waste Collection Center.
- Sanitary waste separately collected and transported to the designated Hospital/Nursing Home notified as sanitary collection centre.
- Promote MSW Segregation at household level through awareness campaigns and other suitable means.

- Wet waste and dry waste shall not be mixed either at the time of collection or transferring the same to processing site.
- The waste from shop keepers, vendor and street hawkers shall be compulsorily collected in segregated form without allowing them to throw the waste at untimely hours near the secondary storage points.

The terms of payment of the contractor are:

- The payment decided as a lump sum fee based on the number of pushcarts, vehicles and equipment provided along with the respective manpower for each package. Any default in the provision of same shall bring a penalty and thereby reducing the lump sum payment.
- The Service Provider contractor shall weigh the waste at the weighbridge set up by BBMP/processing unit operator. If such facilities are not available, the Service Provider contractor must weigh the waste in the intermediate weighbridge (electronic) at his own cost. The records of weighment should be submitted along with the monthly bills.
- No objection certificate from representatives of "Residents Welfare Association" and "SuchiMitra" is to be obtained before release of payment on the monthly bills.

OTHER SWM INITIATIVES BY BBMP

Dry Waste Collection Centres (DWCCs)

The Dry waste collection centers are set up by BBMP for recycling the dry materials like plastic, paper, glass, metals, etc. There is a plan is to set up a DWCC in all the 198 wards. Till October 2013, 148 DWCCs have been set up, of which 100 are functional, out of these 57 DWCCs have been entrusted to NGOs.

Kasa Mukhta Programme

This programme was launched on 24th July 2013. It is an at-source segregation initiative at ward level developed jointly by BBMP & Wake Up Clean Up. It was launched on 24th July 2013 with a view to introduce destination bound processing of wastes and to be scaled City wide once the program is stabilized. The initiative was planned to start in 22 pilot wards.

Registration of Waste pickers – formal recognition of their role by BBMP

Following the Lok Adalat's directive in 2011, the BBMP Commissioner issued an official circular to register waste-pickers and itinerant buyers and enumerate scrap dealer - the first step towards formal recognition of their role.

On 9th August 2011, at the first Waste-pickers Convention, 200 waste-picker ID cards were distributed following the registration. As of 2013, the BBMP has distributed over 5000 ID cards and have sanctioned additional 7000 registrations.

Karnataka Compost Development Corporation

KCDC was established in 1975, involved in eco-friendly treatment of city garbage and agriculture waste through production of compost based organic manure and vermi-compost by adopting aerobic decomposition windrow method.

The plant was receiving 50 tpd in the early years and it was set up to receive 200 tpd after its expansion program under Bangalore Mega City Scheme. From September 2008 onwards the receipt of garbage was stopped due to accumulation of untreated garbage.

KCDC was revived in 2013 after five years of inaction. In June 2013, BBMP started sending KCDC around 100 tons of vegetable waste a day, from Madivala and city market. Currently it treats about 600tons of waste every day i.e 300 tons of the existing waste and 300 tons of segregated wet waste.

PROCESS MAPPING

Process mapping was done to understand the collection system right from the generation, collection to disposal of solid waste from various domains like households and bulk waste generators. An attempt to map the process of waste flow in the 10 selected wards was also made. Chapter 3 consists of the charts showing the existing flow of waste from households and bulk waste generators. It also contains the process flow of waste from the selected 10 wards along with their timing, infrastructure provided and waste generators covered.

ASSESSMENT OF QUANTUM AND COMPOSITION OF WASTE

A study conducted by iDeCK in 2008 on Integrated MSW Strategy for Bangalore City was used to assess the quantum and composition of waste. The study has quantified in detail the composition of waste generated. Using data from this study, the quantity of organic and inorganic waste generated at household level was derived.

Quantity of organic and inorganic waste generated at household level is:

Broad Category	Percentage	Quantity of waste (tonnes)
Organic	**58.33**	**1225**
Vegetable	*29.38*	*617*
Organics	*22.76*	*478*
Grass And Leaves	*6.19*	*130*
Inorganic (Recyclable)	**32.66**	**685**
Paper	*8.88*	*186*
Plastic	*11.88*	*250*
Cardboard	*3.88*	*81*
Textiles	*3.88*	*81*
Leather	*0.38*	*8*
Metal	*1.13*	*24*
Glass	*2.63*	*55*
Inorganic (Landfill/Biomedical/Hazardous)	**9.01**	**190**
Battery	*0.13*	*3*
Electronic Items	*1.75*	*37*
Debris	*5.38*	*113*
Biomedical	*1.75*	*37*
TOTAL	**100**	**2100**

The findings of the study by iDeCK indicate that the per capita household waste generation is about 225.70gpcd. Per capita waste generation excluding slum areas is 248.80gpcd. The population as per Census 2011 is 8,425,970. Taking the figure of per capita waste generation excluding slum areas (248.8gpcd), the total household waste generated in Bangalore is 2100 tonnes.

The break-up of this waste into 3 categories – Organic, Inorganic (Recyclable) and Inorganic (landfill, biomedical, hazardous) is done.

- Organic waste generated from the households is 1225 tpd (58.33%),
- Recyclable component is 685 tpd (32.66%) and
- Non-usable inorganic including inert, debris, biomedical and hazardous waste is 190 tpd (9.01%).

If the organic and recyclable waste is separated from the waste stream at the point of generation and collected in a segregated manner, the remaining 190 tpd (9.01%) is the waste that the authorities need to find a solution for.

As per the SWM Policy document prepared by the Department of Environmental Cell in year 2012, the household waste forms 54% of the total waste generated in the city. Considering total household waste of 2100 tpd as 54%; the remaining 46% i.e. 1788 tpd is the waste from commercial establishments, markets and function halls, institutions and others.

Hence the total waste generated in the city as per our calculations is 3888 tpd (based on study conducted by iDeCK in 2008).

FINDINGS OF THE STUDY

The following are the findings of the study:

Process Mapping – major concerns

- Even though the contract suggests no Garbage on Ground (nGoG) method, the transfer of waste at each stage is done manually
- Segregation of waste is not taking place in an organized manner
- Even if the segregation is happening at individual household or commercial establishments levels, there is no formal system of collecting the waste in a segregated manner and disposing it in the same way so that minimum waste reaches the disposal site
- In most of the places the secondary collection is over by afternoon. Any waste reaching these points (in areas where there is no door-to-door collection) after this time remains there for at least a day before it is cleared the next day
- Even though the contract specifies the tools/ safety equipment to all workers once in 3 months and uniform twice in a year, none of the ward has all the equipment as specified
- Due to lack of 100% door-to-door collection and segregation, not all the dry waste produced reaches the DWCCs
- Due to the protest of the villagers in the areas surrounding the dump sites, the waste collected in compactors/tipper lorries is taken only at night after 11.00 p.m. This results in decay of the wet waste thereby causing more problems at the sites.

Observations from the survey results – from households

- The systems are not standardized across wards in terms of level of segregation at-source, primary collection, street sweeping and secondary collection.
- Performances across the wards vary and mostly depend upon the officers, corporators and people than on resources.
- Average performance of street cleaning is poor.
- Though 75% of the waste is collected directly from the households, the remaining 25% of waste coming on the streets, vacant plots, etc. is not efficiently collected.
- Also most of the waste collection and street cleaning is over by noon and any waste that comes on the road after noon gets cleaned up only the next day. This is one of the major sources of problem in waste management at Bangalore. The waste lying at the secondary collection points spreads onto the roads and footpaths by stray animals and also by addition of more waste till it gets collected.
- There is considerable lack of awareness and participation in segregation of waste produced. The households are not aware about the method of storing dry waste (in plastic bags/buckets) and wet waste (in paper bags/ plastic buckets).
- Just 40% households segregate the waste out of which 30% say that the pourakamikas mix the segregated waste while collecting. This indicates that only 28% of the waste enters the waste stream in a segregated manner.
- Limited people's participation is seen by way of registering complaints to the authority.
- Although respondents seem to be aware about the waste management issues in Bangalore and importance of at-source waste segregation, on ground implementation of the same is restricted to some localities only.
- More than 60% respondents are ready to pay for solid waste management services and 28% are neutral about the payment for the services.
- The wards that are cleaner than the others are the ones where Citizen's groups are active in the field of SWM.

Observations from the survey results – from shops & bulk waste generators

- Overall service delivery and waste segregation in case of shops & bulk waste generators is better than that of households but has scope for improvement.

- In areas dominated by shops & restaurants, most of the doorstep waste collection and street cleaning is over by noon. The waste that comes after noon remains on the road till it is collected the next day.
- In commercial areas, there is a need to strongly address the problem of littering. The shopkeepers can report and BBMP can fine the defaulters in such cases.
- Segregation of waste is performed by more than 60% of respondents in both cases, however some of this segregated waste is mixed up by the workers and only 44%, in case of shops and 54%, in case of bulk generators, enters the waste stream in a segregated manner
- Participation in solid waste management activities like registering complaints, attending seminars/workshops, RWA meetings is low (25%) in case of shops and minimal (10%) in case of bulk waste generators.

Administrative Structure

The following observations were made with respect to the current administrative structure in managing solid waste by BBMP:

- No effective monitoring mechanism. Monitoring at each ward depends upon individual chief executive and the success in implementation of solid waste management rules also depend upon his/her extraordinary championship.
- Change in organizational structure to an approachable decentralized structure.
- Also post of environmental engineers have been created for better skill set to carry the municipal services of solid waste management.
- Adequate training of engineers and role clarity of individual officers and staff is needed to improve monitoring.
- Inadequacy in career growth avenues for qualified / specialized staff is demotivating.

Contract Agreement

The advantages observed are:

- System of giving small and multiple contracts is easy and quick to implement. The private entrepreneurs are willing to invest in collection and transportation equipment, as well as providing labour, tools, equipment, etc.
- BBMP is able to cover the city even with in-house limited resources.

The limitations observed are:

- Fragmenting the accountability - the tendency is to pass the blame between the contractors / multiple staff.
- Segregation has become impossible with passing of blames between the generators and contractors/BBMP.
- A lot of monitoring is required. Lack of the same leads to payment without getting the desired results.
- Technology has not been adequately utilized for monitoring purposes.
- Role of NGOs /SHGs / RWAs is limited due to the current system of contracts.
- Payment by weight acts as a disincentive for the contractor to collect waste in a segregated manner.
- The contract should include the service provider's responsibility of checking if the waste is dumped by service provider of any other area.

Policy Level

Policy of integrated Solid Waste Management 2012 for BBMP - prepared by the Department of Environmental Cell - includes ways of involvement of private sector for MSWM through appointment of independent private agency for bulk waste producers; house-to-house collection contracts to waste pickers/NGOs or SHGs; comprehensive contracts with contractors providing their own vehicles and responsible for Labour Laws; performance oriented contracts based on outputs and not inputs.

A guideline for PPP in waste processing is also part of the SWM Policy for Bangalore.

The policy, however, lacks the ways of incentivizing/dis-incentivizing the citizens and other stakeholders to segregate the waste. It lacks the means of effective mechanism and role of citizens in monitoring the service delivery on a daily basis. It does not contain the standards for evaluating and monitoring the performance of the service providers.

System Deficiencies

- The normative standards stated in the SWM Policy for Bangalore for segregated storage of waste on premises, door-to-door collection, street sweeping, secondary storage have been rarely cross-checked with the on-ground performance of the contractors / workers.
- There is lack of proper data at ward level to measure the performance of the service provider using standard norms.

- The mode of payment is based on quantity of waste brought to the landfill. This acts as a disincentive towards waste segregation and waste reduction.
- Contract changes required to ensure that segregated wet waste is composted fully.

Process Deficiencies

- Segregation of waste and awareness creation

  Though lots of initiatives have been taken in terms of creating awareness about waste segregation, none of them are carried on a regular basis. As a result the initiative of introducing segregation of waste dies before it picks up.
- Primary collection and storage – absence of standards

  The waste collected from door-to-door using pushcarts is unloaded and stored in temporary depots which are vacant plots or road sides which necessitates multiple handling of waste. Waste spills over, which is unsightly and unhygienic.

  The workers collecting waste from door-to-door are either not given the required tools and equipment or they have not been educated enough to use them. As a result, they handle the waste without the use of safety gear like boots, uniform, gloves, etc.
- Dry waste collection centres

  One of the unique initiatives, if properly administered can help in separating almost 30% of waste produced per day. Due to lack of proper waste segregation it is not very effective.

- Secondary collection and transportation
  - Most of the autos are old, unkempt and open without hydraulic system.
  - Practice of manual loading of waste prevalent.
  - Inefficient workshop facilities.
  - Very few compactors and mostly the waste gets transported in open lorries or trucks with bags of segregated waste hanging on the sides.
  - Lack of synchronization of primary and secondary collection of waste result in multiple waste handling.

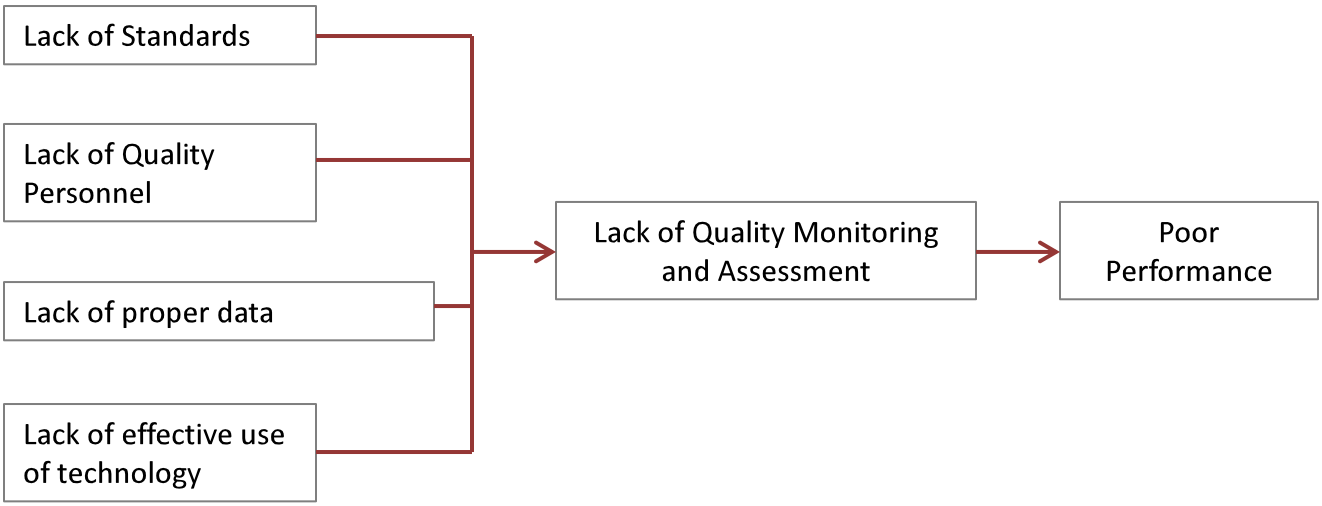
Monitoring and Supervision Deficiencies

- The biometric system suggested in contract document to monitor the punctuality and regularity of the workers/staff is not yet implemented.

- At the ward level, only the junior health inspector is fully responsible for regular monitoring work. The rest of the officers are mostly engaged in activities other than solid waste management.
- Implementation of penalty system is completely missing and even though the SWM policy for Bangalore clearly states the penalty charges, the primary survey does not reveal even a single case where they have been fined for illegal dumping of waste.
- The start-up programs / initiative taken up by the Corporation fail due to lack of strict monitoring and serious implementation of penalty system.

Service Quality Gap

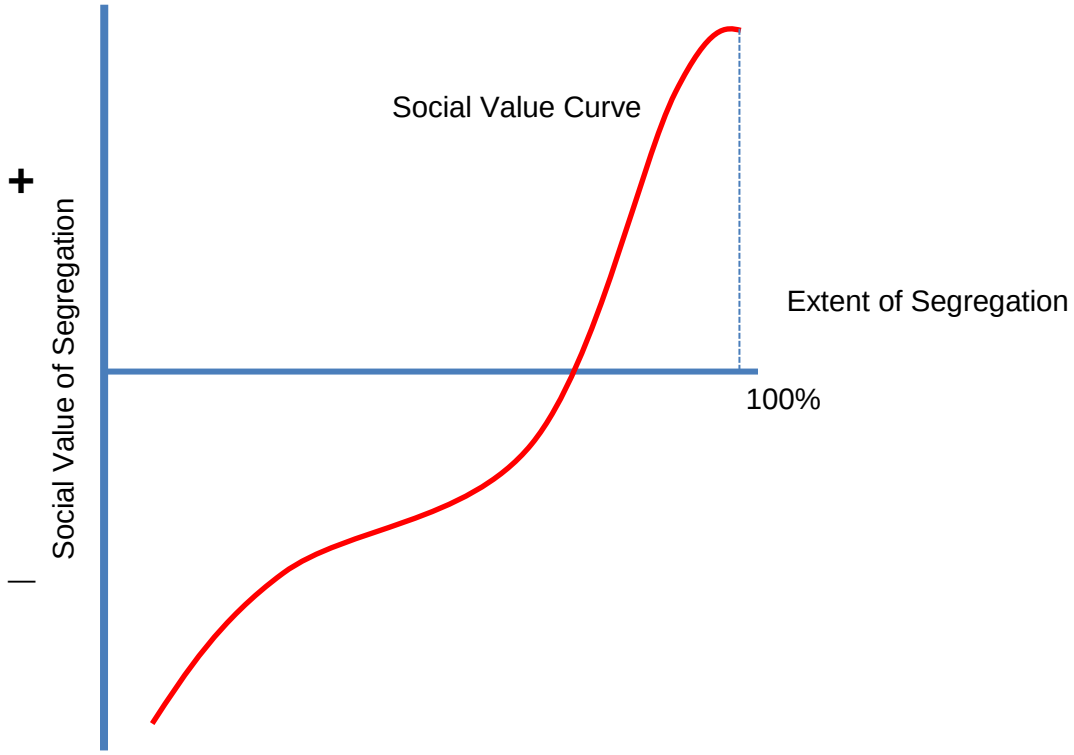
Lack of standards, lack of quality personnel, lack of proper data and lack of effective use of technology leads to lack of quality monitoring and assessment. The poor performance, in current scenario, is the result of lack of quality monitoring and assessment.



RECOMMENDATIONS

The extent of segregation can be linked to the social value of segregation. The greater the extent of segregation, higher will be its positive impact on the society and lesser the extent of segregation, greater will be its negative impact on the society.

The social value curve can move from negative to positive if the extent of segregation increases (as shown in the graph below). Hence large proportion of segregation is important to improve the quality of society.

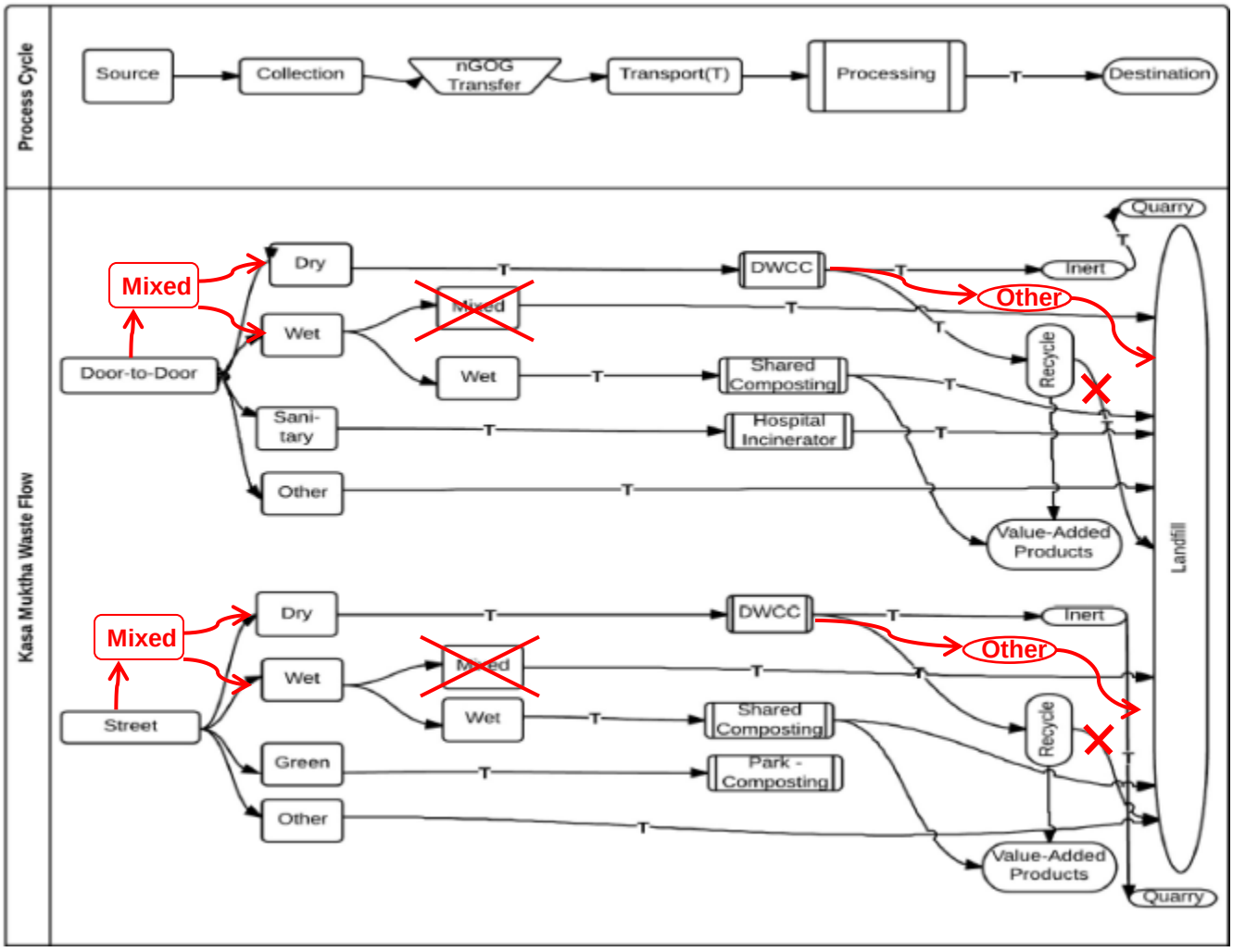


The city is already moving towards the system of segregation for handling the large quantity of waste produced and the infrastructure for the same in already place or in the process. Hence, it would be wise to incorporate segregation of the waste as the solution to the waste management problems. By reducing the quantity of waste produced, one can economically handle the management of solid waste in Bangalore. To achieve this all the stakeholders i.e., the residents, the Corporation, the contractors, the pourakarmikas (workers), rag pickers and the NGOs/RWA's /CBOs/SHGs have to play an important role. The various ways by which it can be done are:

Policy level

- **Policy of Integrated Solid Waste Management 2012 for BBMP to be modified and followed**

Contract changes required to ensure that segregated wet waste is composted fully. The change recommended in the waste process flow in the contract documents is as shown below:



This change in the process flow is to ensure that the waste reaching the landfill site is minimum, achieved after segregation of waste at-source or segregation of mixed waste at the next level.

- **Laws for implementing Extended Producers Responsibilities**

- Strict laws should be framed to implement the Extended Producers Responsibility (EPR), which should take care of large amount of unmanageable waste from this stream.

- Producers should take back the packaging items at a certain rate of redemption (For e.g., thin plastic packets of chips, kurkure with metal lining; expired medicines; empty glass /pet bottles, empty cans, etc.)
- The companies should be made responsible for reducing the large quantity of packaging waste generated through the products they sell.

- **Segregation at-source to be mandatory responsibility of the generator**

- Strict implementation of segregation at-source
- Waste should not be accepted free of cost by those who give mixed waste to the pourakamikas.
- Mixed waste can be collected by the pourakamika by charging a fee for segregating the mixed waste. The pourakarmikas should have the right to reject the mixed waste if it is difficult to segregate the waste.
- Whenever someone misses giving waste to the pourakamika collecting waste from door-to-door, it shall be the responsibility of the generator to drop the waste (on-charge basis) at the Clean Bangalore Centre (CBC)

- **DWCC converted to Clean Bangalore Centres (CBCs)**

Dry Waste Collection Centres to be converted to SWM solution centres for activities related to solid waste management at a community level. They can be called as Clean Bangalore Centres (CBC) that shall run in collaboration with BBMP to provide the land & building and supervision; NGOs/SHGs for day-to-day functioning and; Industry (private players) to bring-in the managerial skills of running the centres and to make them economically sustainable. The following activities can be part of the CBCs:

- Dry Waste collection centre & further segregation of the dry waste (dry waste can be brought to the centre by PKs collecting from door-to-door or by residents themselves).
- Collection bins for mixed waste to be collected on-charge by those who missed giving waste to the pourakarmika collecting the waste from doorstep.
- Collection bins for other inorganic waste (sanitary / hazardous / inert waste) to be collected on-charge by those who missed giving waste to the pourakarmika collecting the waste from doorstep.
- Help/guidance for those who are composting the wet waste at household / community level

- A store for selling standardized materials related to SWM (like bins, hand gloves, waste paper bags for collecting wet waste, covers for collecting dry waste, material for composting wet waste, compost produced from wet waste, etc.)
- Information on proper segregation of waste
- Awareness campaigns to be conducted on a regular basis in the CBCs

The Clean Bangalore Centres should be a role model for maintaining cleanliness in the locality.

Organizational / Institutional

- BBMP to have a separate MSWM department with staff dedicated solely for SWM related work.
- Appointment of Environmental Engineers / Public Health Engineers / Sanitation experts with effective training related to Municipal Solid Waste Management
- Define clear roles and responsibilities of all working in SWM Department with adequate career growth avenues for qualified / specialized staff.

Due diligence of System

- Three bins system of waste segregation (wet, dry and other inorganic waste)
- Tackling wet waste at household / community level / city level
- Dry Waste Collection Centres to be run by SHGs/NGOs/private bodies on self-sustainable basis
- Collection and transportation of other inorganic waste
- Standardization of segregation, collection and transportation system
- Synchronizing primary and secondary collection
- Limit Contractual services, enhanced role of BBMP, citizens and NGOs/SHGs

➢ **Three bin system of waste segregation**

- Introduction of segregation of waste into 3 broad categories need to be brought about.
- The 3 categories are:

- wet waste (organic waste) approx. 60%,
- dry waste (recyclable waste) approx. 30%and
- other inorganic waste (sanitary / hazardous / inert waste) approx. 10%

- This is necessary to remove the menace of segregating the third category mainly the sanitary/biomedical/hazardous waste from the wet and dry waste streams and thereby make it easier to process the usable substances from the waste

➢ **Tackling wet waste (60%) at household / community / city level**

- Encourage composting of waste at household / community level
- Service can be provided by BBMP pourakamikas / NGOs for those who are willing to treat the wet waste at household / small scale level using various technologies to convert it into compost
- The pourakarmikas collecting the waste from the doorstep can be equipped for hand-holding such an activity and also supply the material for the same. This service is to be charged to the household and done without affecting primary collection.
- NGOs or other private agencies can also be allowed to provide such a service. They can also have a buy-back system of the compost generated.
- Areas where household / community level composting is not prevalent, the current system of door-to-door collection and transportation to KCDC / private composting units to be adopted. Waste to reach at these units before it decays.
- The Clean Bangalore Centres in each ward to assist the residents in this regard.

➢ **Tackling dry waste (30%) at Self sustainable Dry Waste Collection Centres / Clean Bangalore Centres (CBC)**

- DWCCs proposed to be converted into Clean Bangalore Centre (CBCs) that are established or are under construction in each ward.
- The service provider to collect/buy the dry waste once a week from various generators within the ward using their own vehicle/s. The dry waste can also be collected by the door to door Pourakarmikas and sold at CBCs. Or citizen's can also come and sell it at the centre at their convenient time.
- The service provider earns by selling the segregated dry waste at the wholesale market.
- BBMP to ensure that these service providers collect all the waste (including low value dry waste) from the generators

➢ **Collection and Transportation of other inorganic waste (10%)**

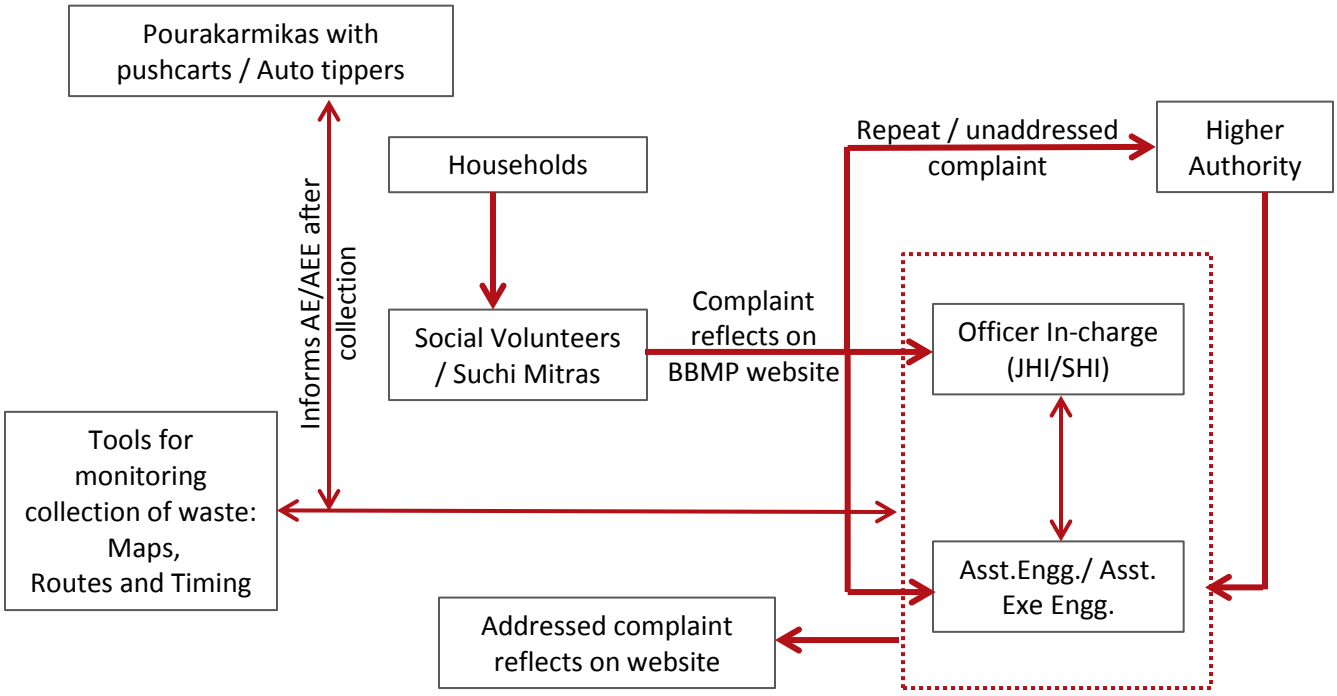
- Current system of collecting waste using push carts or autos, with an additional system of collecting the waste in a segregated manner to be deployed by BBMP
- Inorganic waste (sanitary / hazardous / inert) from all the generators and organic waste from those who are not processing the wet waste to be collected in separate containers.
- Hazardous waste to be addressed through EPR
- Wet waste to be taken to composting units (within 24 hours) only
- Certain portion of waste like sanitary and biomedical waste to be sent to the designated incinerator centres. The remaining inorganic waste (< 10%) to be sent to landfill sites and

therefore around 200 tpd of solid waste can be dumped in landfill sites. If the amount of this waste increases, the contractors should pay a penalty. A target time needs to be set to achieve this.

Monitoring and Supervision

- **Introduce Citizen's Monitoring System**

- Modern concepts of social volunteers can be introduced to harness citizen's voice as a resource to solve real life problems such civic issues.
- Preparing citizen's report cards would involve them to bring about a positive change in each ward. (Best practice case of ward no. 103, Punjabi Bagh, New Delhi).
- Modern day technologies like smart phones, social networking sites, etc. should be used for quick reporting and generation of MIS reports.
- Involvement of citizen's through regular report card system & its effectiveness will keep the interest of the citizen's alive and also keep the authorities on its toes for performing.



- **Strict Monitoring and Penalty System by BBMP**

- Monitoring Information System (MIS) for Solid Waste Management in each ward should include ward maps, route maps, and timing of services.

- Use of technology (smartphones, internet, etc.), media (television, newspaper), signage, websites to be done for awareness creation, achieving standardization and monitoring.
- Services provided by the contractors / SHGs / NGOs to be monitored by the Citizen volunteers and SWM department officials.
- Penalty system as suggested in the Policy for Integrated Solid Waste Management 2012 for BBMP to be followed and implemented
- Pourkarmikas should be allowed to reject mixed waste at the household level or accept it with a penalty. The composting units should stop accepting the waste if the contractor continues to send mixed waste.
- Professional Management of the whole system is needed
- For preparing the ward level data base, a paper on 'Integrated Sustainable Waste Management (ISWM) Action Plan for BBMP wards' prepared by Civic Bangalore can be referred.

➢ **Citizen's connect / disconnect**

- The key to this proposal is regular awareness and strict implementation drive till the habit of segregation is inculcated in the current and new generations.
- 'Kasa Mukta Week' may be celebrated to make people aware of their roles and deliver their responsibility. Involve Schools in the programmes.
- Doubt clarification for waste segregation using BBMP's hotline (recorded message) or suitable apps.
- Regular training programs to pourkarmikas and demonstration to households.
- Regular awareness programs for educating the citizens about the importance of segregation should be carried out
- Help from schools to mobilize the students by explaining about household waste segregation and inculcating such habits in the young ones for easy implementation at household level

Implementation and benefits

Most of the infrastructure is already in place for this model. Implementation and enforcement of the rules needs to be achieved for its success.

This model would help in tackling the growing amount of waste generated due to changing lifestyles and would help in resource recovery at minimal cost just by segregating the waste at-source. The key to the success of this model will be daily collection of wet waste and transportation of the same to the resource recovery plants or decentralized treatment units. This would help in engagement of existing

pourakarmikas and contract workers but reduce the burden of high contractual cost to the BBMP. It would also curtail the extent of mal-practices in engagement of contractors. Involvement of citizen's through regular report card system and its effectiveness will keep the interest of the citizen's alive and also keep the authorities on its toes for performing.

Way Forward

A model packet (2-3 wards) can be selected for implementation of the above suggestions. This packet can act like a lab for experimentation of suggested model. If successful, the model can be replicated in 50% of the packets in the second phase (6 months) and then in other parts of the city.

1. INTRODUCTION

1.1 PROBLEMS ASSOCIATED WITH SOLID WASTE MANAGEMENT IN INDIAN CITIES

India is the second largest nation in the world, with a population of 1.21 billion, accounting for nearly 18% of world's human population. Its urban population grew at a rate of 31.8% during the last decade to 377 million, which is greater than the entire population of United States, the third largest country in the world according to population. With the growing urban population in India, the amount of waste generated in every town or city is a matter of concern. This waste generated need to be managed for maintaining cleanliness and hygienic living environment for the city habitants. The per capita waste generation rate in India has increased from 0.44 kg/day in 2001 to 0.5 kg/day in 2011, fuelled by changing lifestyles and increased purchasing power of urban Indians[10].

Solid waste management is the only service which is exclusively a municipal service across India. Often this service is provided by the Health Department of a ULB, usually headed by a Health Officer. However, following the guidelines issued under Solid Waste (Management & Handling) Rules 2000, some of the larger ULBs have created specific SWM Departments which are staffed by Environmental Engineers.

Presently, several deficiencies persist in the management of solid waste across Indian cities. These, as highlighted by Asnani include the following: absence of segregation and storage of solid waste at source; lack of proper primary collection system from the source of waste generation; irregular sweeping of streets; temporary waste storage depots which necessitate multiple handling of waste; inadequate system for transportation of solid waste; and unscientific processing and disposal of waste.[11]

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[10] *Annepu, R. K., 2012. Sustainable Solid Waste Management in India. Downloaded from: http://swmindia.blogspot.in/*

[11] *Asnani, P. U., 2006. Solid Waste Management. Chapter 8 in India Infrastructure Report. Oxford University Press, New Delhi.*

Further, issues such as rapid increase in areas to be served and quantity of waste generated aggravate these deficiencies[12].

These deficiencies result in irregular dumping of waste on roads, drains, vacant sites and any place possible outside the premises. This being the general habit of most of the citizens, the common areas of the city always remains dirty until the municipal bodies clean them up. It ought to be mentioned that there are two key human behavioural factors which directly impact each of these deficiencies. These include: (i) apathy of municipal authorities as they often do not prioritize solid waste management as a municipal service and are not suitably trained; and (ii) absence of participation by the citizens and community at large in management of solid wastes (for which, again, the municipal authorities are often held responsible) (Asnani, 2006: 161).One of the major problems faced by many ULBs is that the sites used for dumping the waste are either close to some existing villages or are future city areas. This results in anger and outrage amongst the villagers that causes agitation for dumping of waste. The Municipal bodies responsible for waste management have to look for other areas where they can dump the waste on a daily basis. Over a period of time the same problem starts in these new dumping areas. This is a persistent problem and hence a solution needs to be derived.

The problem of managing the solid waste might just grow and get out of hand if not catered to within a time bound manner. According to estimates, the total municipal solid waste generated in urban India in 2011 is 68.8 million tons per year (TPY) or 188,500 tons per day (TPD), indicating a 50% increase in MSW generated within a decade since 2001. In a "business as usual scenario", urban India will generate 160.5 million TPY (440,000 TPD) by 2041; in the next decade, urban India will generate a total of 920 million TPY of municipal solid waste that needs to be properly managed in order to avoid further deterioration of public health, air, water and land resources, and the quality of life in Indian cities. In a "business as usual" scenario, India will not be able to dispose these wastes properly. (Annepu, 2012: 3)

1.2 PROBLEMS OF SOLID WASTE MANAGEMENT IN BANGALORE

Like many other Indian cities, Bangalore is also facing issues in disposal of large quantities of waste produced every day. The total Municipal Solid Waste generated in Bangalore city has increased from 650

[12] *Kumar, S., 2005. Municipal Solid Waste Management in India: Present Practices and Future Challenge*.

TPD in 1988 to 1,450 TPD in 2000 and about 3,500 TPD in 2009.The per capita waste generation has also increased from 0.16 kg/d (1988) to0.58 kg/d (2009)[13].

The severity of the issue became more evident in year 2012 when garbage piles started to build alongside streets and footpaths continuously for days together following a closure order of Mavallipura landfill site on 11thJuly 2012 from the Karnataka State Pollution Control Board (KSPCB). Following this, there were agitations by the local residents and some NGOs demanding for the closure of other landfill sites due to environmental and health impacts. Subsequently, another agitation at Mandur landfill site had begun calling for its closure based on the issues pertaining to the earlier landfill site[14].

Rapid urbanization, industrialization, raised standard of living and change in the pattern of consumption, etc. have enhanced the generation of solid waste and its management has become a major problem. The unscientific management and disposal of solid waste in urban cities have resulted in the adverse effects on public health risks (ex: disease vectors, flies, mosquitoes, cockroaches, rodents), environment such as air, water and land pollution and un-aesthetic appearance.

This issue of SWM has highlighted the biggest constraint of space in the city. Land is a scarce resource and finding adequate land in a city like Bangalore for disposing of garbage is likely to become even more difficult in the coming years. Adding to this, is the unavoidable truth that population and consumerism is all set to grow exponentially. By 2030, the average MSW in the city would is expected to rise by five times and locating more landfills would be nearly impossible. It is therefore, important to understand the current practices, the status of the initiatives taken up for collection and disposal and benchmarking with the best practices in other cities.

In this context, it is necessary to reduce the waste reaching the final disposal in large quantities. Hence there is a need to study current practice of primary collection system of solid waste management in Bangalore and suggest ways to achieve the objective of waste reduction.

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[13] H N Chanakya, T V Ramachandra and Shwetmala, 2005, Towards a Sustainable Waste Management system for Bangalore

[14] http://www.esgindia.org/sites/default/files/campaigns/press/esg-release-swm-pil-hc-kar-directions-22.pdf

1.3 PROFILE OF THE CITY

Bangalore, the capital of Karnataka State (77°37'19.54'' E and 12°59'09.76'' N) is the principal administrative, cultural, commercial, industrial, and knowledge capital of the State of Karnataka. It is one of India's fast developing city with an average annual growth rate of 3.25 % and population of 8.4 million (census 2011). It has an area of 800 sq. km and is situated at an altitude of 920 m above mean sea level. The salubrious climate all around the year has enabled in attracting the investment in technology and other sectors.

- Climate and Rainfall:

Due to its high elevation, Bangalore usually enjoys a more moderate climate throughout the year. The mean annual total rain fall is about 970 mm. The coolest month is January with an average low temperature of 15.1 °C and the hottest month is April with an average high temperature of 33.6 °C. Bangalore receives rainfall from both the northeast and the southwest monsoons and the wettest months are September, October and August, in that order.

- Wind Direction and Relative Humidity:

Winds blow mainly from the directions between the south – west and north – west during the south – west monsoon season. In the post monsoon season, wind blows mainly in the north easterly or easterly direction. During the rest of the year, wind blows from the direction between north and east. The maximum normal wind speed recorded at Bangalore is 17.5 km/hr in the months of May and July. The mean relative humidity varies from 24% to 86% at Bangalore IMD [India Meteorological Observatory].

- Administrative area and population growth

Bangalore city administrative jurisdiction was widened in 2007 by merging the 100 wards of Bangalore Mahanagara Palike with seven City Municipal Councils (CMCs), one Town Municipal Council (TMC) and 111 villages around the city to form a single administrative area of 800sq.km. For administrative purpose the city is divided into 10 zones, which is further divided into 198 wards.

With an estimated population of 8.4 million in 2011, Bangalore is India's third most populous city. As a growing metropolitan city in a developing country, Bangalore confronts substantial pollution and other logistical and socio-economic problems.

Table 1: Population growth of Bangalore

Census	Population	%
1941	406,760	—
1951	778,977	91.5%
1961	1,207,000	54.9%
1971	1,654,000	37.0%
1981	2,922,000	76.7%
1991	4,130,000	41.3%
2001	5,101,000	23.5%
2011	8,425,970	65.2%

Source: Census of India

1.4 ABOUT THE STUDY

Proper Solid Waste Management by the Urban Local Bodies is an important function to keep the environment clean, people healthy, attract investments and strengthen urban economy. Solid Waste Management has direct impact on urban housing market and affects all sections of the people. Its role in attracting people and investment is significant and therefore has impact on the growth of the city.

The partners for the proposed study will be the Centre of Excellence (CoE) in Urban Governance, IIM Bangalore and Centre for Sustainable Development (CSD), Bangalore.

Expected Outcomes from the study:

- A comprehensive report on the status of SWM in the selected wards, including processes of generation and collection of solid wastes and citizens' behaviour.
- A model system for primary collection based on a set of best practices of SWM.

1.5 OBJECTIVES

The objectives of this research study are as follows:

- To assess the quantum and the composition of MSW in selected wards of Bangalore.

- To undertake due diligence of the primary collection systems of MSW in selected wards, and identify the key issues and gaps hindering the collection process. This would include studying various practices tried by different groups.
- To study the behaviour of the citizen and identify their concerns and issues in storage, segregation and disposal of solid waste.
- To recommend model collection system and best practices to be followed during the collection system. Also, to suggest a suitable strategy for influencing behavior of citizens.

In the context of the aforementioned objectives, the study will be focused on two components: (i) prevailing processes of generation and management of solid waste in Bangalore; and (ii) citizen participation in managing solid wastes. Details of issues to be studied under each component of the study are listed below:

- Understanding prevailing processes of generation and management of solid wastes
- Current system of collection, segregation and disposal for individual households, apartments, gated communities, hospitals, hotels, markets, etc.
- Quantity, periodicity, contract agreement, processes
- Legal backup
- Recycling, composting, collection for animal feed, etc.
- Best practices in other cities in the country and other countries
- Main areas of weaknesses in the current system
- Citizen participation in solid waste management
- Attitude towards solid waste management, specifically segregation of solid waste
- Willingness to adopt best practices
- Willingness to pay for the waste disposal

1.6 METHODOLOGY

The study methodology includes the following steps:

1.6.1 Review of Literature

Comprehensive literature on SWM covering the research papers, studies, articles with reference to Bangalore was reviewed. Information was collected on best practices in solid waste management in other Indian and, international cities. Also some of the best practices (at a small scale) in Bangalore were reviewed.

Further, the relevant laws and rules on the subject viz. the Karnataka Municipal Corporation Act, 1976, the Environment Protection Act, 1986, the Municipal Solid Waste (Management and Handling) Rules, 2000, the SWM Policy for Bangalore, 2012, BBMP's Master Plan for Municipal Solid Waste Management in Greater Bangalore 2008 and the guidelines of the Supreme Court were also studied. Chapter 2 documents the literature and the best practices studied.

1.6.2 Selection of Study Area

Out of 198 wards, it was proposed that 5% of wards i.e., 10 wards would be chosen in the first phase of the study. The selection of wards was done considering different strata of citizens, institutions, locations, etc.

There are total 8 zones under BBMP jurisdiction. In order to get the status of solid waste management for the entire city, one ward per zone was selected. The selection of one ward per zone was done through random sampling method.

However, the selected wards from each zone have the following categories of waste generators in that particular ward:

- Residential population;
- Slums / areas around slums;
- Commercial establishments (hoteliers / marriage halls / convention centres /shopping malls);
- Markets (vegetables, fruits, meat);
- Institutions (hospitals, schools, colleges, etc.)
- Industries (including IT Parks)

The residential population consists of two categories: a) Individual dwellings and b) Apartments. The individual dwellings are of two categories: i) General and ii) Slums.

It is important to select the wards covering different strata of population generating varied type and quantity of waste in order to study behaviour of individual groups and to identify their individual concerns and issues is segregation, storage and disposal of waste. This would also help in understanding the existing level of participation and possible participation by the different categories of waste generators. Citizen's level of civic and environment awareness and their current satisfaction on the topic can also be achieved.

Out of the remaining two wards, one ward was selected from old areas of the city where there is maximum floating population, high density commercial areas and haphazard/unplanned dense development and the other ward was selected based on the best practices currently adopted in segregation, storage and disposal of waste.

The ten wards selected based on the above criteria are:

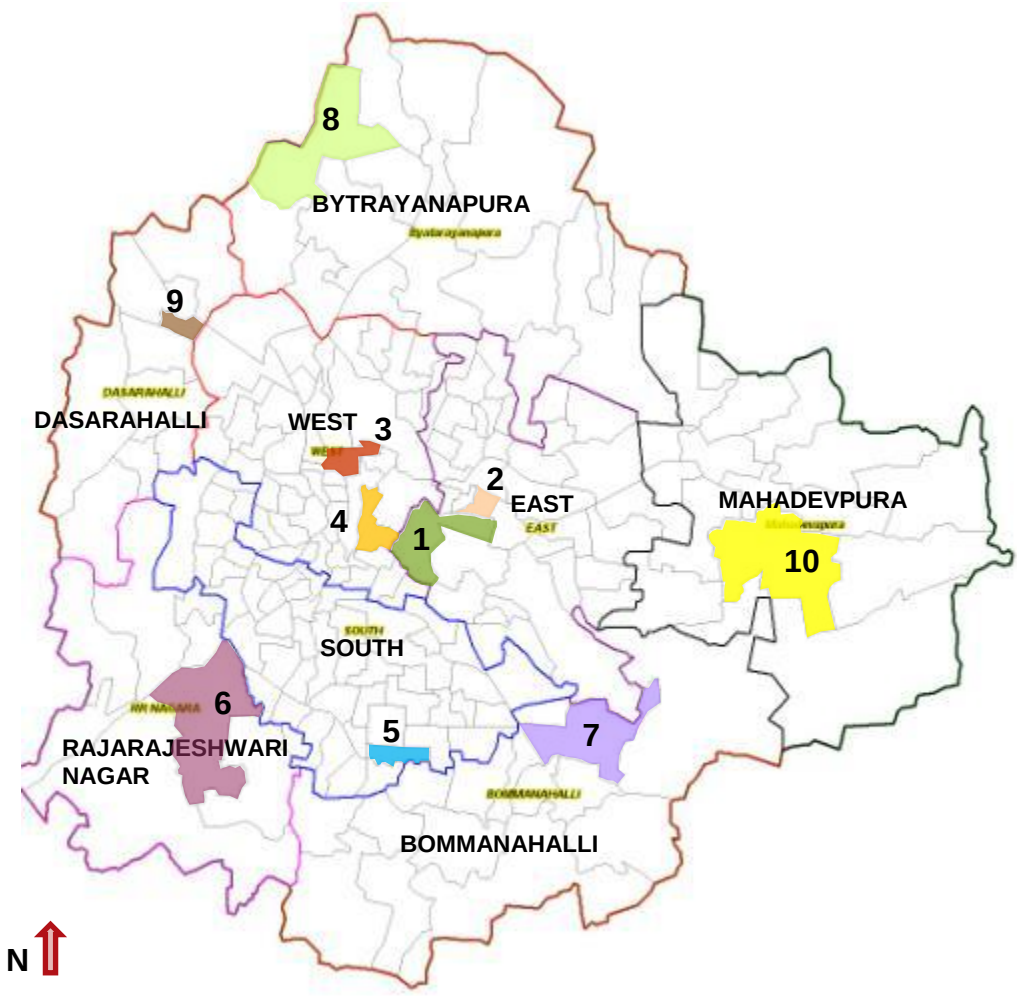
Table 2: Wards selected for the Study

Sl.No.	Ward Number	Ward Name	Zone	Area (sq.km)	Remarks
1	110	Sampangiram Nagar	East	4.45	Old city
2	91	Bharathi Nagar	East	0.78	Russell Market
3	65	Kadu Malleshwaram	West	11.36	Planned area
4	94	Gandhi Nagar	West	1.93	
5	178	Sarakki	South	1.34	
6	160	Rajarajeshwari Nagar	Rajarajeshwari Nagar	11.35	New area
7	174	HSR Layout	Bommanahalli	6.98	Apartments dominated
8	3	Atturu	Yelahanka/Bytrayanapura	10.13	
9	15	T.Dasarahalli	Dasarahalli	0.88	Apartments dominated
10	85	Doddanekkundi	8-Mahadevpura Zone	12.12	Apartments dominated

The ward selected from old areas of the city is Ward no. 110 Sampangiram Nagar and the ward selected based on best practices adopted is Ward No. 65 Kadu Malleshwaram. The selection of Ward no.65 was

based on the discussions with the BBMP officials, few NGOs and field visits made to the ward. The wards selected are indicated in the map below:

Figure 1: Map showing location of selected wards



The following information was collected from BBMP and other concerned authorities and organizations involved in MSWM of the selected wards for the study:

- Ward-wise population and area (population density)
- Ward-wise quantity and composition of waste generated
- Percentage break-up of waste generated from households, commercial establishments, markets, institutes, etc.
- System of collection from bulk waste generators like hotels, marriage/community halls, markets, slaughter houses, etc., if any.
- Coverage of door-to door waste collection system in each ward

- Number of employees assigned for door-to door collection out of total employees
- Any other group involved in door-to door collection like NGO's, RWAs, rag pickers, etc.
- Method of segregation of waste: at storage level, at collection level, etc.
- Quantum of segregation of waste at ward level
- Number of collection centres in each ward (for collection of segregated waste)

This information and other initiatives and programs taking place in the city have also been identified and described in Chapter 3 along with their pros and cons.

1.6.4 Process Mapping

Understanding and mapping the processes involved right from generation of MSW from various domains to storage, segregation, door-to-door collection, transportation, treatment and disposal of MSW. Process flow charts for all the selected wards are studied and analysis of areas where the performance is poor is identified and explained in Chapter 3.

1.6.5 Determining the quantum and composition of waste

An attempt was made to quantify the waste generated in selected wards. The list of secondary collection points was derived from the individual ward offices of the 10 selected wards. Secondary collection points in a ward are the points where the waste is brought from different sources like households, shops, institutions, etc. through different means like push carts, auto tippers or dropped by generators themselves. The number of secondary collection points in the selected wards varies from a minimum of 11 points to a maximum of 87 points. For collecting information on the quantity and composition of waste reaching these secondary collection points, random selection of 5 points from each of the selected wards was made. Data on quantity of waste reaching these secondary collection points was collected over a period of one month.

One of the ways to find out the quantum of waste generated per person per day was to know the population dumping the waste at that collection point. This information could be used to find out the amount of waste generated per person per day. If we knew this amount for each of the collection points in a ward, we could average out the quantity for the entire ward. When similar information was available for 10 wards, we could find the average waste produced/dumped per person per day for an average of 10 wards. This figure could be extrapolated to find the total quantity of waste generated for the entire city based on the total population.

However, it was not possible to find out the population catered to, by the selected secondary points, since waste from any ward is being dumped by the citizens.

Similarly in order to derive the composition of waste from the selected wards, Dry Waste Collection Centres (DWCC) set up by BBMP were identified. Out of the 10 wards selected for the study, dry waste collection centres have already been set up in 8 wards. Data from 3-4 of such DWCCs was collected. However the information is not in an orderly fashion and is limited to only a few dry waste items. This information would not be sufficient to find out the biodegradable contents of the waste, as these DWCCs are not receiving the entire dry waste produced in a particular ward and have various other means of escaping the waste stream. Hence it would not have given appropriate results on composition of waste.

A detailed survey needs to be conducted in order to derive the quantum and composition of waste generated in Bangalore.

In order to achieve the quantum and composition of waste, a study conducted by iDeCK in 2008 on Integrated MSW Strategy for Bangalore City was referred. The study was carried in 8 zones of Bangalore and the selected households contained the various categories, i.e., HIG, MIG, LIG and slum area. The sample waste generated was collected from 128 households for 7 days (896 samples). The composition of waste in the study was derived by taking the waste generated by the selected households as the sample for the study.

The data from this study was used to arrive at the organic and inorganic quantities of waste generated at household level.

1.6.6 Citizen's Survey

Objective of Citizen's Survey

To achieve the two objectives of understanding the primary collection systems of MSW in selected wards, and identifying the key issues and gaps hindering the collection process, citizen's survey was conducted in the 10 wards selected for the study. The purpose of conducting this survey was:

- To understand the extent and efficiency of doorstep waste collection service provided in each ward.
- To understand the level of segregation happening at household level and citizen's attitude about segregation, in general.

- Whether the segregated waste is being collected in an effective way to ensure mixing of waste does not happen.
- To understand the frequency of door-to-door collection of segregated / non-segregated waste in selected wards.
- To understand the extent and efficiency of street cleaning.
- Penalization, in case segregation is not done by various categories of households.
- People's satisfaction level with respect to solid waste management services.
- Identification of problems faced by the citizens.
- Extent and willingness of citizens to participate in keeping their locality clean.
- Level of involvement of different groups like RWAs, NGOs, etc. in segregation and door-to-door waste collection in selected wards.
- Willingness of citizens to pay for door-to-door collection of waste.

Method of sampling for citizen's survey

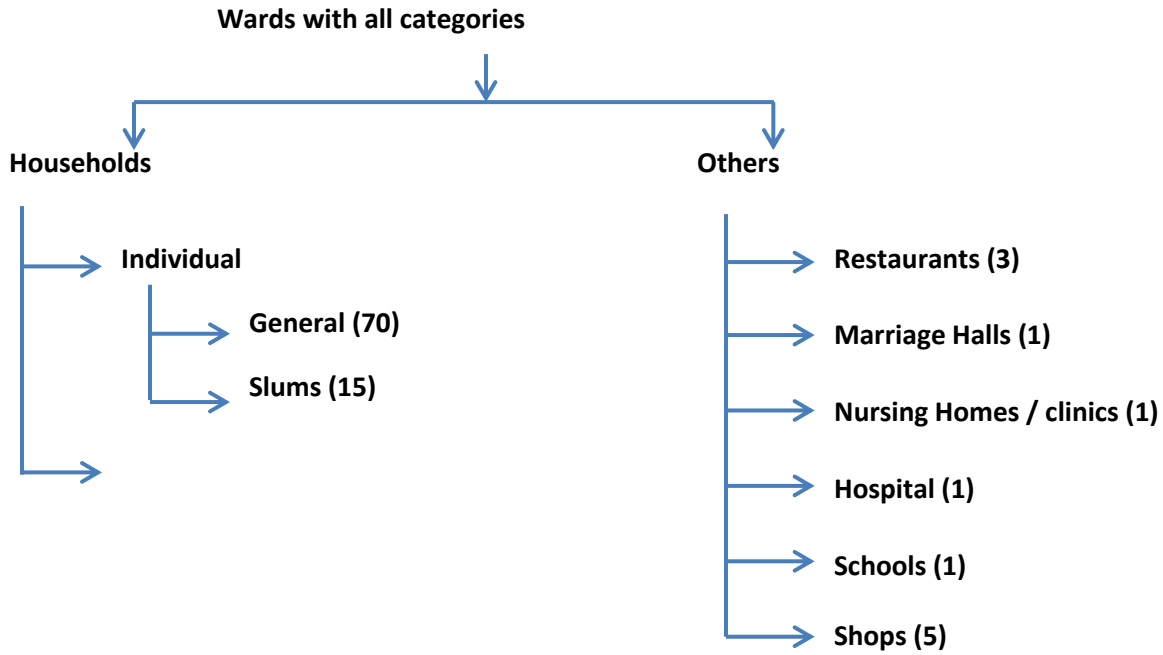
Stratified sampling was done in order to ensure different categories of citizen's generating varied composition of solid waste. The following categories were covered as part of the sampling:

1) Households
    i) Individual Households,
        a) General
        b) Slums
    ii) Apartments,
2) Restaurants,
3) Marriage Halls,
4) Nursing homes/ Clinics,
5) Schools,
6) Shops

Based on this, a sample of 1000 households was surveyed from the selected wards. From each ward 100 samples were randomly selected based on the presence of various categories in each ward.

For the wards with all the above categories, the distribution of the survey made was:

Figure 2: Distribution of survey samples across all categories



Note:

- Figures in bracket denote the number of samples covered
- In those wards where there are no slums or no apartments, the number of such samples shall be loaded onto Individual - General household
- Refer Annexure 1 for details of samples selected for all the 10 wards.
- Refer Annexure 2 for household survey questionnaire and Process mapping questionnaire

Data analysis plan to study the issues and problems in selected wards

In order to analyse the data collected from the surveys conducted in the 10 wards covering various categories of households and bulk waste generators, a data analysis plan was formulated. It consists of indicators for easy understanding of the level of service provided in the 10 wards. Handbook on Service Level Benchmarking by MoUD was referred. The following is the list of indicators on which the data collected is analysed:

Table 3: Indicators for data analysis

Sl No	Indicator	Unit	Remarks
I	Indicators for examining the due diligence of the primary collection of waste in selected wards		
1	Household level coverage of SWM services through door-to-door collection of waste	%	(Total number of households and establishments with daily door-to-door collection / Total number of households and establishments in the service area) * 100
2	Frequency of door-to-door collection of waste	%	Indicating percentage of households & establishments with daily / 6 days a week / alternate days collection of waste from doorstep
3a	Time of collection of waste from doorstep	graph	Percentage of households and establishments with morning /afternoon / evening door step collection
3b	Efficiency in collecting waste at a Fixed time	%	(No. of households and establishments covered at a fixed time daily / Total number of households and establishments in the service area) * 100
4a	Frequency of street cleaning	%	Indicating street cleaning on a daily basis/alternate day/twice a week/never
4b	Time of collection of waste from the streets	graph	Percentage of households and establishments with morning /afternoon / evening street cleaning
II	Indicators for studying the behaviour of citizen and their concerns and issues in storage, segregation and disposal of waste		
5	Method of disposal of waste by the households and establishments when there is no doorstep collection in their presence	graph	Percentage of households and establishments adopting various methods of waste disposal like keeping the waste near the gate / dispose waste on way to work / give to the maid for disposal
6	Extent of segregation of waste	%	(Total number of households and establishments segregating the waste/ Total number of households and establishments in the service area) * 100
7	% of segregated waste at	%	(No. of households and establishments from where

Sl No	Indicator	Unit	Remarks
	source being collected in a segregated manner by the service provider		segregated waste is collected and stored in a segregated manner / number of households and establishments segregating the waste)* 100
8	Graph showing various reasons by households & establishments for not segregating the waste at source	graph	Indicating percentage of people giving various reasons like lack of awareness / lack of proper ways of collecting segregated waste / too much effort / following others in the locality. To identify the reasons and thereby think of solutions to improve segregation at source
9a	Satisfaction level of the people with respect to doorstep collection of waste	graph	Percentage of households and establishments with various satisfaction levels (fully / partially / dissatisfied/ highly dissatisfied
9b	Satisfaction level of the people with respect to collection of waste from the street in their locality	graph	Percentage of households and establishments with various satisfaction levels (fully / partially / dissatisfied/ highly dissatisfied
9c	Satisfaction level of the people with respect to street sweeping in their locality	graph	Percentage of households and establishments with various satisfaction levels (fully / partially / dissatisfied/ highly dissatisfied
III	Indicators for people's awareness and participation		
10a	Percentage of households and establishments participating in any form of awareness program	%	(Number of households and establishments participating in any form of awareness program / Total number of households and establishments in the service area) * 100
10b	Different awareness programs in which households and establishments have	graph	Percentage of households and establishments participating in different types of awareness programs like attending seminars/ registering complaint / participating in RWA meeting / coming across a campaign for waste

Sl No	Indicator	Unit	Remarks
	participated		segregation
11	Level of awareness and interest in participation by households and establishments in improving the solid waste management at Bangalore	graph	1. Awareness about extent of solid waste management problem in Bangalore 2. Awareness about change in way waste is managed 3. Awareness about importance of waste segregation at source 4. Willingness to pay for better waste management 5. Awareness about citizen's responsibility in keeping the city clean 6. Opinion on ways of ensuring effective waste segregation 7. Opinion on ways of ensuring effective waste treatment for resource recovery

The data collected from the survey was tabulated and compiled in Chapter 5 to generate the above indicated charts for analysis purpose.

1.6.7 Discussions with other stakeholders

The other method to achieve Objective 3 is to discuss waste management practices adopted by involving various categories of waste generators like hoteliers/ marriage halls/ convention centres, markets/shop owners, hospitals, educational institutes, builders (construction waste), contractors, etc. This method is ideally suited to understand the behaviour and attitude of bulk waste generators towards maintaining a solid waste free environment for the city.

The purpose of these discussions was

- To understand the method adopted by individual groups to store, segregate and dispose the waste and the problems faced by them regarding the same
- Method of in-house waste processing, if any, to minimize the waste going out of the premises
- Willingness of bulk waste generators to adopt best practices in waste disposal
- Willing to pay for the services provided by the municipal authorities

The shops and bulk waste generators were covered as part of the primary survey. The data collected for shops and bulk waste generators was analyzed based on the indicators tabulated above. One to one meetings were also conducted with NGOs, contractors and hoteliers during the study to understand the various systems and problems pertaining to those.

1.6.8 Analysis and report writing

Studying and analysing the data collected from secondary sources regarding quantum of waste generated vis-a-vis effective management of the waste within that area so that it remains clean throughout. The study includes qualitative and quantitative analysis of level of services provided by different groups involved in segregation and door-to-door collection of MSW. It includes study of process mapping of solid waste management in the city and its various lacunae. The results obtained from the citizens' survey are analyzed.

Thereafter, suitable recommendations are formulated based on the findings from the study. The analysis and recommendations are presented in a report.

2. LITERATURE REVIEW

2.1 INSTITUTIONAL FRAMEWORK (LEGAL)

Judicial Intervention to Improve the System

A public interest litigation was filed by Mrs. Almitra H. Patel and another in The Supreme Court of India in the year 1996 (Special Civil Application No. 888 of 1996) against the Government of India, all state governments and several municipal authorities in the country alleging that they have failed to discharge their obligatory duty to manage municipal solid waste appropriately. The Supreme Court set up an Expert Committee, which deliberated on the issue after consulting 300 municipal authorities in class I cities and other stakeholders by holding regional workshops in Mumbai, Delhi, Chennai, and Kolkata. It submitted its report to the Supreme Court in March, 1999 making detailed recommendations, which were circulated to all the class I cities and various stakeholders through the Government of India with interim directions for implementation.

To ensure compliance, the principal recommendations of the Supreme Court appointed Committee have been incorporated in the Municipal Solid Waste (Management and Handling) Rules 2000 notified by the Ministry of Environment and Forest in September 2000[15].

Municipal Solid Waste (Management and Handling) Rules 2000

Looking at the problems in managing the solid waste of many Indian cities, the Ministry of Environment and Forest notified Municipal Solid Waste (Management and Handling) Rules 2000 after widely circulating the draft rules in 1999 inviting objections and suggestions if any. The municipal bodies are responsible for following the Rules which give guidelines on conducting door-to door collection, segregation, transportation, disposal and treatment of solid waste. It has also given guidelines on conducting public awareness campaigns and segregation at source. Reduce-Reuse-Recycle is the key to achieving efficient waste management. The Rules are mandatory for all municipal authorities in the

[15] *Asnani, P. U., 2006. Solid Waste Management. Chapter 8 in India Infrastructure Report. Oxford University Press, New Delhi.*

country, irrespective of their size and population, to implement the rules. To improve the systems the following seven directives are given.

1. Prohibit littering on the streets by ensuring storage of waste at source in two bins; one for biodegradable waste and another for recyclable material.

2. Primary collection of biodegradable and non-biodegradable waste from the doorstep, (including slums and squatter areas) at pre-informed timings on a day-to-day basis using containerized tricycle/handcarts/pick up vans.

3. Street sweeping covering all the residential and commercial areas on all the days of the year irrespective of Sundays and public holidays.

4. Abolition of open waste storage depots and provision of covered containers or closed body waste storage depots.

5. Transportation of waste in covered vehicles on a day to day basis.

6. Treatment of biodegradable waste using composting or waste to energy technologies meeting the standards.

7. Minimize the waste going to the land fill and dispose of only rejects from the treatment plants and inert material at the landfills as per the standards laid down in the rules.

The rules are to be implemented and monitored in a time bound manner (Table 1).

Table 4: Timeframe for implementation of the Rules

S.No.	Compliance criteria	Schedule
A	Setting up of waste processing and disposal facilities	By 31 December 2003 or earlier
B	Monitoring the performance of waste processing and disposal facilities	Once in six months
C	Improvement of existing landfill sites as per provisions of these rules	By 31 December 2001 or earlier
D	Identification of landfill sites for future use and making site(s) ready for operation.	By 31 December 2002 or earlier

Compliance of the Rules

These Rules are being followed to some extent in many cities, but the problem persists. This is because the municipal bodies have implemented the guidelines in bits and pieces. Some cities have improved the waste collection from the streets, some have emphasized on door-to-door waste collection and street sweeping. A few have implemented sanitary disposal methods at dumping sites. Segregation is implemented in some pockets of various cities. Due to lack of comprehensive implementation and enforcement of Rules, the system on the whole is still facing many problems and even after putting in tremendous efforts across all those who are responsible, the Indian cities still remain filthy and unhygienic.

In India Infrastructure Report 2006, Asnani has listed the constraints in compliance of the Rules. As per municipalities, compliance in waste collection is constrained by:

- lack of public awareness, motivation, education;
- lack of wide publicity through electronic and print media;
- lack of finances to create awareness;
- resistance to change;
- difficulty educating slum dwellers;
- lack of sufficient knowledge on benefits of segregation;
- non-cooperation from households, trade and commerce;
- unwillingness on part of citizens to spend on separate bin for recyclables;
- lack of litter bins in the city;
- non availability of primary collection vehicles and equipment;
- lack of powers to levy spot fines;
- lack of financial resources for procurement of tools and modern vehicles.

In creating treatment and disposal facilities, the constraints outlined were:

- paucity of financial resources as well as lack of support from state government;
- non-availability of appropriate land;
- prohibitive time and cost considerations in land acquisition and implementation of treatment and landfill technologies;
- lack of technical knowhow and skilled manpower for treatment and disposal of waste;
- low quality of municipal solid waste;
- delay in clearance of disposal sites.

2.2 ORGANIZATIONAL STRUCTURE

Institutional set up in India

In India, the law sets out in a very specific manner how solid waste should be managed. Solid waste management is a state function; however, the central government has powers to enact laws and frame rules for environmental protection. Accordingly, the Government of India has enacted Environment Protection Act 1986 (EPA) and under the provisions of this act has framed rules for managing and handling municipal solid waste, biomedical waste, hazardous waste, and so on.

Management of municipal solid waste is covered in all state laws pertaining to municipal governance, but all the issues relating to SWM are not adequately addressed in state laws. The government of India has, therefore, framed uniform rules, the Municipal Solid Waste (Management and Handling) Rules 2000, pursuant to the EPA and has made it mandatory for all municipal authorities in the country to implement those rules within the prescribed time frame.

Table 5: SWM Institutions and Functions

Responsible institution	Roles and responsibilities in SWM
Central government	Make laws and rules; frame policies; prepare guidelines, manuals, and technical assistance; provide financial support; monitor implementation of laws and rules.
State government	Make state-level laws and rules; frame policies; prepare guidelines, manuals, and technical assistance; provide financial support; monitor implementation of laws and rules.
Municipal authorities and state government	Plan for SWM treatment facilities.
Municipal authorities	Collect, transport, treat, and dispose of waste.
Municipal authorities with the approval of state governments	Frame bylaws; levy and collect fees.
Municipal authorities and state and central governments	Finance SWM systems.

Urban Local Bodies: A Key Player in India

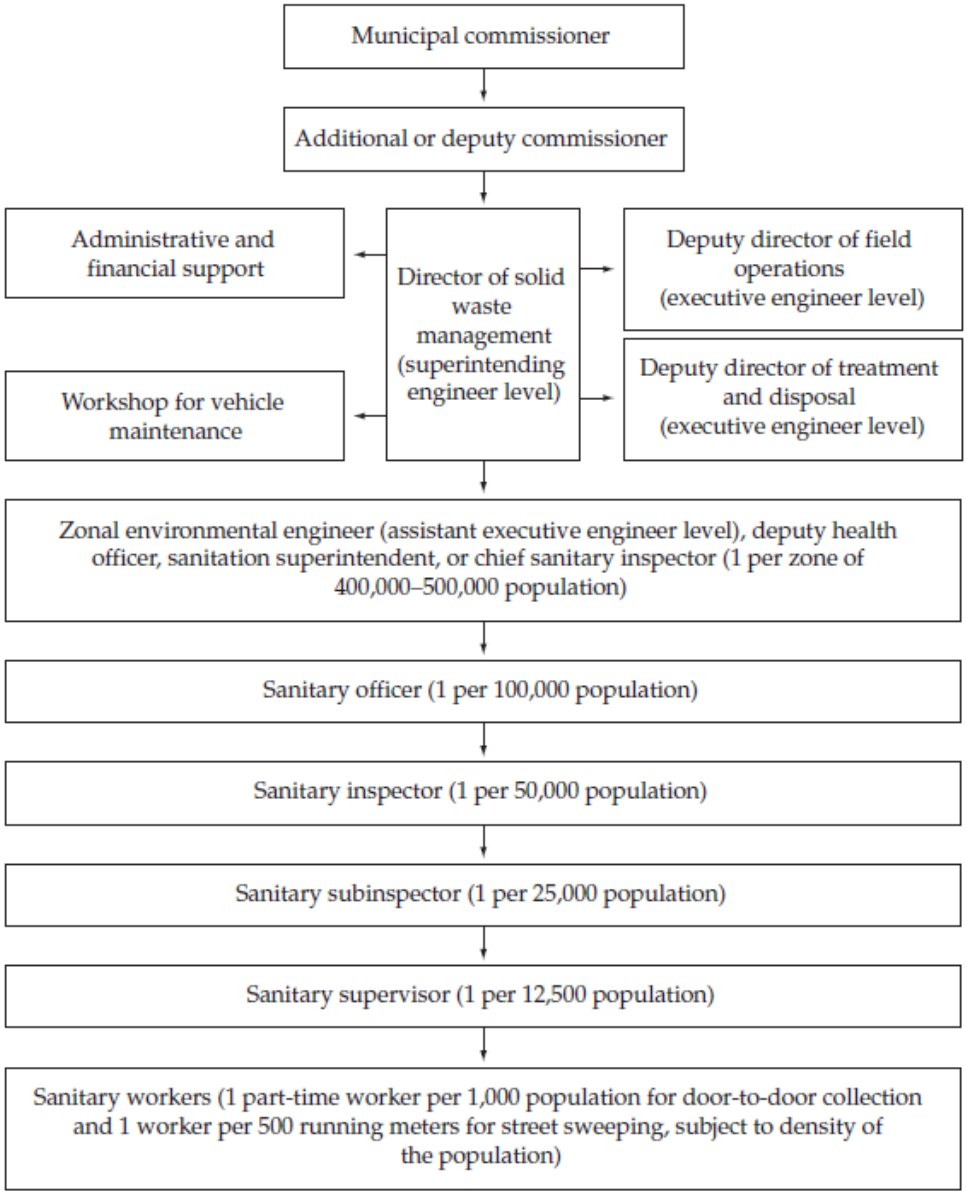
In most cases, SWM is a responsibility of the local authorities. Municipalities are therefore responsible for collection, sweeping, storage, transfer, treatment, and final disposal of waste. In many cases, however, the provision of this service is not efficient, and the providers are not accountable to the residents and business establishments they serve. Another typical problem is that SWM services come under municipal departments without the expertise to handle them, such as public health departments. In only a few large cities are engineers in charge of SWM systems, but they are not necessarily environmental engineers with experience in such systems.

Professionalization of SWM

A step needed to improve SWM systems in India is to upgrade the profession of those working with waste. Most often, the profession is neglected and seen as very low status, ignoring the importance such a crucial job has for the well-being of the population. Professionalizing the solid waste sector means building the capacity of workers to perform more effectively and efficiently given the existing conditions.

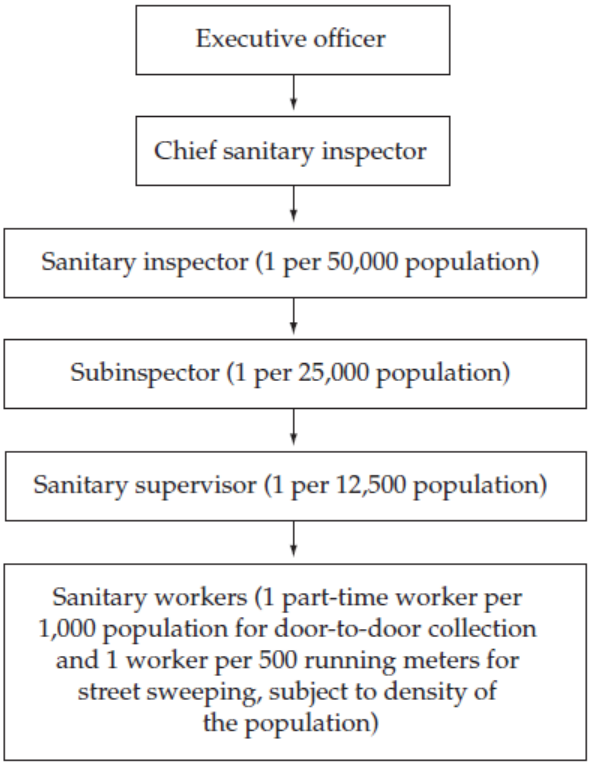
It also means that workers will perform their duties in a safe environment under healthy conditions, such as being provided with proper clothing and proper equipment to perform the job. Training, motivation, incentives for outstanding service, and disincentives for those who fail to perform are essential for human resource development.

Figure 3: Large Municipal Corporation - population above 20 lakh



Source: Ministry of Urban Development May 2000

Figure 4: Municipality - population > 1 lakh



Source: Ministry of Urban Development May 2000

The Supreme Court's expert committee on SWM has recommended hiring the following professionals in municipal services to scientifically manage municipal solid waste:

- One superintending engineer (public health or environmental engineer) per 2 million population
- One executive engineer (public health or environmental engineer) per 1 million population
- One assistant executive engineer (public health or environmental engineer) per 500,000 population
- One assistant engineer per 250,000 population
- One qualified diplomat chief sanitary inspector per 100,000 population
- One qualified diplomat sanitary inspector per 50,000 population or part thereof
- One qualified diplomat sanitary sub-inspector per 25,000 population or part thereof
- One sanitary supervisor (mukadam, who can read, write, and report) per 12,500 population or part thereof

The Manual on Solid Waste Management (Ministry of Urban Development and Poverty Alleviation 2000), which was developed by the Central Public Health and Environmental Engineering Organization (CPHEEO), recommends the following deployment of human resources in India:

Door-to-Door Collection

Given the local conditions of narrow lanes and the availability of a low-cost workforce, deploying people rather than machinery for door-to-door collection of waste is appropriate. One sanitation worker can provide door-to-door collection service to an average 1,000 people or 200 houses or shops in just four hours. This number varies depending on population density. In high-density areas, a part-time worker can cover even 300 houses, whereas in low-density, posh residential areas, one worker may cover only 125 to 150 houses.

A vehicle such as a pickup van can be deployed for door-to-door collection in areas with a hilly terrain or in flat areas that do not have an adequate labor force. In such cases, a small van or other vehicle can cover 1,000 to 1,500 households and shops. One driver and one or two sanitary workers should be sufficient in such instances.

Indian culture requires that garbage be removed from the house in the morning. Therefore, four hours' deployment of labor for door-to-door collection is considered adequate.

Street Sweeping

According to the norms for street sweeping, city streets need to be grouped into three categories: high density, medium density, and low density. Sanitation workers are allotted a length of street in accordance with the following norms prescribed in the Manual on Solid Waste Management (Ministry of Urban Development and Poverty Alleviation 2000):

- High-density area = 250 to 350 running meters of road length
- Medium-density area = 400 to 600 running meters of road length
- Low-density area = 650 to 750 running meters of road length

SWM services must be provided on all days of the year, including Sundays and public holidays. Therefore, 17 percent additional staff is necessary to provide substitutes for weekly days off of the usual workforce. This additional staff must be built into the SWM system. Moreover, additional workers may be needed if the staff is absent or on leave for other reasons so that the continuity and reliability of service can be maintained.

2.3 TECHNOLOGY OPTIONS

The main technological options available for processing/ treatment and disposal of MSW are composting, vermicomposting, anaerobic digestion/biomethanation, incineration, gasification and pyrolysis, plasma pyrolysis, production of Refuse Derived Fuel (RDF), also known as pelletization and sanitary landfilling/landfill gas recovery. Not all technologies are equally good. Each one of them has advantages and limitations.

Composting projects in India

There are many small and large composting projects in the country though the exact figure is not known. The treatment capacity designed for these facilities in large cities ranges from 100–700 TPD.[16] Many have been closed down or are functioning at a lower capacity. Those functioning are generally being managed by the private sector through a contractual arrangement with municipal authorities. Most of the plants are facing a problem of marketing the compost due to an ineffective marketing mechanism.

The capital investment requirement for such projects is typically in the range of Rs.10 to 20 million per 100 MT per day plant depending on sophistication.

Composting Technologies

Organic matter constitutes 35-40% of the municipal solid waste generated in India. Composting is the controlled decomposition of complex organic materials by microorganisms such as fungi and bacteria that convert degradable organic waste into humus like substance. This finished product, which looks like soil, is high in carbon and nitrogen and is an excellent medium for growing plants. Apart from being clean, cheap, and safe, composting can significantly reduce the amount of disposable garbage. The organic fertilizer can be used instead of chemical fertilizers and is better specially when used for vegetables. It increases the soil's ability to hold water and makes the soil easier to cultivate. It helps the soil retain more of the plant nutrients.

Although decomposition occurs naturally, composting facilities are designed to speed the rate of biological decomposition by managing key parameters, including moisture content, oxygen,

[16] *Asnani, P. U., 2006. Solid Waste Management, Chapter 8 in India Infrastructure Report. Oxford University Press, New Delhi.*

temperature, and the ratio of carbon to nitrogen. Aerobic Composting employs oxygen as part of the decomposition process.

Main advantages of composting include improvement in soil texture and augmenting of micronutrient deficiencies. It also increases moisture-holding capacity of the soil and helps in maintaining soil health. Moreover, it is an age-old established concept for recycling nutrients to the soil. It is simple and straightforward to adopt, for source separated MSW. It does not require large capital investment, compared to other waste treatment options. The technology is scale neutral.

Composting is suitable for organic biodegradable fraction of MSW, yard (or garden) waste/waste containing high proportion of lignocelluloses materials, which do not readily degrade under anaerobic conditions, waste from slaughterhouse and dairy waste.

This method, however, is not very suitable for wastes that may be too wet and during heavy rains open compost plants have to be stopped. Land required for open compost plants is relatively large. Also, issues of methane emission, odour, and flies from badly managed open compost plants remain.

At the operational level, if waste segregation at source is not properly carried out, there is possibility of toxic material entering the stream of MSW. It is essential that compost produced be safe for application. Standardization of compost quality is, therefore, necessary. The MSW (Management and Handling) Rules 2000 (MSW Rules 2000) have specified certain limits to acceptable percentage of heavy metals in compost produced from MSW and a mechanism is put in place to ensure that the same are strictly implemented.

Marketing of compost is a major concern for private operators. Lack of awareness among the farmers regarding the benefits of using compost is an impediment to its sale. Also, there is a need to market the product near the compost site to minimize transportation cost.

Composting facilities use two basic methods to introduce air.

Windrow systems: Windrow composting is the most common method of composting in India; it involves the stabilization of organic solid waste through aerobic decomposition. Windrow composting facilities can efficiently handle large quantities of waste in comparison to vermicomposting.

This type of facility is where material is composted in long piles (windrows) on a flat site. Windrows are kept porous mechanically by turning the material periodically. If piles are not turned often enough, the center of the pile may not receive enough oxygen, producing strong, unpleasant odors.

Aerated static pile systems: In this type, air is introduced into a large pile through air duct systems installed beneath the base of the pile. Aeration can be positive, blowing up through the pile; or negative, drawing air down through the pile. Negative aeration has the added capability of exhausting the processed air through odor scrubber systems when necessary. In general, aerated static pile systems have higher capital costs but lower overall operating costs than windrow systems.

A turned-aerated pile system combines both of the above technologies for more consistent process control and product quality.

Vermi composting: This uses worms to achieve controlled composting of organic wastes. Worms digest organic materials. In addition to significantly reducing the quantity of waste material, the end product can be used as an organic fertilizer.

Compared to other composts, this has a finer texture, do a better job of enhancing the soil, have typically higher levels of nitrogen, potassium and phosphorous, and have more microorganisms to fight diseases in plants.

Green waste composting: Green waste consists of leaves, brush, tree trimmings, grass, garden waste, shrubs and materials generated by nurseries, public gardens, and individual citizens. Green waste usually does not require much preprocessing to remove contaminants. Only impurities such as plastic bags, wire or rope may be removed by hand. Reducing the size of brush and tree trimmings facilitates handling and speeds the composting process. The composting process can be further enhanced if leaves are also pre-shredded. The nutrient level in green waste is generally high and it is marketed easily.

Mixed solid waste (MSW) composting: Paper, food scraps and green waste make up the compostable portion of the mixed municipal solid waste. However, mixed waste also includes non-biodegradable items such as plastics and metals. The quality of the compost product will depend on the degree to which non-compostable items are removed in the process. Generally, separating contaminants early in the process result in higher quality compost. Material Recovery Facilities allow us to process mixed municipal solid waste to recover recyclable materials. This is done in various ways. The simplest consists of conveyors systems from which useful material is picked up through manual labor. More sophisticated facilities use shredders, conveyors, screens, and magnets to separate components of the waste. Some facilities also use devices that use forced air to separate the light burnable fraction from the remaining inert material. Computerized equipment is sometimes used to recover and segregate aluminum, paper, glass, and plastic. These are all expensive. The best solution is to get segregated waste for processing.

Composting technologies have an added advantage of producing fertilizers which can be conveniently sold to nearby rural areas. The composting technologies can create large scale employment in the urban areas, without putting any financial burden on the city administration.

Biomethanation plants in India

Recently a 5 MW power plant based on biomethanation technology was constructed and operationalized at Lucknow but unfortunately it had to be closed down for various reasons, one among them being non-supply of appropriate quality of MSW to the plant. The organic content in the waste supplied to the plant is reported to have been as low as 15 per cent.

Biomethanation technology on a small scale is also functioning at Vijayawada and at other places in the country for the treatment of selected organic waste collected from canteens, vegetable markets, etc.[17]

Anaerobic digestion and Biomethanation

Biomethanation is a comparatively well-established technology for disinfections, deodorization and stabilization of sewage sludge, farmyard manures, animal slurries, and industrial sludge.

This is a biological process that occurs in the absence of oxygen. Anaerobic processes can either occur naturally or in a controlled environment. The organic waste is put in an airtight container called a digester where decomposition begins.

Its application to the organic fraction of MSW is more recent and less extensive. It leads to bio-gas/power generation in addition to production of compost (residual sludge). This method provides a value addition to the aerobic (composting) process and also offers certain other clear advantages over composting in terms of energy production/consumption, compost quality and net environmental gains.

This method is suitable for kitchen wastes and, other putrescible wastes, which may be too wet and lacking in structure for aerobic composting. It is a net energy-producing process (100–150 kWh per tonne of waste input). A totally enclosed system enables all the gas produced to be collected for use. A modular construction of plant and closed treatment needs less land area. This plant is free from bad odour, rodent and fly menace, visible pollution, and social resistance. It has potential for co-disposal with other organic waste streams from agro-based industry. The plant can be scaled up depending on the availability of the waste.

[17] *Asnani, P. U., 2006. Solid Waste Management, Chapter 8 in India Infrastructure Report. Oxford University Press, New Delhi.*

However, this method is suitable for only the organic biodegradable fraction of MSW; it does not degrade any complex organics or oils, grease, or ligno-cellulosic materials such as yard waste. Similar to the aerobic composting process input waste needs to be segregated for improving digestion efficiency (biogas yield) and the quality of residual sludge.

While the liquid sludge can be used as rich organic manure, either directly or after drying, its quality needs to be ensured to meet statutory standards. No grinding of waste material should take place. Wastewater generated in the plant requires treatment before disposal to meet statutory standards. Biogas leakage poses a small environmental and fire hazard. This plant is more capital intensive than aerobic composting.

Waste-to-Energy Projects in India[18]

There are no WTE mass burn combustion plants currently in operation in India. Only two such plants were built in India until now. The latest one among them has finished construction on the Okhla landfill site, New Delhi and is about to start operations. An earlier WTE plant, which was built in Timarpur, New Delhi is not in operation anymore. The two WTE plants in Hyderabad and Vijayawada are not mass burn combustion. They combust RDF produced after considerable processing of MSW, and addition of secondary biomass fuels like rice husk. Therefore they are RDF-WTE plants.

There are 6 RDF plants in India, near Hyderabad, Vijayawada, Jaipur, Chandigarh, Mumbai and Rajkot. The plant in Vijayawada used to serve the city of Guntur too. The Hyderabad and Vijayawada plants handled 700 TPD and 500 TPD of MSW to generate 6 MW of electricity respectively. RDF produced in these plants was combusted in specifically designed WTE boilers. Both these facilities are currently not in operation.

The RDF plants near Jaipur and Chandigarh combust the RDF produced in cement kilns to replace fossil fuels. They handle 500 TPD of MSW each. The plant is not operated regularly. The plant in Chandigarh is known to have been dormant too, but it is being retrofitted with MSW drying systems to reduce moisture in the final RDF.

[18] *Annepu, R. K., 2012, Sustainable Solid Waste Management in India, downloaded from: http://swmindia.blogspot.in/*

The RDF plant in Rajkot handles 300 TPD of waste. Its present operational status is unknown too. It is the same case with the small scale RDF plant in Mumbai, which produces RDF pellets by processing 80 TPD of MSW.

Waste-to-Energy technologies

Waste-to-energy (WTE) facilities dispose solid waste or recover energy through mass burning, refuse-derived fuel incineration, pyrolysis, or any other means of using the heat of combustion. A volume reduction of 90 percent is typical for these facilities; the unburned waste fraction (ash) continues to require landfill disposal or may, in certain circumstances, be recycled into useful products such as bricks or concrete.

The energy generated can be used to offset the initial capital and operating costs of a waste to- energy facility. The three general types of waste-to-energy facilities include mass burn incinerators, refuse derived fuel facilities, and pyrolysis facilities. Mass burn incinerators: Mass burn incinerators burn mixed municipal solid waste at very high temperatures with limited preprocessing. In some cases, additional preprocessing is added to remove materials for recycling or other materials that may cause ash contamination, damage equipment, or contribute to toxic air emissions. To control temperature, air is allowed to enter the combustion chamber at a volume and rate significantly greater than that needed for combustion (excess air). Most incinerators produce steam, which is then used either for heating, industrial processes, or electricity generation.

RDF facilities: Refuse derived fuel (RDF) facilities process solid waste into a relatively homogeneous fuel with a uniform particle size and defined moisture content, suitable for burning in conventional boiler systems. A typical plant would have an extensive system for material recovery. An unusable fraction is disposed at a landfill. RDF can be prepared as shredded fluff or compressed pellets. After processing, RDF is typically burned in a dedicated combustion unit directly affiliated with the processing area, or sold to an electric utility or an industrial customer.

Pyrolysis: Pyrolysis is the process of decomposing materials with heat in an oxygen deficient atmosphere. In a pyrolytic gasification facility, waste would be preprocessed to remove materials, such as metals, that cannot be decomposed. The waste would then be dried and transported to a chamber where it would be exposed to radiant heat tubes in an oxygen-free atmosphere. The heat reduces the waste into basic components: gases, (methane, ethane, hydrogen, and carbon monoxide); liquids (oil and tar); and solids (char and carbon black). The gases can be cleaned and used as a fuel for other

purposes or transferred back to the chamber where it would be used to heat the radiant tubes. Solid residues are land-filled. There is reason to believe that pyrolysis can provide more complete combustion than mass burn or RDF technologies. More complete combustion reduces the levels of some pollutants in emissions from the facility. The main uncertainty of pyrolysis for handling municipal solid waste is that economic and technical feasibility have not yet been demonstrated on a full-scale commercial basis. More development is needed to make this technology commercially viable.

Conclusion

All incineration based technologies are capital intensive and also costly to operate. In addition concerns about emission control, ash disposal, long term regulatory issues, have not been fully addressed. During the process some of the ash floats out with the hot air. This is called fly ash. Both the fly ash and the ash that is left in the furnace after burning have high concentrations of dangerous toxins such as dioxins and heavy metals. Disposing of this ash is a problem. The ash that is buried at the landfills leaches the area and cause severe contamination. Burning garbage is not a clean process as it produces tons of toxic ash and pollutes the air and water. A large amount of the waste that is burnt here can be recovered and recycled. In fact, at present, incineration is kept as the last resort and is used mainly for treating the infectious waste. In addition, the quality of municipal waste of a typical Indian city makes them less suitable for disposal by incineration as compared to other simpler composting technologies.

2.4 PRIVATE SECTOR PARTICIPATION

Solid waste management (SWM) is a mandatory duty of all municipal authorities in the country. They spend a significant proportion of their total budget on it, yet service is very poorly performed, with treatment and disposal getting the least attention.

The many attempts to reform the public authorities in order to improve the reliability and efficiency of services have shown limited or no effect. The pathetic situation makes it necessary for the municipal authorities to seriously consider solutions that are “outside the box” to improve services. One option is to involve the private sector more extensively in providing services, with the municipal authority moving from being a service provider to being a regulator and service facilitator. Experience in many countries shows that, in certain circumstances, involving the private sector can significantly improve SWM service quality.

Reasons for Involving the Private Sector

According to India's constitution, SWM falls within the purview of the state government.

The activities are local ones and are entrusted to urban local bodies (ULBs) through state legislation. Because these activities are nonexclusive, non-rival, and essential, the responsibility for providing them lies within the public domain. ULBs accordingly undertake the task of SWM service delivery.

However, many municipal authorities in India provide SWM services very inefficiently. Old and inappropriate vehicles and tools for collection, inadequate transport, and inefficient disposal not only cause unhygienic working conditions and slow down the process but also severely affect the environment. Productivity is very low, resulting in a high unit cost of service. Collection coverage rates are only 50 to 70 percent.[19] The collected waste is disposed of at open dumping grounds within or outside cities, causing health hazards and environmental degradation.

Enabling improvements through the participation of the private sector depends on the political will for change; clear agreements and contracts; the public authority's ability to regulate the service, monitor performance, and enforce the terms of agreement; financial capacities; and mutual trust between all partners.

Service contracts

Contracts are generally given for door-to-door collection of waste in the morning hours with or without the equipment of the contractor. This activity is labour intensive and generally taken up by small contractors or NGOs at a low cost. Cities of Bangalore, Ahmedabad, Nagpur, Jaipur, North Dumdum, New Barrackpore (West Bengal), Gandhinagar, Vejalpur (Gujarat) are some examples.

Different models are adopted in different cities. At some places, contracts are given to private operators for doorstep collection and transportation based on wards allotted to each contractor, who appoints his own manpower, uses his own tools, vehicles and equipment and is paid per month by the municipal corporation for the services rendered (for example, Bangalore, Jaipur, and Nagpur). In other cases, contracts are awarded to NGOs for door-to-door collection and supervision only against a monthly payment (for example, Vejalpur). In some towns contracts are given to NGOs or individuals to collect the waste from door-to-door but the contractor is expected to recover the user fee from the citizens directly as prescribed by the local body (examples would be Gandhinagar, North Dumdum, New Barrackpore, etc.). In Ahmedabad door-to-door

[19] *Zhu, D. et al., 2008. Improving Municipal Solid Waste Management in India: A Sourcebook for Policy Makers and Practitioners. World Bank Institute (WBI) Development Studies.*

collection is entrusted to resident welfare associations and associations of backward classes and they are given a monthly grant for supporting sanitation workers and annual grants for purchase of tools, etc. Contract packages are made by municipal authorities keeping in mind the work to be done and the minimum wages payable under the law. The contractor is paid per month on the basis of the number of houses served.[20]

Street sweeping

Street sweeping contracts are less common. They are generally given to cover un-served and newly developed areas. Payments are made per km area served or on the basis of unit area fixed for street sweeping. Surat was perhaps the first city to award contracts for brushing the streets at night after the plague in 1994 and transformed the city into one of the cleanest in India. Following this example, Hyderabad has successfully outsourced the sweeping of 75 per cent of its streets using 161 small contracts, applying a unique unit area method of 8 km road length per 18 sanitation workers.

Secondary storage and transportation

Municipal authorities enter into secondary storage and/or transportation contracts to avoid investing in vehicles and equipment and to avail of a more efficient system. In such an arrangement, the private firms provide containers and/or vehicles with drivers as well as fuel. The onus of maintaining the fleet of vehicles also lies with them. Such contractors are either paid per trip to the treatment/disposal site or per tonne of waste transported (examples can be found in Ahmedabad, Surat, and Mumbai).

Opportunities and Challenges in Private Sector Involvement

The overall objective of involving the private sector is to achieve an improvement in SWM service and to extend coverage to the yet unserved. Delegating tasks and responsibilities to the private sector, however, also entails new challenges for all.

All critical factors must be taken into account to prevent misuse or failure of private sector participation. The advantages and disadvantages of involving the private sector strongly depend on the manner in which the tasks and service are contracted out and on the way the daily operational procedures of collaboration between public and private sector are handled and ensured.

[20] *Asnani, P. U., 2006. Solid Waste Management, Chapter 8 in India Infrastructure Report, Oxford University Press, New Delhi.*

Opportunities

Some examples of characteristics of the private sector that offer possible opportunities follow:

Flexibility:

- The private sector can easily hire qualified staff members and pay the salaries those experts demand.
- Salaries and bonuses can be based on staff performance, thus also providing incentives for efficiency and good work.
- Employment is easily terminated when performance is unsatisfactory.
- More effective administration with fewer bureaucratic delays will result.
- Responsibilities will be more clearly defined, with no interdepartmental overlaps and no cross-departmental coordination needs.
- A faster and simpler decision-making process can be implemented.

Increased efficiency:

- New equipment or spare parts for equipment maintenance can be easily acquired.
- The private sector has ready access to technology and expertise.
- The private sector has easy access to financial resources for new investments.
- Adapting technology to context and situation will be easier, thus increasing equipment performance.
- Full cost accounting and incentives for the lowest possible unit cost can be implemented.

Contestability:

- Performance monitoring is necessary.
- The focus should be on customer satisfaction.
- The service provider must be accountable to the beneficiaries for services rendered.
- Incentives for good performance and efficiency can be offered through competition.
- Less political interference will occur with private sector involvement.

Challenges

Private sector participation in SWM can be a very attractive option. However, if certain conditions cannot be met, the partnership between the public and private entities may face severe risks. It is crucial that the following conditions and the risks they pose be carefully considered and steps taken to avoid them.

No competition:

- If not enough private sector companies are interested in providing the service, choice and performance incentives will be minimized.

- Lack of sufficient capacities and skills to ensure satisfactory performance could reduce competition.
- A very strong private sector and weak municipal capacities could result in an unbalanced partnership.
- Long-term contracts with the private sector (creating a monopoly) could lead to loss of control by the municipality, which would eliminate one means of enforcing performance standards.

Uncertain safety and social benefits for workers:

- The private sector may not provide workers social security benefits, pensions, sick leave, social insurance, regular medical examinations, vaccinations, and so on.
- The private sector may not ensure use of safety and protective equipment.
- The private sector may pay wages for unskilled labor that are minimal or even below minimum wage.

No financial mechanism to ensure timely, regular payment for services:

- Municipal financial means may be inadequate to maintain regular payments to the private sector.
- Municipal bureaucratic and administrative deficiencies may severely delay payments to the private sector, thus endangering cash flow and the sustainability of the service.

Corruption:

- Suspicion of corruption could discourage enterprises from bidding because they do not believe that the most competitive and competent bid will win the tender.
- Lower standards of operation and service would prevail if monitoring inspectors were bribed.
- Lack of transparency could result in lack of trust between the public (civil society), municipal officials, and the private sector.

Unclear or unstable policy toward private sector participation:

- Fear of reversal of policy and termination of contracts with political change could discourage private sector involvement.

Many of these risks can be avoided with improved tendering procedures and appropriate contracting and negotiations.

2.5 ROLE OF INFORMAL SECTOR: NGOs & CBOs

There is enormous potential to involve RWAs, NGOs and CBOs in SWM services in a cost-effective manner without getting into contracts with private operators. With some support from the ULB in the form of grant or subsidy, the community is keen to manage its own waste. There are NGOs/ CBOs which

also promote the welfare of rag pickers. They are willing to come forward to involve the rag pickers in door-to- door collection and source segregation of waste. In some models, followed in Ahmedabad and Ludhiana, there is no contractual relationship between the ULBs and RWAs/NGOs as they only get grants to support their activity carried out through their own labour and grants can be discontinued if purpose is not served.

Whereas the private sector can play an important role in construction, operation, and maintenance of treatment and disposal facility, NGOs can play an important role in:

• organizing rag-pickers/waste collectors for door-to-door collection and segregation of waste

•creating public awareness for storage of organic and recyclable waste separately at source and handing over the waste to the waste collector

• promoting recycling of waste and decentralized treatment of waste involving community, CBOs, etc.

Rag-pickers could be involved in door-to-door collection of municipal solid waste as well as recyclable waste so that they could get a user fee for collecting waste from the doorstep and derive additional income from sale of recyclables. There is a potential of recovering at least 15 per cent of the waste generated in the country which could be more than 15,000 MT per day providing employment opportunities to about 5,00,000 rag-pickers in the country. Despite immense potential in big cities in this area, NGO/CBO participation is still on a very small scale.

The Self-Employed Women's Association (SEWA) has taken up the task of door-to-door waste collection in Vejalpur and Gandhinagar cities near Ahmedabad and providing employment to rag-pickers. Similarly, the Centre for Development Communication in Jaipur has taken up the work of primary collection and transportation of waste involving half a dozen cities covering population of over a million. Exnora which initially introduced the concept of door-to-door collection on cost recovery basis in India has been playing an important role in Chennai in door-to-door collection of waste with community participation.[21] Sustainability of this service can be ensured through user charges levied on beneficiary households, shops, and establishments.

[21] *Asnani, P. U., 2006. Solid Waste Management, Chapter 8 in India Infrastructure Report. Oxford University Press, New Delhi.*

2.6 BEST PRACTICES IN SOLID WASTE MANAGEMENT

Some of the best practices in Solid waste management, in Indian as well as international context have been analyzed. The analysis is carried out based on the following criterions:

- Citizen Participation
- Primary Collection & segregation of waste
- Transportation and disposal of waste
- Treatment / technology

A handful of Indian cities have been successful in undertaking practices to manage municipal solid wastes, which can be potentially adopted by others. Below are some of the best practices in SWM in which have been highlighted recently in literature and in the media.

- Ahmadabad
- Surat
- Vellore
- Chennai
- Pune
- Bangalore
- San Francisco
- Singapore

2.6.1 Ahmedabad

Table 6: Ahmedabad – General Information

Country	India
State	Gujarat
District	Ahmedabad
Area Metropolitan City	464 km2
Population (2011) Metropolitan City	6,270,156

Ahmedabad is the 7th largest metropolis in India, having a population of almost 6 million and spread over an area of 464sq.km. For effective service provision and smooth administration to all citizens,

Ahmedabad Municipal Corporation (AMC) has divided its activities in 6 Zones and 64 wards. Almost, 3600 Metric Tons of solid waste is generated from the city on a daily basis including 300 MT of construction and demolition debris. AMC has undertaken the mission towards achieving a clean and green Ahmedabad through the Solid Waste Management (SWM) Department which is in charge of all functions concerned with municipal waste collection, transportation, treatment and disposal of waste. AMC has allocated a funding of Rs.2130 million in its annual budget 2012-13 towards the development of SWM.

Municipal Solid Waste management system

Nearly 61 percent of total municipal solid waste is collected through municipal bins and street sweeping. Street sweeping includes 365 working days and a total of 1,484 km roads are swept on a daily basis with the strength of more than 12,000 workers. The timings allocated for this are from 6.30 am to 11.30 am and 3.00 pm to 6.00 pm.

The door / gate to dump system include 365 working days. More than 700 vehicles are deployed for this and the timings allocated are from 7.00 am onwards. In July 2009, they also introduced closed body Hydraulic Euro III vehicles for lifting solid waste. Solid waste is collected in the morning from residential units and in the evening from commercial units. Refuse compactors take waste from these vehicles to the treatment plants. This project covers the entire city. Apart from the above two mentioned methods, there is secondary collection and transportation where in more than 100 vehicles are used at over 1,050 sites. There are weigh bridges as well where they pass through to gauge the weight of the waste collected, which is later recorded.

Since about 3,600 MT of solid waste is collected per day, a suitable method for its treatment needs to be implemented and Ahmedabad has assigned it to a few companies who have been given the contract to handle 2,050 tons of solid waste. Various companies assigned for the treatment of solid waste are: Excel Ind., UPL DJAI Power Ltd., Creative Eco-Recycle Pvt. Ltd and Hanjer Biotech Energies Pvt. Ltd.

Characteristics of waste in AMC

Out of the total waste collected in AMC, 56.23% is found to be biodegradable, 23.77% non-bio-degradable but recyclable and the remaining 20% is found to be non-bio-degradable as well as non-recyclable.

Figure 5: Characteristics of waste

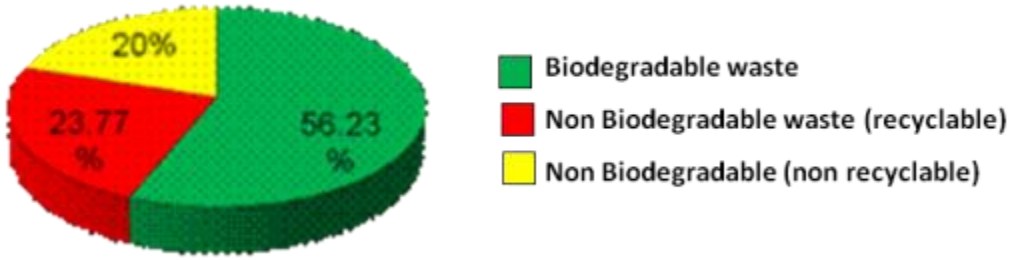


Table 7: Waste collection data - AMC

Zones	Wards	Collection sites	Containers	Mechanized dumper placers
Central	9	62	113	>1,200
East	10	157	139	
West	11	95	134	
South	8	133	154	
North	10	109	136	
New west	9	533	28	
Total	57	1,089	704	

Nearly a quarter of its daily waste (500-700 tonnes) is processed by the private firm-Excel industries- who transform the waste into organic manure through microbial culture. Around 500 tonnes of waste produce about 150 tonnes of manure, ironically on a site adjoining city's dump fill mound, without elevating its own ground over all these years.

For the disposal there are securely engineered landfill sites constructed over an area of 12.88 hectares, to accommodate 1.15 million tons of waste. It costs about INR 13 crore.

Chemical Analysis of Ahmedabad's MSW collected at disposal site[22]:-

a) Carbon/nitrogen ratio generally varies from 30 to 50.

[22] *Data based on waste characterization done by Abellon Clean Energy, 2010*

b) Lower Calorific Value (LCV) for MSW is < 1000 K Cal/Kg.

c) Moisture in MSW varies from 30% to 55%.

Note: Waste comes at disposal site without segregation, i.e. mixed MSW.

Initiatives taken by the AMC

1. Mobile Court Initiative for Littering & Nuisance

- AMC launched country's first Sanitation Mobile Court on 4th June, 2009 dedicated to contain littering.
- 95,566 cases have been registered and Rs. 3.25 Crore penalty levied from such offenders.

2. Project for Awareness: Started a Project for IEC (Information, Education, Communication) Activities and awareness generation among the general public towards cleanliness, waste treatment & waste disposal:

- To form participatory committees and conduct group meetings in the wards
- Publicity through television channels / local cable network
- Advertisement in newspapers
- Preparation & distribution of pamphlets
- Preparation & erection of banners
- Preparation & exhibiting of awareness creation slides in cinema theatres
- Conducting street plays
- Organizing of rally involving school & college students
- Imparting awareness training to municipal staff and councilors
- Conducting miscellaneous events.

3. Present dump site capping or land reclamation project (under planning)

- Since last 30 years solid waste is being disposed & accumulated at Pirana dumping site having total area of about 84 acres.
- About 65 acres of land is accumulated with heaps of garbage having 15-20 meter height.
- AMC is developing a project for capping of the site or reclamation of the site on PPP mode.

4. Transfer Stations (under construction)

Advantages: Savings in transportation cost, reduction in pollution, easement of traffic conjunction

- Six transfer stations of about 400 MT capacities each to be setup in five zones.

- Total 12 stationary compactors and 60 large containers (20-25 CMT capacity which can carry 10 to 12 MT of MSW). There will be 2 stationary compactor and 10 large containers in each transfer station.
- 40 large hook loader vehicles have been proposed to transport waste from six transfer stations to the disposal site /treatment plant.

5. Project for recovery of dry recyclables(under planning on a larger scale)

- The focus is on segregation of solid dry recyclable waste at the source i.e. at the household level and also to create awareness for people's participation.
- **Benefits:** Incentive to households for waste segregation enables cleaner waste streams, increases usability of waste.

6. Decentralized model for biodegradable waste: effective utilization of garden / hotel kitchen waste

- AMC started this pilot project in September 20 11.
- Daily garden, hotel, kitchen and other green waste is converted into organic manure with the help of Excel Industries Ltd.'s Organic Waste Convertor (OWC) machine on PPP mode.
- OWC machine with capacity of converting 200 kgs biodegradable waste into compost has been put on experimental basis for 60 days to observe the process and effectiveness of the machine.
- Such small project to convert biodegradable waste to compost is useful for residential societies, big hotels, canteens, etc.
- AMC wishes to encourage such decentralized mode.

Eco Club:

- Registered members can give their green waste at site and they will get credit points.
- Green waste can produce 30 per cent organic manure which is returned to the member without any charges.
- Electronic weighing scale is used for weighing.
- Organic manure will be given in 900 grams packet to the members in eco compostable 'True Green' bag.
- Time for Eco Club activity: 8 am to 10 am and 4 pm to 6 pm.

7. Solid Waste Processing Planning

AMC has received various offers from experienced companies for processing MSW on PPP mode in the year 2011 & in 2012.

AMC has awarded consultancy to Deloitte Touche Tohmatsu India Pvt. Ltd. for technical, commercial and financial evaluation. The selection process has been completed. The following two companies have awarded work for solid waste processing 1000 tons each on a daily basis for 29 years.

i) Abellon Clean Energy Pvt Ltd (Waste into Electricity)

ii) A 2 Z Infrastructure Ltd. (Waste into Compost & RDF)

8. Preparation of Ahmedabad SWM Master Plan for 2031 (under preparation)

AMC has decided to prepare a Solid Waste Master Plan for 2031 with the help of Urban Management Centre.

9. Preparation of Public Health Bylaws

AMC has given work order to prepare Public Health Bye-laws keeping in mind of all present requirement & future planning for better administration, to All India Institute of Local Self Government (Consultant).

Draft Public Health bye-laws have been submitted recently by the consultant and further process of legalization of the same is under process.

10. Scientific and safe disposal of Carcasses of animals & waste from slaughter house, fish market, meat market etc.

AMC is in the process of issuing a competitive bid for design, construction, and operation & maintenance of a daily 10-15 tons processing plant on Public Private Partnership mode for 30 years with the help of a competent consultant firm for exploring best suitable technology.

11. Scientific disposal of Construction & Demolition Waste

- AMC has issued an expression of interest for design, construct, operate & maintain a daily 300 tons processing plant for construction & demolition waste and collection & transportation of such waste from city area on Public Private Partnership mode for 30 years.
- The selection process has been completed and DNP Infrastructure Pvt. Ltd has been awarded the work. DNP has started collection & transportation of C & D Waste across Ahmedabad City.
- AMC has allotted 5 acres of land for processing plant. It will be operational soon and going to make bricks, tiles & other materials from such waste.

12. e-Waste management

- For effective implementation of e-waste (Management and Handling) Rules, 2011 in Ahmedabad, AMC in coordination with GPCB and with the help of corporate sector is planning to establish points system for e-waste collection, safe transportation and safe storage / disposal of the same.
- Ernst & Young is preparing a competitive bid document for the same on PPP basis and it is in the final stage of issuance.

13. Involving Community for Clean, Green & Beautiful City

- Rotary Club of Ahmedabad - Prahladnager and all other Rotary Clubs of Ahmedabad are planning join AMC's - A clean and Green City under Adopt a Street.
- Rotary Club will invite residents to adopt a street as a volunteer. Such registered volunteer will take care of such street for cleanliness, make aware all residents of that street about sanitation, facilitate AMC for its various schemes for sustainable solid waste management system in that area & community.

14. Development of Roadmap for Zero Waste Ahmedabad by 2031

AMC participated at the special event of ISWA World Congress 2011 and agreed on the "Declaration for Zero Waste Ahmedabad" by 2031. AMC has signed a Memorandum of Understanding with UNCRD (United Nations Center for Regional Development, Japan) which is providing technical assistance for developing a "Roadmap for Zero Waste Ahmedabad by 2031".

For this initiative AMC had a detailed multi-stake holders 'consultation meeting with the help of UNCRD Japan on 18thApril, 2012 for developing a draft road map. This draft is at the verge of finalization and 2nd multi-stakeholders consultation on the Pre-Final Draft Road Map for Zero Waste Ahmedabad was held on 12th September, 2012. This meeting was jointly organized by the AMC &UNCRD with the support of Zero Waste South Australia. From this potential technical support from UNCRD in developing a "Road Map for Zero Waste Ahmedabad", AMC will move forward for increasing resource efficiency and reduction of waste, development and implementation of policies for resource efficiency and environmentally sound waste management, development and enforcement of policies, strategies, laws, regulations and also involve continued, new & innovative public-private partnerships among industry, governments, academia and other non-governmental stakeholders aiming to enhance capacity and technology.

By adopting this Zero Waste concept in City of Ahmedabad with the help of UNCRD, Ahmedabad would also serve as the root or catalyst for policy changes at National level in realizing resource efficient and zero waste societies in India.

A Roadmap for Zero Waste Ahmedabad – a visionary document to guide Ahmedabad towards becoming a 'Resource Efficient and Zero Waste City' by 2031 was released on 12thJanuary, 2013.

All of the above provides a much generalized view of the practices and current situation in Ahmedabad as per the information given by the Corporation. There are other schemes that have been developed by the Corporation that are in use and are scheduled to run for a few years to come such as the Preparation of a Master Plan for Solid waste management of Ahmedabad where the initiative is taken by the AMC and the job has been given to the UMC (Urban Management Center).

Detailed Description of the Actual Services Provided by UMC

UMC conducted numerous visits to sites for the purposes of data collection, field visits, interaction with ULB officials, citizens, focused groups, etc. In addition to data collection, detailed site visits were conducted at the following locations to assess the status of MSWM services:

- Waste collection points in residential, commercial, and special market areas (including meat & vegetable); formal and informal open dumping sites in and around the city, etc.
- Natural water bodies including nalas, river, lakes, ponds, etc. to assess the environmental degradation caused due to lack of MSWM services in the city.
- Public toilets, urinals and open defecation (OD) spots.
- Special areas such as railway station, Gujarat University, other campuses of large institutional areas, GIDC estates in the city, etc.
- Some select outgrowths/ contiguous settlements to the city.
- Other site visits included areas such as the slums, residential areas, municipal civic centres, retail and wholesale markets, health and educational institutions, etc.
- The purpose of these detailed field visits was to establish a qualitative relationship between the statistical details provided by the ULB with the actual ground realities, which in many cases, were found to be in conflict with each other. Based on the verification of collected data by AMC, UMC conducted further studies to summaries the findings and present proposals to fill any gaps in MSWM services.

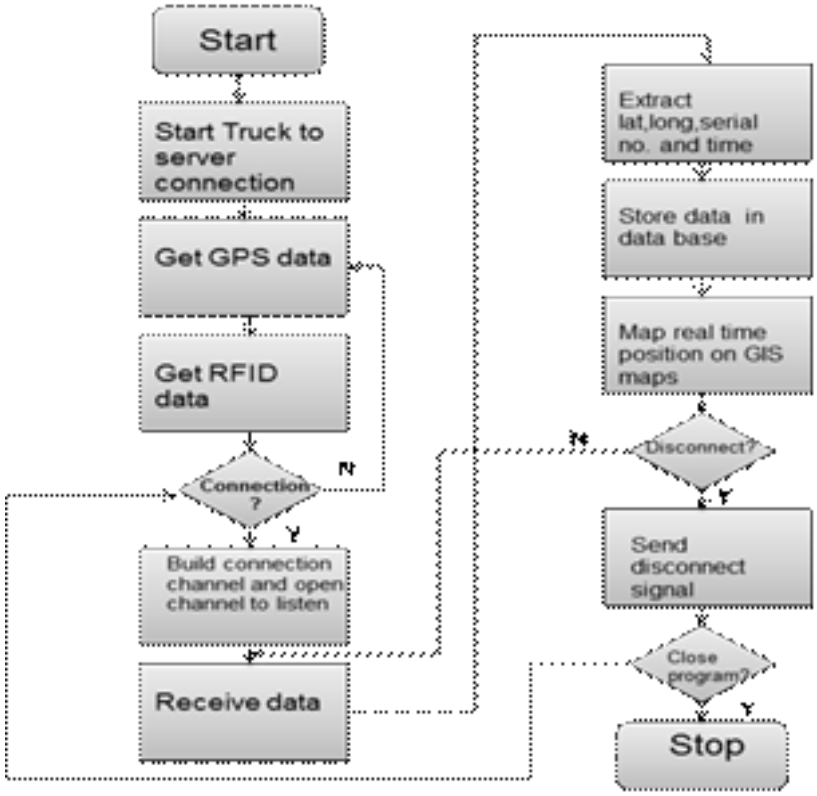
UMC created the framework for the proposed Master Plan and also facilitated consultations between concerned organizations and stakeholders to develop the Master Plan. The organization also aided the finalization of technological, social and financial options for the Master Plan and its process.

UMC's Master Plan for SWM is aimed to guide AMC towards its goal of becoming a Zero Waste city by 2031. AMC has signed a MoU with the United Nations Center for Regional Development (UNCRD) for the same and UNCRD is providing technical support to AMC for developing a "Roadmap for Zero Waste Ahmedabad".

Another Initiative that has harnessed some interest is the RFID (Radio-frequency identification) Technology. A study was conducted by Suchit S. Purohit and Vinod M. Bothale who proposed through their study an automated system for waste collection and container monitoring system using RFID, global positioning systems (GPS), geographical information systems (GIS) and GSM (Global System for Mobile Communications). RFID is a generic term for technologies that use radio waves to identify people, animals or objects without being in physical or visual contact with them. The proposed system consists of RFID tags mounted on containers, RFID readers mounted on trucks along with GPS for location tracking and GSM module for wireless transmission. The system provides real time monitoring of waste collection through a web based application. This application helps administrators in decision making related to reallocation of routes and containers, and handling management issues such as observing performance of contractors and waste generation characteristics of a particular area. It also enhances transparency in the working of the civic administration. It also provides added services such as:

- Usage and route planning optimization of garbage trucks
- Efficient monitoring and management of waste bins
- Weighing of waste during collection
- Verification of collection service
- Future application of Pay-As-You-Throw programs
- Better recycling

Figure 6: Process Flow



Challenges that can potentially be faced in implementing such as a system are:

- Accurately geo-coding all the bin locations of the city
- Establishing an intelligent algorithm/logic for flagging the bin lifted/ not lifted
- Choosing the appropriate tag/reader technology in a specific application area
- Large volumes of data
- Maintenance of product information
- Configuration and management of readers and devices
- Data security and privacy

Even though new and improved technologies are being implemented, there are a few pitfalls in the system. According to the chairman of the health committee, Narendra Brahmbhatt, “poor public awareness among the masses and a typical Amdavadi mentality to litter without feeling any guilt may delay our plans”. The civic body is yet to identify dustbin sites for garbage collection from private societies, residential colonies, flats and bungalows spread over an area of 192 square kilometres. As per the SC guidelines, the public dustbins should not be placed more than 500 metres away from the residential premises or a colony. Considering this fact, Ahmedabad needs over 1,000 dustbin sites for

systematic garbage collection. However, as of now, it seems to be a tall order for the civic body to convert the existing 312 out of the 708 dustbin sites into completely covered sites. This is seemingly a tall order and Ahmedabad seems to be in no rush to accomplish it.

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2.6.2 Surat

Table 8: Surat – General information

Country	India
State	Gujarat
District	Surat
Area Metropolitan City	326.515 km2
Population (2011) Metropolitan City	4,585,367

Surat is the biggest trade hub in Gujarat and is one of the fastest growing cities in terms of infrastructure and urban development. The city doubled in size during the years 1981-1991 due to which many fringe areas remained un-served with basic amenities like water supply and sanitation. The rapid population growth in Surat caused several management problems for the ULB. The Surat Municipal Corporation (SMC) is responsible for provision and maintenance of the entire range of civic infrastructure services in the city, including water supply systems, sanitation and drainage facilities, solid waste collection, and disposal. During the early 90's, Municipal SWM was in a poor state with waste being disposed in drains and water bodies. The waste collection efficiency of the city was very poor.

This sporadic development and lack of basic services and infrastructure led to the outbreak of Plague in the year 1994 which claimed several lives. The major cause of the outbreak was considered to be ineffective waste management, which led to the blockage of storm water drains resulting in flooding of the fringe areas of the city.

Recuperation of Solid Waste Management Services

Since May 1995, a remarkable turnaround in the state of affairs was observed, as a result a series of initiatives were taken by the civic administration. As the outburst of plague turned out to be a manifestation of the inability of the civic authority to provide necessary basic services, the government undertook a massive clean-up drive as well as administrative reform exercise which transformed Surat into one of the cleanest cities in just 18 months.

Some of the initiatives undertaken were:

- Re-arranging the six zones of waste management into 52 sanitary districts for better control of waste collection;
- Introduction of daily monitoring system for better waste collection efficiency

- Posting of sweepers for round the clock duty at nuisance spots, which were invariably cleaned at least twice a day.
- Engaging private contractors for collection and transportation of waste to the disposal site, as well as sweeping and scrapping all major streets during the night time;
- Slum improvement operations were undertaken with the assistance of NGOs;
- Revamping the entire administrative and financial management system of SMC; and
- Policy decisions were taken to create a responsive waste management system by introducing complaint redressal systems.

The drive was aimed at transforming the city, as well as the attitude of the people and government officials.

Door to door Garbage Collection

After the implementation of daily Door to Door garbage collection system in the morning hours from 7 am till 1 pm; it has now become the practice of every citizen to store the household waste temporarily in dustbin till door-to-door garbage collection vehicle arrives. This has made a good improvement in the overall scenario. Sense of good hygiene and awareness towards environment are visible. On request form shop keepers, waste collection system is made operative in second shift from 5 pm to 11 pm to facilitate commercial units.

Night Brushing and Scraping

Unlike other cities Surat practices night brushing and scraping of roads. Forty-seven major roads have been identified for night cleaning by 1183 persons and 99 vehicles deployed through 31 agencies. Rs.30 paisa per sq mt is paid for night cleaning amounting to an annual expenditure of Rs.472 lakh resulting in annual saving of Rs.30 lakh.

Participatory approach

Although the SMC was the primary catalyst for this initiative, little could have been achieved without the passive or active participation of different segments of the population of Surat. By mid-1996, the SMC had increased the cleaning of accumulated garbage from 50% (at time of plague) to about 94% of the amount generated. The SMC achieved this by strict monitoring, regulations and streamlining of garbage collection and disposal. Households, industries and eateries were given individual cleanliness instruction, and field employees issue regular instructions and information to householders on how to

sort, pack and dispose of garbage. Regular workshops were conducted in the slums of Surat to disseminate knowledge on cleanliness and hygiene.

At present garbage is collected at least once in 24 hours and all refuse is disposed of in well-maintained landfills. Private contractors at present, handle almost 40% of the solid waste generated daily in Surat. Spot "administrative charges" punish those who dispose garbage in violation of the municipal by-laws. This punitive measure automatically increases social vigilance at the community level, thereby increasing the level of civic consciousness.

The SMC also strengthened the health infrastructure, revived work ethics among health workers, and introduced a meticulous disease monitoring system. This provides an early warning system to alert Surat of a potential outbreak of an epidemic. This has impacted Surat's health indicators considerably. Civic consciousness has been enhanced in the slum areas, with the slum dwellers themselves taking charge of cleanliness of inner lanes. Community response has been very positive due to constant interaction of field workers and periodic interaction with senior officials. Regular public meetings are held for health education through poster campaigns, audio and video mediums.

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2.6.3 Vellore

Table 9: Vellore – General Information

State	Tamil Nadu
District	Vellore
Area (City)	87.915 km^2
Population(City)	501,966 (2,011)
Density	701/km^2

Vellore Corporation generates around 180 tons of waste per day, including 3 tons from fish markets, 19 tons from vegetable markets, 2 tons from slaughterhouses, 12 tons from commercial areas, 41 tons from the roadside and 104 tons from door-to-door collection (Aishwarya VP, 2013).

Existing Situation of Solid Waste Collection and Management

Primary Collection: Vellore City Municipal Corporation has initiated the system of door to door collection of solid waste from the households and other establishments. Vellore City Municipal Corporation is maintaining 48 wards. Source segregation is insisted in all the wards but implemented in some areas only. The local body has provided 22 hand drawn carts and 50 tricycles for door-to-door collection of solid waste.

Street Sweeping: Street Sweeping is carried out in all the 48 wards. About 38 MT waste is collected through street sweeping. The local body has engaged 382 sanitary workers against sanctioned post of 474 to manage the solid wastes generated in the town.

Secondary Waste Collection: The collected garbage is shifted to the Compost yard through 5 tipper lorries, 4 dumper placers, 1 refuse collector and 4 autos.

Transportation of Waste: The local body has engaged 14 vehicles for the transportation of wastes to the disposal site.

Disposal of Solid Waste: Scientific method of disposal of waste is not followed in the town due to lack of adequate landfill site. Currently open dumping is practiced at Sathuperi compost yard. Now**,** a land of 8.33 acres of extent is purchased at Sathuppalayam and composting in scientific method has been proposed here.

Table 10: Details of Zones

1	No. of Zones / Wards	48
2	No. of Zones / Wards managed directly by local bodies	48
3	No. of Zones managed by private agencies	NIL
4	No. of transfer stations	1
5	No. of transfer stations used by local bodies	1
6	No. of transfer stations used by private agencies	NIL
7	Approximate area of each transfer stations	1500sq.ft

Table 11: Details of Municipal Solid Waste Dump yards

1	No. of Dump Yard (Including proposed dump yard)	2		
2	Location of the Dump Yards	1	Sathuperi	
		2	Sathupalayam (proposed)	
3	Area of Dump Yard	16.24 acres		
4	Life expectancy of the Dump Site	1	Sathuperi	1 Year
		2	Sathupalayam	25 Years
5	Total No. of years in use	Around 40 years		
6	Waste disposed per day	95 MT		
7	Area available for composting	16.24 Acres		
8	Is there any open burning	NIL		
9	Is there any dedicated landfill? If so, the location of landfill with area	NIL		

But now there has been a change in the whole system mainly because the Vellore Corporation has decided to privatize solid waste management in the corporation area. The decision to privatize SWM was taken after the addition of two municipalities, six town panchayats and nine village panchayats to Vellore Municipal Corporation, pushing up the number of wards in the Corporation to 60 and the area has increased from 11.65sq.km to 87.92sq.km.

The Corporation generated 200 tonnes of solid waste per day as per the 2011 population. The existing vehicles were able to remove only 150 tonnes of garbage. The 715 posts of sanitary workers are to be entrusted to the private agency to be selected through tenders.

Model for SWM

The Corporation has decided to make Zone-1 comprising 15 wards in the extension areas of Gandhinagar, Kazhinjur, Virudhambut, Tharapadavedu, Katpadi and Kangeyanallur, as a model for the implementation of SWM project, in pursuance to the direction of the CMA who has asked the Corporation to select a zone for establishing an SWM model. A SWM project is already in place in Gandhinagar, where the office of the erstwhile town panchayat houses a compost yard, and garbage is being regularly collected through carts from the houses and business premises. A similar system is also in place in Kazhinjur. Four places have been identified in Zone 1 for undertaking the work of segregation

of wastes and composting the garbage. The existing infrastructure in Katpadi, Gandhinagar, Kazhinjur and Pallikuppam would be modified.

While the Corporation has placed orders for six more dumper placers and four more refuse collectors for undertaking the garbage collection, removal and dumping work.

Sanitary Workers: The up gradation of the Corporation and the functioning of the local body as an integrated Corporation after the extension of new areas with effect from October 25, 2011, had increased the requirement of sanitary workers to 1,450, whereas the Corporation had only 559 workers, leaving a shortage of 891 workers. The Corporation engaged 460 SHG workers at the rate of 10 each from 46 SHGs on contract basis to undertake the additional work in all the four zones, and their contract was till October 2013 (Murthi, 2013).

Since it has been privatized, the responsibility of Vellore's solid waste management has jointly been taken up by Exnora and the Vellore Model which essentially comprises of the solid and liquid waste management.

The Vellore Model involves source segregation into biodegradable and non-biodegradable waste, composting of the biodegradable waste, selling of the compost and recycling the non-biodegradable waste. The solid and liquid waste management project was implemented by C. Srinivasan all over the country. He is also the project director of the newly started Indian Green Service (IGS), who introduced the innovative system in Vellore district when he was the president of Exnora Green Cross (EGC), Vellore. He goes by this statement, "Any biodegradable waste becomes a waste only after 24 hours, when it starts emitting foul odour. If it is lifted once in 12 hours, it is a resource, which could be sold. Now we have started promoting the concept of solid and liquid resource management, as against waste management which was hitherto being implemented in different parts of the country".

This model has turned out to be profitable at effectively disposing of non-medical waste from various units from the Christian Medical College (CMC), Vellore. The medical wastes are treated through a common effluent treatment plant for hospitals in Vellore district, being implemented by a private agency at Kandippedu village near Katpadi.

According to C. Srinivasan, president, EGC, the sale of the recyclable wastes alone had yielded an income of about Rs.3 lakh in the last three months, which meant an assured income of about Rs.1 lakh per month. It only proved that the project was not only effective but also self-sustaining. Buyers had been identified for all the different kinds of wastes generated. While primary segregation was done at the

source itself, a secondary segregation of the biodegradable wastes (BW) and non-biodegradable wastes (NBW) was done at the SWM Centre opposite to the CMC in Bagayam.

Over 200 workers, mostly members of women's self-help groups, were engaged round-the-clock in the task of segregating the two types of wastes. From here, the segregated cattle-edible BW was sent to the cattle shed, where they were consumed by the cattle, while the non-cattle-edible BW was sent to the compost tank, for composting into manure. The cow dung was fed into two biogas plants for generation of biogas, which was used as fuel in the canteen for workers. The slurry after production of the biogas is used for producing compost and the maggots generated on that slurry is fed to the chicken. Some of the remaining non cattle-edible waste is also fed to the chicken, frogs and earthworms. The segregated waste from the fish market is directly fed to the ducks. After eating this healthy food, the chicken and ducks produce eggs more than what they were producing before.

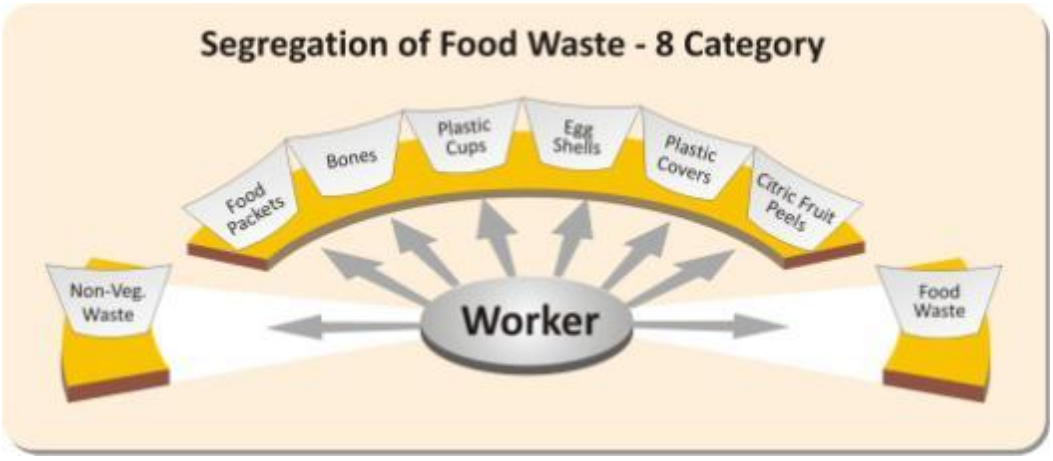
The NBW were sent to a tertiary segregation unit where the plastic covers, injection bottles and waste papers were separated, packed and dispatched to the buyers. Before that, the plastic covers containing liquid edible items were cleaned and dried. R.M. Swamy, supervisor, SWM Centre said that electric fly control systems were used in the secondary segregation unit to kill the flies that swarm the food wastes in order to prevent the flies from causing health hazards.

EGC and the Vellore Model's description of segregation

Figure 7: Segregation of dry waste - 17 categories

Figure 8: Segregation of wet waste - 20 categories

Figure 9: Segregation of food waste - 8 categories



Setbacks

Even excellent models such as this have a few pitfalls within the system. Here fortunately it is something that can be rectified over a short period of time. The solid waste management scheme is facing a shortage of staff. The lack of personnel is affecting the scheme's progress. Officials said there were more than 1,000 sanitary workers in the Corporation, including 460 temporary workers belonging to various self-help groups. Only 70 people were involved in the segregation and recycling work, while

others were involved in door to door collection, street sweeping, drain cleaning and such activities. They feared that if they were diverted to the recycling work, door to door collection would get affected.

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2.6.4 Chennai

Table 12: Chennai-General information

Country	India
State	Tamil Nadu
Districts	Chennai, Kanchipuramand Tiruvallur
City Area	426 km2
City Population (2011)	6,500,000
Density	26,702/km2

Chennai is the first city in India to contract out MSWM services to a private foreign agency, ONYX, a Singapore based company. Around 4,900 tonnes of waste is generated around Chennai Corporation limits every day. The per capita generation rate is 0.6kg/day. Municipal Solid Waste includes commercial

and residential wastes generated in municipal or notified areas, in either solid or semi-solid form excluding industrial hazardous wastes, but including treated bio-medical wastes (MoEF, 2000). Around 30 per cent of municipal solid waste is biodegradable (The Hindu, 2013). The waste disposal locations since 2006 have been at Perungudiyard and Kodunguiyuryard, outside of Chennai. They received about 40,000 MT/year of waste.

History and its effect

N.Raman et al (2008) have analyzed the impact of solid waste on ground water and soil quality on places closer to Pallavaram solid waste landfill in Chennai. The physical and chemical parameters like pH, electrical conductivity, total dissolved salts, total suspended solids, alkalinity calcium, magnesium, chloride and metals like sodium, potassium, lead, cadmium were studied. It was found that parameters like pH, hardness of water, calcium, and manganese were beyond the acceptable limits in accordance with the IS 10500 drinking water quality standards. In the case of alkalinity, and metals like copper, manganese, cadmium, nickel and chromium, their presence were beyond the acceptable limits.

Considering the components of the MSW the impacts of hazardous waste have resulted in affecting the ecosystem and also the human environment. Another component like the biomedical waste when mixed with the municipal solid waste without being segregated, poses a risk of injury and infection to sanitary workers and rag pickers working at these dumpsites. Since most of these dumpsites are unscientifically managed, the chances of pathogens contained in infectious waste becoming airborne and getting released to nearby water bodies or affecting the local resident population are highly prevalent.

Regarding the betterment of waste management in the city, they have recognized three different organizations namely the CoC, ONYX and CBOs such as Civic Exnora who are involved in the MSWM of the city. This has improved the quantity collected, but no progress has been made in respect of total solid waste management. EXNORA through its several civic associations and several other resident associations have been active in door-to-door collection of solid waste in their neighborhood. This has been a significant feature for several years and Chennai City has a good standard of awareness and action for solid waste management at local levels.

Current situation and responsibilities

The city has been divided into 10 zones and out of them CoC undertakes 7 zones while the remaining 3 are privatized. The characteristics of ONYX's features are: a) Imported technologies for MSWM, b)

Containerization of household waste before collection, c) Mechanization of handling tasks by lifting, tipping and compacting devices, d) Day and night services of collection, e) Professional equipment for collectors, f) Better machinery, maintenance and relatively young work force, g) Training program for workers, h) Transfer system and haulage and finally i) Transfer stations. The above study conducted by Esakku, Kurian et al derives the result that privatization is beneficial for MSWM in reducing the waste collection cost. The CoC also undertook a project to develop a waste to power plant through gasification technology in 2001. However, this failed due to disagreements in the power purchase rate and the protests by the environmentalists.

Components of municipal solid waste

The type of litter generated and the approximate time it takes to degenerate is mentioned in the table below.

Table 13: Components of municipal solid waste

Type of litter	Approximate time it takes to degenerate
Organic waste such as vegetable and fruit peels, leftover foodstuff, etc.	A week or two
Paper	10 - 30 days
Cotton cloth	2 - 5 months
Wood	10 - 15 years
Woolen items	1 year
Tin, Aluminium, and other metal items such as cans	100 - 500 years
Plastic bags	One million years?
Glass bottles	Undetermined

The practices implemented by Civic Exnora are: a) Community motivation and encouragement of high level self-involvement, b) Incomes at the household level through recycling and reusing and c) Spreading the message and leading the community to zero waste management. Improvements have also been made on the open dumb sites; CES (Center for Environmental Studies) came up with a research project on Sustainable solid waste landfill management in Asia. Related to the open dump sites, proposals have been made for better infrastructure such as a) Closure of sanitary landfill with top cover and a gas vent, b) Mechanical composting and RDF plant for waste management, c) Construction of leachate

evaporation ponds, d) Construction of soil bunds around dump sites to prevent spilling and e) Phase wise improvement of the dump sites to sanitary landfills.

Setbacks

Some of the downfalls of the above mentioned operations are: a) Abolition of open storage scheme was not entirely successful due to lack of financial resources, non-cooperation of the population and inaccessible areas/ narrow lanes, b) Daily sweeping of the street became hard to implement due to shortage of sanitary workers, public holidays and lack of financial support, c) Transportation in covered vehicles started facing difficulties due to insufficient number of vehicles, attitude of workers and financial resources.

This experience in Chennai principally states that cost effective management is singularly accomplished by the private sector. The CoC apart from implementing various rules and operations still faces problems due to lack of financial support, lack of CBO's, political issues and public support to provide a better MSWM for the city.

Currently the Chennai Corporation has shortlisted about 10 companies to come up with proposals for new solid waste management plants outside the city. They are looking at zero emission projects which are environmentally safe.

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2.6.5 Pune

Table 14: Pune-General Information

Country	India
State	Maharashtra
District	Pune
City area	710 sq km
City Population (2011)	3,115,431

Existing Situation of Solid Waste Management in Pune City

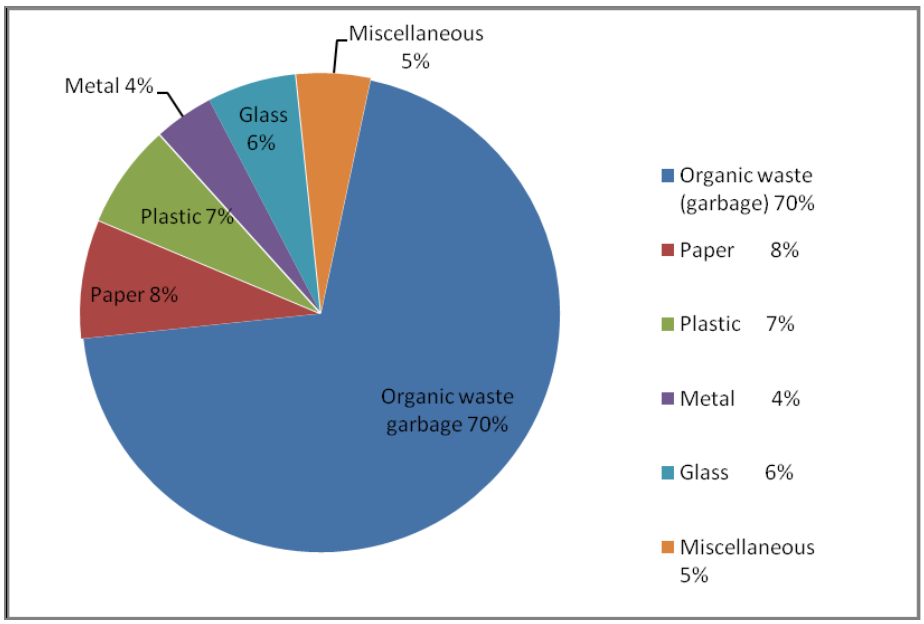
Pune, the second largest city in Maharashtra seems to be moving ahead in the garbage disposal area at a rapid pace. Pune generates 1,400 metric tons of solid waste per day but its composition is also changing, with more plastics and non-biodegradable elements to reflect the changing patterns of consumption of the growing middle classes (Ahluwalia, 2012).

There is major problem of its disposal and management of solid waste in Pune city. Pune Municipal Corporation (PMC) disposes municipal solid waste at Urali Devachi Depot which is 20 km away from Pune city. Due to unscientific disposal of MSW the huge heaps are produced at the disposal site. The decomposition of waste produces leachate. This leachate gets percolated in surrounding ground water. According to the research journal by Mane T.T and Hingane Hemalatha N., concentration of chromium and zinc in leachate is 5 to 8 mg/l and 10 to 15 mg/l respectively which is more than permissible limit of MPCB (Maharashtra Pollution Control Board). The concentration of chromium and zinc is 5 to 8 mg/l and 6 to 9.5 mg/l in nearby well water. This clearly indicates that there is higher concentration of these metals in well water. The people residing in these areas are using well water for drinking, domestic and for agricultural use. It is observed that the people living in this area having health and hygienic problems such as allergic, asthmatic, bronchitis, skin irritation and gastro intestinal diseases

Table 15: Leachate analysis generated at disposal site which is accumulated in ponds

Parameters	Samples				MPCB consent Limit
	Jul. 2010	Aug.2010	Nov.2010	Dec.2010	
Chromium(mg/l)	7	6	8	5	<0.1 mg/l
Zinc (mg/l)	10	15	13	12	<5 mg/l

It was concluded that the gases released due to open dumping were Sulphur dioxide, methane and carbon dioxide which were released above their average limit caused respiratory disorders and the leachate released in the water made in unfit for consumption or irrigation. There is a requirement for an updated version of the current management of waste.



Setbacks

The reasons why some of the previously mentioned operations have failed are because- There is still a low level of segregation at the source by citizens and SWaCH does not collect waste from bulk generators. Apart from that, a) people are not willing to pay Rs.10/- as a user fee as per resolution passed by General body of PMC, b) in case of sickness absenteeism or absenteeism due to other reasons, c) there has been an inability to arrange for substitute mechanism to collect the waste and finally d) the rag- pickers are demanding extra charge from citizens. Apart from this there are situations where the rag- pickers perform poorly in certain wards compared to others.

With all of the above in mind, it becomes clear that even with the shortcomings, Pune has managed to catch the eye for proper disposal of waste and its management.

Pune: SWM initiatives

The change came a long time ago in 1993 when the Kagad Kach Patra Kashtakari Panchayat (KKPKP) was initialized by two women, Poornima Chikarmane and Laxmi Narayan, two lecturers at the SNDT University in Pune. The KKPKP was a trade union of waste pickers and this along with the PMC (Pune Municipal Corporation) which complied with the Rules of 2000 jointly began the SWaCH in 2007. These provided door to door collection of waste for offices, households, shops etc. They also got into the habit

of segregating the waste at the source, as recyclable and non- recyclable and also wet and dry. They managed to compost about 10 tons of this solid waste collected from 250-300 households.

Now the PMC has also tried to set up the zero waste program, something that started in San Francisco for the first time. This began in Katraj, the largest ward in Pune. Launched in February 2011, this was a collective effort of Janwani, an NGO, Cummins India, and SWaCH, who came together to provide the model, the financing and manpower. The result is that only two tonnes of waste is sent per day to the landfill site, compared with 10 tonnes per day earlier. The PMC is determined to scale up this initiative (Ahluwalia, 2012).

The PMC has also set up 14 biomethanation-cum- power generation plants (BCPG) plants of 5tpd capacity. These plants treat organic waste in a decentralized and environment-friendly manner. Given the collection efficiency of 80-90 per cent, of which 45 per cent is segregated waste, the PMC has allotted separate vehicles for the collection of wet waste, which comes to about 300-350 tonnes per day. For each BCPG plant, the PMC provides 600 sq metres of land, 5,000 litres of water and electricity connection at site (both water and electricity free of cost).

The waste is treated in two-stage biomethanation process by using closed vessels where, in the absence of oxygen, micro-organisms break down the organic matter into a stable residue, and generate a methane- rich biogas in the process. This gas can then be used as a source of renewable energy to produce electricity (net surplus after own requirement) of 400 KWh per day, which is being used for street lights in the surrounding area. The solid residue is used as manure, and the aqueous liquor is a nutrient-rich fertiliser which can be used to recycle nutrients back to agricultural land (Ahluwalia, 2012).

From June 1, 2010, the PMC has stopped open dumping, and the total waste generated is processed scientifically. Hanjer Biotech is operating a processing plant of 1,000 tpd of mixed waste producing RDF, manure and fuel at the old dumping site at Urali and Fursungi. The company has constructed a scientific landfill to dispose the inert waste (about 20 per cent).

At the high end of the technology spectrum is the "non-incineration based thermal waste to energy" plant set up in a PPP model in the Ramtekdi Industrial Area. The investment of Rs.140 crore was made by the private company, Rochem Separation Systems India Pvt Ltd, based on the patented Concord Blue gasification technology on the 2.5 acre land provided by the PMC on a lease-rental basis. This state-of-the-art technology, for which the patent is held by Prayas Goel, Managing Director of Concord Blue,

processes unsegregated waste to produce energy, fulfilling the requirements of the EPA and European standards with regard to emissions.

The syngas (synthesized gas) is produced from unsegregated waste, which is a combination of biodegradable and non-biodegradable components by a thermal process of heating in complete absence of oxygen followed by reformation of the produced gas, which leads to a clean hydrogen rich gas that can be utilized for power generation (currently operational in the said facility). Unlike biogas which is produced from a biological activity of bacteria breaking down only the biodegradable component of the waste, syngas is produced from a thermal process and hence is a solution for the complete spectrum of solid waste sans inert. Also, syngas is rich in hydrogen, making it one of the cleanest fuels, unlike biogas which constitutes about 50 per cent methane.

With respect to all of the above there is still an increment in the usage and dumping of plastics for which we still need to find a safe disposal method. Incinerating plastics without expensive control equipment gives rise to dioxins and furans from the PVC component of plastics which are carcinogenic in nature and hence extremely harmful to all living beings. The Concord Blue technology, owing to its non-incineration platform, converts solid waste into gas without production of dioxin and furans over the permissible limit.

The PMC is committed to transporting 700 tons of unsegregated waste for 30 years, and the company has to process the waste on the same day. The PMC has to pay a processing fee of Rs.300 per ton of waste, and the company is free to sell the power to appropriate third-party buyers. The carbon credits when realized will be shared equally by the two.

Setbacks

There is still a low level of segregation at the source by citizens and SWaCH does not collect waste from bulk generators. Apart from that:

a) people are not willing to pay Rs.10/- as a user fee as per resolution passed by General body of PMC, b) in case of sickness absenteeism or absenteeism due to other reasons, there has been an inability to arrange for substitute mechanism to collect the waste and finally

c) The rag- pickers are demanding extra charge from citizens. Apart from this there are situations where the rag- pickers perform poorly in certain wards compared to others.

With all of the above in mind, it becomes clear that even with the shortcomings, Pune has managed to catch the eye for proper disposal of waste and its management.

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2.6.6 MCD Punjabi Bagh (ward 103) – Time bound Transformation using Citizen's monitoring mechanism

Ward 103 is small but has all the challenges that one would see in Delhi. It has affluent colonies, middle class colonies, slums and an urbanized village. Transforming Urban India in two years may be difficult but transforming one ward and using it as a lab to replicate and transform urban India was the initiative taken by the councilor Ms.Satvinder Kaur Sirsa and her shadow councilor Ms. Bhargava. Their vision was to transform the ward to become one of the best wards in Delhi with facilities that are as good as Jorbagh, Golf Links, Westend etc. The transformation should not be just physical but socio economic as well such that there is no BPL person in the ward, no open defecation, no malnutrition, no slums and so on.

With a lot of help from a multitude of stakeholders, Ms.Bhargava has taken the role of a "shadow councillor" to lead this transformation effort. In UK, there is a shadow cabinet but that is run by the opposition. In this case Ms. Sirsa will take care of all the political, regulatory and statutory duties of a councillor while Ms. Bhargava will take care of all the development activities. The motto is to blame no one and inspire everyone.

Punjabi Bagh is a resident's initiative. It is not an NGO. It has no structure and no bank accounts. It cannot pay money or receive money. A monitoring system was put in place and a large number of residents from ward 103 were needed to help in monitoring the service delivery by the authorities or contractors for various services like street sweeping, manhole cleaning, removal of construction waste, nuisance of burning leaves, storm water drain cleaning, removal of silt on roads, etc. The medium of communication was short messaging service (sms) and social networking sites like face book.

The only role citizen's needed to play was monitoring which does not involve much work - all they have to do is to report the sanitation conditions of the area assigned to them.

The Problem

- Service providers were not meeting service standards
- Garbage rotting at collection points
- Poor health outcomes

The Solution

- Daily self-reporting sms (Green, Red, Yellow)
- Cause if yellow or red
- Random cross check by residents, sanitary inspectors
- Score for ward, score for Delhi (drilldown available)
- Weekly/monthly reports to MCD seniors
- Root cause elimination

The outcome of this initiative was that the score changed in one month from 2.6/10 to 10/10.

Figure 10: Screenshot of a Ward Daily Report

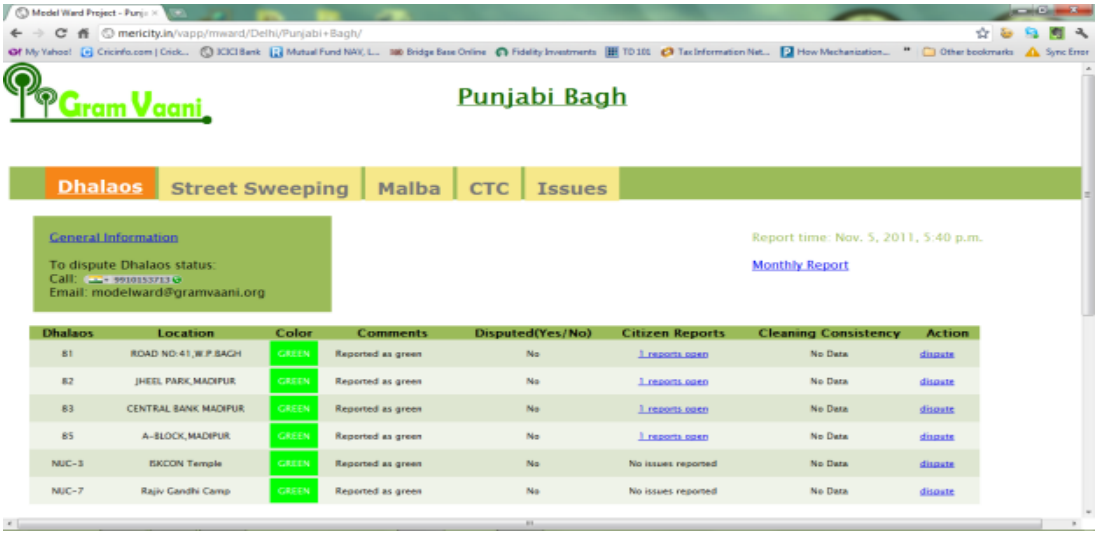


Figure 11: September 2011 Report

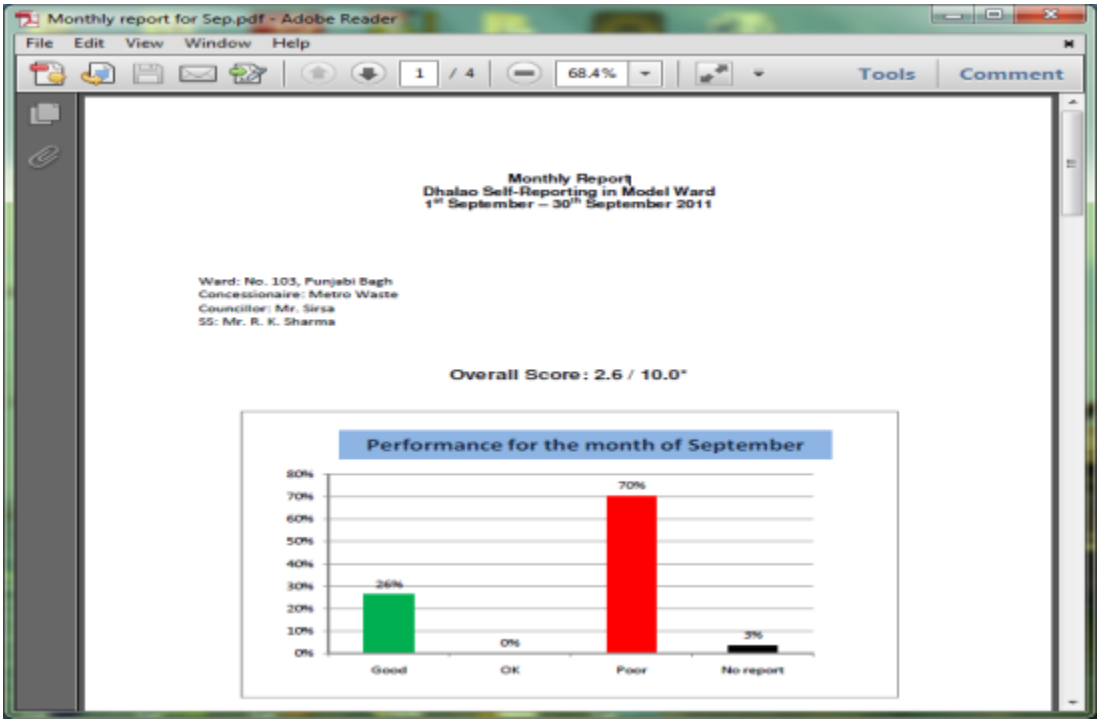


Figure 12: September 2011 Report (2)

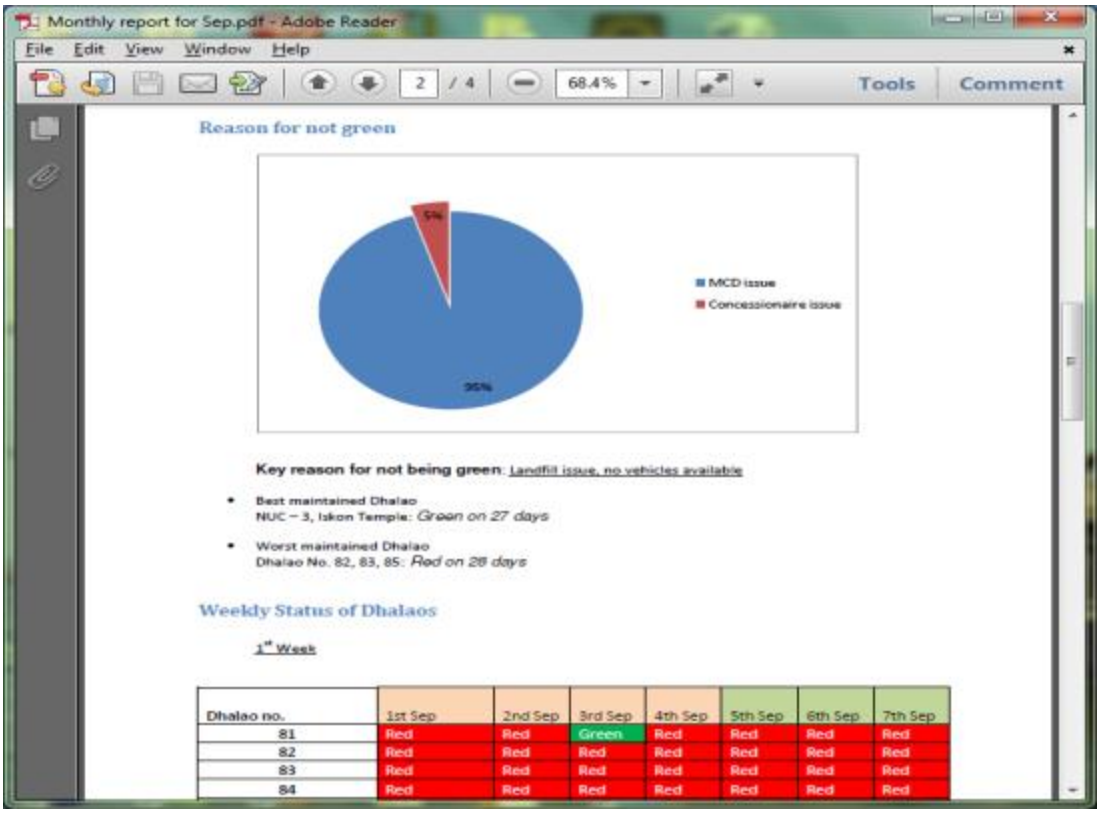
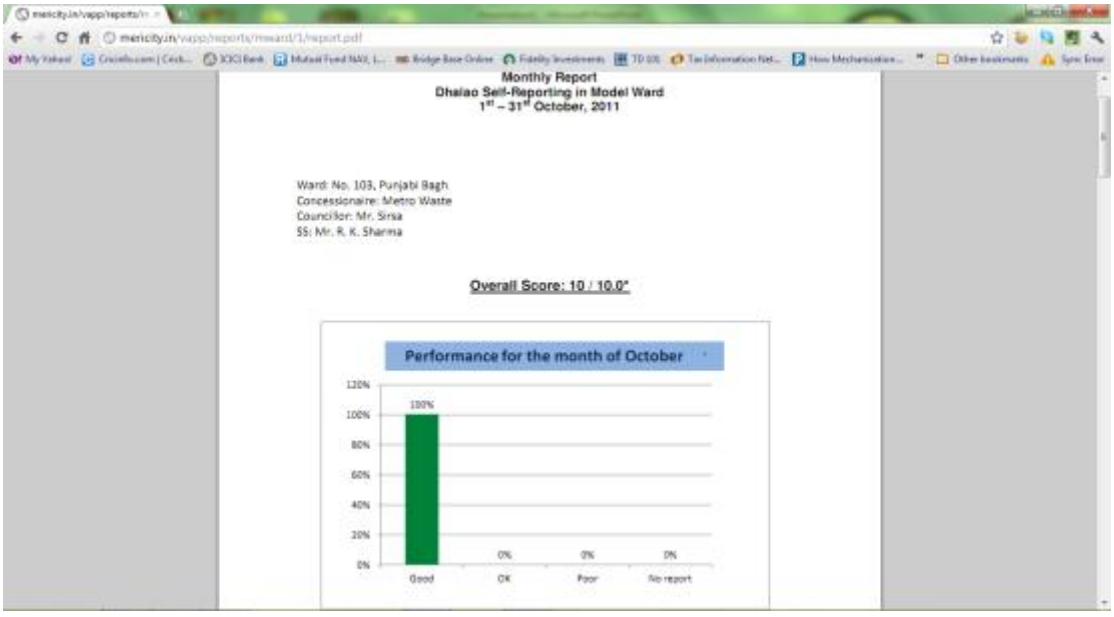


Figure 13: October 2011 Report



Learning

So the problem can only be solved when citizen data is used to support them in their efforts. Municipal Ward 103, Punjabi Bagh, New Delhi (150,000 citizens) is an example to understand how to channelize

the citizen data to create long lasting change. This is an interesting model built around third-party service provider monitoring scheme and public worker incentives and is working by use of technology. The ward is like a lab to understand what works and what doesn't. The key learning's are:

- Natural resistance to self-reporting has to be overcome
- Management must use the reports to seek improvements
- Random cross checks important (though tendency to lie on a daily auditable medium is low)
- Technology helps to make reporting easy and useful (SMS +automated reports)
- Start small and expand items plus geography

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2.6.7 New Moti Bagh Colony at New Delhi gets 'green certification'

New Moti Bagh is a gated, high security, low density, government built luxury residential colony made for the exclusive use of senior civil servants from the Indian Administrative Service (IAS), Indian Revenue Service (IRS) Indian Foreign Service (IFS), and other civil services, Police Officers from the Indian Police Service (IPS), Judges, and high ranking politicians. New Moti Bagh is located in the exclusive New Delhi Municipal Council (NDMC) area of South Delhi, near the Moti bagh, adjoining Chanakyapuri.

Work on the complex started in December 2007. The project was assigned to the National Buildings Construction Corporation (NBCC), a Government of India undertaking. The work on the project was completed in 2012. The Union urban development ministry claims it as the "laboratory" of creating a sustainable neighbourhood in that country that can be replicated by others.

The residential complex, spread over 110 acres, has almost 60% of the land under green area and the ground coverage is only 18%.

Residential Accommodation

There are a total of 492 residential units in the complex: 116 independent bungalows, and 376 large sized apartments. The residential complex has 99 percent occupancy. In addition to the housing for

senior civil servants there are 500 units for servants and other service providers, classified as Economical Weaker Section (EWS).

The project was designed considering that the location of trees. It claims that no trees were cut when the complex was redeveloped. Even the roads have been designed in such a way so as not to cut trees. Over 10% of the trees here are fruit bearing plant. Moreover, 4,156 trees have been planted.

Amenities

New Moti Bagh residential complex is configured like a town ship. It has its own security, with CCTV, scanners, guards, shopping area, bank, subsidized club, primary school, parks, jogging tracks, servant quarters etc.

All units, and public areas, have power back-up. All units are also provided with solar water heating system with assured hot and cold water, solar lighting, waste management system, sewage recycling systems, water management systems and rainwater harvesting system.

Water Management

From October 2013, the Colony has started supplying one lakh liters purified odourless water to New Delhi Municipal Council (NDMC), which is enough to irrigate a park — equal to say two Mughal Gardens in the Rashtrapati Bhawan complex.

It is the first project where a neighborhood residential colony is giving back water to a municipal body. The Township consumes 800,000 liters of water every day, or approximately 1626 liters per household. It generates about 600,000 liters of sewage per day, which works out to about 605 litres per household. The waste water is treated in a waste water treatment facility which has a capacity to purify 5,60,000 litres of waste water per day.

Waste Management

To make the complex a zero-waste colony, a solid waste treatment plant became operational in October 2013. According to Green Planet Waste Management Ltd, which has taken up the project for 10 years, the township generates 4.5 tonnes household and 4 tonnes of horticulture waste per day. This is treated in a solid waste treatment plant, and an organic waste converter machine, which has a capacity of 1.5 tonnes per shift.

Green Certificate for New Moti Bagh Colony

For their initiative of installing a waste water treatment plant and supplying 1 lakh litres of treated water every day to New Delhi Municipal Council (NDMC), New Moti Bagh Colony became the largest residential colony to get green homes certification.

In January 2014, the colony received the tag of Indian Green Building Council (IGBC) Green Homes Silver. IGBC Green Homes is the first rating programme developed in India exclusively for the residential sector. It is based on accepted energy and environmental principles and strikes a balance between known established practices and emerging concepts. The system is designed to be comprehensive in scope, yet simple in operation.

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2.6.8 Advanced Locality Management Scheme of Mumbai

The Advanced Locality Management (ALM) was set in motion in order to establish a civic-citizen partnership model which would be able to tackle the excess of waste generated by the city. As Mumbai is the financial capital of the country, it has seen an unprecedented growth in population over the years. This unregulated growth has given rise to a variety of problems, such as those of housing, water and sanitation, garbage disposal etc. In order to tackle this, it is necessary to include the citizens in certain aspects of governance and make them central to the process of development. With this intension, Advanced Locality Management scheme was formed by MCGM to encourage the collaboration between citizens, municipal administration and waste pickers and to create a sense of ownership in the neighbourhoods. The focus of the initiative was decided as 'waste minimization' and 'segregation of waste at source'. It was initiated in 1997, in Ghatkopar and by 2000 there were 700 ALMs across the city. As of today there are more than 900 ALMs functioning.

The Background

The ALM scheme was started in Joshi Lane, Ghatkopar, which lies in the North Eastern Suburb of Mumbai. The citizens of Joshi Lane were facing the problem of solid waste which gathered on the

streets, blocking vehicular traffic and causing a stench. The MCGM officials were of the opinion that the problem was due to lack of support from the citizens, which led them to hold discussions and meetings with representatives of different societies of Joshi Lane. On the basis of these discussions, it was felt that in order to improve the delivery of services, people's participation was of utmost importance.

Understanding the issue, the residents decided to collectively apply the principle of three 'R's, 'reduce-reuse-recycle' along with segregation of waste at the source. Citizens formed a 'Street Committee' and maintained vigilance to prevent littering. Rag pickers were engaged in this scheme, for door-to-door waste collection and speedy removal of segregated waste. The Street Committee approached the MCGM and formalized the partnership wherein the 'Street Committee' would ensure the three 'R's and waste segregation, whereas the MCGM would carry out street cleaning, regular pick-up of the garbage collection, and disposal. The scheme was then adopted by surrounding lanes voluntarily. In November 1997, the ALM scheme was formalized by the six Street Committees of Ghatkopar and was accepted by the Additional Municipal Commissioner, MCGM for implementation in Mumbai city.

Process of formation of an ALM

One ALM was formed either with members of one housing society or a group of housing societies in a locality - depending on the size of a housing society - the residents and nonresident population of which were committed to improving the quality of life with close cooperation with the MCGM. The two parties in the ALM were: (i) the residents and shopkeepers of the locality and (ii) the administration of the MCGM.

Following were the conditions for residents and shopkeepers to form an ALM:

- The residents form a 'Local Committee' (LC) with one representative from each chawl or building and selected office bearers for interaction with the Municipal Corporation.
- The LC meets once a week and maintain a register to note the problems of the society. The Ward Office to be then notified about the problem and the residents' intention to form an ALM through a formal letter.
- The residents to maintain two components of waste, wet-waste (biodegradable waste) and dry-waste (recyclable waste).
- Dry-waste to be disposed of directly through rag-pickers and wet-waste to be converted to compost through vermi-composting either individually or at community level. The excess waste is to be

handed over to the MCGM. The debris to be disposed of by the generator at the MCGM designated areas.

The following process was set up for the administration of the MCGM:

- An ALM Society is registered with the local Municipal Ward Office, which appoints a Nodal Officer to collaborate with the ALM and attend to citizen complaints. This Nodal officer follows up all the actions required at the MCGM level, based on the requirements and complaints of the ALM. In essence, the Nodal officer co-ordinates the actions required with regards to different departments of the MCGM, at the ward level. This is the essential aspect of this partnership that ensures success of the ALM. In case the complaints are not addressed then the Nodal officer passes them on to the Deputy Municipal Commissioner or the Additional Municipal Commissioner of the same zone.
- A representative of the Ward Office addresses the first ALM meeting.
- During this meeting, major and minor problems of the locality are identified and the problems mentioned in the register are attended to by the Ward Officer.
- MCGM also takes help of local voluntary organizations to speed up the work.
- A common fund is set up at the rate of Re 1 per apartment per day, collected on a quarterly basis. Contributions are received from the residents of the lane and are treated as contribution towards the 'Maintenance Fund'. All expenses are to be incurred from the Maintenance Fund.
- An ALM representative attends the monthly meeting with the Assistant Municipal Commissioner (AMC) at the Ward Office where locality registers and/or unresolved problems are screened by the AMC. General meetings for the whole area are held on monthly or quarterly basis, whose minutes are recorded and then circulated in an ALM Newsletter. During this meeting, all the problems concerning MCGM with respect to the ALM area are discussed among the ALM Committee and other citizens of the neighbourhood.

Institutional Framework

The ALM scheme began to spread and as its success was being felt by the MCGM, the MCGM appointed an Officer on Special Duty (OSD) for the purpose of educating people and creating awareness about the scheme. The OSD coordinated with the overall performance of the ALMs which was reviewed by the Additional Municipal Commissioner. On demand by the ALM citizens, the Ward Officer also allocated a specific day and time to the citizens where different issues like solid waste could be discussed at the Ward Office in the presence of all other heads of the department. The MCGM also allocated areas (usually per councilor ward) to a Nodal Officer to attend to complaints and to actually visit the ALMs.

Various NGOs who were already involved in work relating to local governance and groups of senior citizens involved in civic issues became a part of the ALM process. With the involvement of NGOs, corporates also joined the process.

The role of rag pickers in the overall solid waste management in keeping the city clean emerged as a result of ALM movement and hence MCGM took a decision to support the activities of rag pickers by providing them with sheds, vehicles for dry transportation, open spaces and also helped them in linking with ALM and Co-operatives Housing, Corporate and Ward Office. The rag pickers were involved in the collection of dry recyclable waste directly from individual houses. MCGM started supporting NGOs like Stree Mukti Sangathana (SMS), Force and Akkar Mumbai to organize and train the rag pickers. As a result rag pickers became more organized, received fairer prices to their collection, and better health and insurance services, along with work provided by the NGOs.

The private contractors in turn played a role in the collection, segregation and disposal of solid waste. The role of the beneficiaries is to segregate the waste at source and maintain vigilance on the spot to prevent littering. Besides this, they are also involved in creating awareness among the community for the propagation of the concept of source segregation along with importance of disposal of waste in the bins to avoid littering of roads and other public places.

It can be observed that the institutional mechanism in the present case was formal with specific roles assigned to specific people. Since the initiative for the ALM movement came from the public who compelled the local authority i.e. MCGM to take necessary actions, there was no definite hierarchy in the management framework.

System of waste collection

The residents of the locality are the major players in waste management, being assisted by ragpickers, MCGM workers and the private operators together, depending on the area delineated to each service provider.

Technology Used

Under the scheme, it is mandatory that waste segregation is carried out by the household itself. The wet waste is processed through vermi-culture to form compost at individual or community vermi-composting units. Dry waste is collected by the rag-pickers and directly sold by them to the recycling units.

Outcomes of the ALMs

- ALMs have formed strong citizen's group and are working with M.C.G.M. to improve the civic amenities in their local area.
- Volunteers have evolved from citizens to be active in the local issues, which are big social assets.
- ALMs are working beyond waste management on other environmental issues.
- ALMs are practicing environment friendly activities such as water harvesting, solar panel system.
- Vigilance, safety and illegal hawking are high-priority areas.
- Streets lanes are adopted and maintained them.
- ALM support MCGM by supervising utility services such as BSES cables and offence are brought to the notice of the concerned authorities.
- Educating and Mobilizing citizens from neighboring areas towards carrying the ALM movement forward.

Present status of ALM's

- More than 900 ALMs are formed and the scheme is getting popular day-by-day.
- Ward level meetings conducted regularly by Assistant Municipal Commissioner.
- NGO's such as Stree Mukti Sanghatana, FORCE & AAKAAR are working with various ALM's.
- Incentives given to ALM's in terms of Privilege Cards, Priority of Civil Works in their areas.
- ALM's brought up many issues pertaining to encroachment, hawking, parking which led to never ending disputes at ward level with lack of monitoring & support from higher level.
- Due to interaction with various departments in MCGM, ALM got exposed to many more services of MCGM and hence this increased ALMs demand for civic services.

Limitations observed in implementation of ALM

- Due to lack of infrastructure to collect segregated waste from the administration and lack of space in societies to conduct vermi composting, the ALM lost interest in segregation activities and the focus of segregation was lost.
- ALM activity being a voluntary service was not appreciated and encouraged by political wing and the administrative wing.
- The publicity and awareness mushroomed many new ALM's and MCGM was not in a position to provide sufficient infrastructure and manpower, hence the prime function of segregation at source was diluted by the ALM's

- Administration felt that the ALM's were more complaint oriented. Around 20% of the pressure groups have political agendas.
- Lack of monitoring by a Nodal Officers and lack of awareness among the new nodal officers weakened the feedback system.

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2.6.9 Dry waste collection centre at Domlur, Bangalore

Introduction

'Waste Wise ', an NGO is involved in door-to-door collection of dry waste at households and commercial establishments in Ward No. 112, Domlur, joined hands with BBMP to establish the dry waste collection centre.

This initiative was started on 31st May 2012. The BBMP has given the place/building to the NGO. It is now run by 2-3 micro entrepreneurs who are working towards a target of collecting 1tonne of dry waste per day, i.e., 30 tonnes per month. In June 2012, when it started, the collection was 4.5 tonnes per month which is now increased to 22.5 tonnes per month. Total population of the ward is around 30,000.

The Extent

The NGO is covering 2700 households in the area out of a total of 5000. It also goes and collects dry waste from small shops, commercial establishments and apartments, all inclusive around 25 in number.

- Percentage of households covered: 75%
- Percentage of commercial areas covered: 50%

SWM Infrastructure

Two vehicles, one owned by the NGO and the other owned by two micro entrepreneurs, are used for the purpose of collection of dry waste. Total number of workers under the project is 8. The micro

entrepreneurs and the workers were all rag pickers who have got this opportunity and earn a better living out of waste.

The functioning

The RWAs help in motivating the citizens to segregate the waste into dry and wet, by visiting every household and shop. Waste Wise Trust employees collect the dry waste once a week from the households and twice a week from the commercial areas. They also provide leaflets to the residents and the shopkeepers guiding them about method of segregation. More importantly the leaflet has a helpline number and the time of waste collection. The time of collection is from 8.30a.m. - 3.00p.m. And for individual citizens the time of collection is given differently. The waste is collected by taking the vehicle in front of each household. Announcement system is used for calling and the residents come out to give the waste. An electronic weighing scale is used to weigh the waste and paid on a daily basis accordingly.

The dry waste thus collected is segregated at the centre and the mixed waste is segregated into various categories. It is sold to the dealers at Shivaji Nagar on a daily basis or twice a week. They teach the citizens again in case they are giving wet waste mixed with the dry waste.

Figure 14: Dry Waste Collection Centre at Domlur

Rates fixed for buying Dry waste from the citizens

The rate at which the NGO buys the dry waste from the residents is given below.

Table 16: Rate of buying dry waste from citizens

Type of waste	Rate
Mixed dry waste	Rs.2 per kg
Card board box	Rs.4 per kg
Newspaper	Rs.7 per kg
Metal	Rs.15 per kg

Type of waste	Rate
Glass bottles	50 paisa per bottle
Electrical wires	Rs.20 per kg
E waste (speaker, computer, keyboard, mobile, etc.)	Rs.55 per kg

- Monthly earning of the employees/rag pickers: Rs.8,000-12,000
- Monthly earning of the centre: Rs.55,000-60,000
- Monthly maximum earning of the centre till now:Rs.78,000

BBMP has given the building and the place, while the bills like electricity and water are paid by the centre.

Expansion Plans

There are 6 RWAs who are cooperating in implementation of this initiative. Currently the NGO is covering areas of 4 RWAs and have plans to cover the remaining 2 RWAs within a period of 2-3 months.

Problems faced

Initially the competition was between the informal dry waste collectors and the NGO. BBMP intervened to bar the informal sector from collecting dry waste from the residential areas. Currently, the competition is high in case of commercial areas and there are others like BBMP workers, informal rag pickers, etc. who get the dry waste collected from these areas. BBMP also charges an amount of Rs.3000-4000 to the commercial complexes for providing door-to-door service.

Observations:

- This is a sustainable model where both the residents are benefitting by selling their waste and the NGO workers are able to earn a better livelihood.
- Some monetary assistance can be provided in the initial period. In the early months of the initiative, the centre was earning Rs.35,000 and had 4 workers.

2.6.10 A Case study on operations in Ward 150, Bangalore[23]

Overview

Ward 150 lies in the Bommanahalli zone of BBMP, and is quite reflective of the average ward in Bangalore, with apartments, independent layouts, gated communities, informal street hawkers, small to medium sized shops, large commercial establishments, institutions, offices and slums. Like most other wards, segregation of waste at source has only recently caught on with a wide audience in the ward, primarily owing to the citizen's initiatives to get to a zero-waste ward, and also supported by limited push from BBMP to send notifications to non-segregators. 'Hasiru Dala' – the waste-picker's cooperative entered the scene of waste management in last week of June, 2013. Hasiru Dala's proposal was to collect segregated waste from apartments, and charge the apartments on the basis of differential pricing for different categories of waste.

Pricing strategy for apartments

The pricing for the categories of waste, as well as the destinations of the waste are compiled as follows.

Table 17: Pricing strategy for apartments

Category of waste	Frequency of collection	Processing	Price
Kitchen + Garden waste	Every day	KCDC for composting.	Rs. 1.5 / kilo
Sanitary waste + Reject waste		Landfill through a BBMP contractor. It is proposed to send Sanitary waste to collection centers, once they're operational	Rs. 3 / kilo
Dry recyclable waste, E-waste	Every week	Picked by local waste-pickers / recyclers authorized by Hasiru Dala	Rs. 2 / kilo (apartment receives)
Tubelights + bulbs	Every quarter	Picked by Hasiru Dala and given to an	Rs. 10 / piece

[23] *Comparison of Decentralized waste management (with segregation) vs. Centralized waste management (without segregation), a study conducted by Hasirudala, November 2013*

Category of waste	Frequency of collection	Processing	Price
		authorized e-waste collector	
Construction debris	On demand	Transported to local construction contractors for filler material.	Pending BBMP approval for dumping site.

The comparative analysis on decentralized treatment of segregated waste vs centralized treatment of un-segregated waste that follows is based on the data collected by Hasiru Dala in the operations since July 2013.

Participating apartments considered for the report

Hasiru Dala services 7 apartment complexes, and these complexes are considered for the analysis below:

i) Mantri Flora Apartment – 320 households
ii) Trinity Acres and Woods Apartment – 220 households
iii) Springfields Apartment – 550 households
iv) Oceanus Trinton Apartment – 90 households
v) SJR Verity Apartment – 310 households
vi) Raindrops Apartment – 120 households
vii) Ozone Residenza Apartment – 40 households

Table 18: Comparison of decentralized destination-bound collection vs centralized collection

Category of comparison	Centralized treatment of un-segregated waste (till July 2013)	Decentralized treatment of segregated waste (from July 2013 onward)
Number of households under consideration	1650	1650
Number of apartment complexes	7	7
Weighted average cumulative amount of waste sent to landfills / month	49.7 tons / month	14.4 tons / month
Weighted average cumulative amount of waste sent to landfills	1.66 tons / day	480 kgs / day

Category of comparison	Centralized treatment of un-segregated waste (till July 2013)	Decentralized treatment of segregated waste (from July 2013 onward)
/ day		
Weighted average amount of waste sent to landfills / day / household	1kg / day / household[1]	290gms / day / household[1]
Total distance for landfill site – round trip	120kms / day (Dodaballapur)	56kms / week (Mandur)
Total distance for wet waste destination (KCDC) – round trip	-	12kms / day
Total distance for dry waste destination (segregation godown) – round trip	-	9kms / day
Weighted average distance of transporting waste to respective destinations	60kms / day	34kms / day
Weighted average cost of diesel for transporting waste to destinations	Rs.450/day	Rs.230/day
Average cost of tipping fee paid by BBMP at landfill / month (@Rs. 250/ton)	Rs.12,425 / month	Rs.3,600 / month
Number of people involved in transportation	6	4
Number of people employed in secondary segregation of primary segregated waste	0	3
Average cost / household / month for waste pickup services offered	Rs.100 / month / household	Rs.70 / month / household

2.6.11 San Francisco (Sister City Of Bangalore)

Table 19: San Francisco-General information

Country	United States
State	California
Population:	805,235 (2010)
Area	121 sq.km
Population density	6,633/ sq.km
Average Annual Rainfall	518.16 mm
Average Temperature range	8oC to 21oC
Altitude:	16m above sea level
Waste diversion rate	77%
Waste generation	1.7 kg/capita/day

San Francisco has a remarkably high per capita waste-generation rate 1.7 kg/capita/day. Over 70% of this waste is generated by businesses and institutions.

San Francisco has established itself as a global leader in waste management. The city has achieved 77 percent waste diversion, the highest in the United States, with a three pronged approach:

- Enacting strong waste reduction legislation,
- Partnering with a like-minded waste management company to innovate new programs, and
- Working to create a culture of recycling and composting through incentives and outreach.

The city's waste is regulated primarily by the San Francisco Department of Public Works and Public Health. The Department of Environment (SFE) is responsible for reaching the city's zero waste goals.

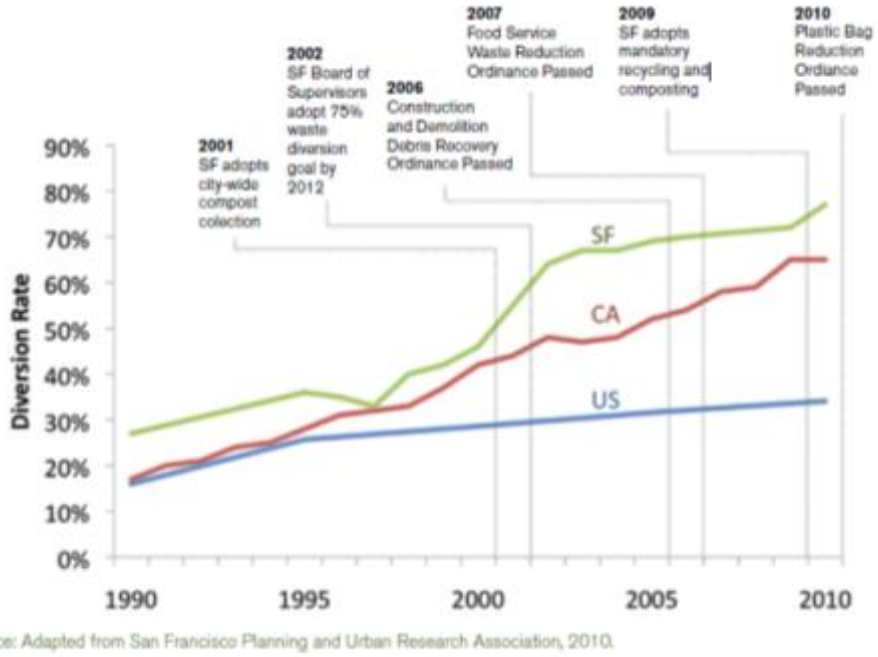
SFE works closely with Recology, the private waste management partner with a union workforce that collects, recycles, and disposes of all commercial and residential waste in the city. SFE's Zero Waste team focuses on outreach, implementation of city-mandated recycling programs in sectors, and advancing waste reduction policy at the local and state level.

Building upon Legislative Successes

San Francisco's zero waste journey began with enactment of a state law in 1989, the Integrated Waste Management Act. The law required cities and counties to divert 25 percent of municipal solid waste by

1995 and 50 percent by 2000. Over the last two decades, San Francisco built upon this requirement by passing several successive ordinances that targeted additional areas of the waste stream.

Figure 15: San Francisco Waste Legislation and Diversion Rates



Source: Adapted from San Francisco Planning and Urban Research Association, 2010.

In 2002, the city set an ambitious goal to achieve zero waste to disposal by 2020. Since then, legislation has pushed the city residents, and businesses to increase their recycling rates. These waste reduction laws include the Construction and Demolition Debris Recovery Ordinance of 2006 and the Food Service Waste Reduction Ordinance of 2007, which requires restaurants to use compostable or recyclable take-out containers. In 2009, after residents and businesses became accustomed to voluntary composting, San Francisco passed a landmark law that mandated recycling and composting for all residents and businesses. Most recently, the city passed an ordinance requiring all retail stores to provide compostable, recycled, or recyclable bags starting from October 2012.All of these laws have been timed so that the necessary infrastructure is available, and participants are given support, tools, and education. The legislation also empowers SFE to roll out programs to every home and business and enforce rules as needed.

One reason for the continued engagement on zero waste is a citizen base that demands a political commitment to environmental sustainability. Another driver for passing these waste reduction laws is the cost associated with land filling at the Altamont Landfill in Livermore, 82 km away, where San

Francisco hauls its waste daily. The city, which does not own its own landfill, contracted with Waste Management for capacity at Altamont in 1987. The contract allows for 65 years of capacity or 15 million tons of capacity, whichever arrives first. At a rate of 1,800 tons daily, the city expects to hit its capacity limit by 2015 or, based on newer diversion figures, by 2016. In anticipation, San Francisco just awarded its next waste disposal contract to Recology, at a new landfill in Yuba County, under similar terms: 10 years or five million tons of capacity, whichever comes first. Hence, increased diversion and hitting zero waste goals will continue to create real savings in landfill costs.

Partnering with a Local Company Yields Inventive Programs

San Francisco's current recycling system, the Fantastic 3, started in 1999. The program uses black, blue, and green carts for trash, recycling, and composting, respectively. Fully rolled out in 2003, businesses and residences segregate waste at the source, and double-chambered back-loading trucks pick up the trash and recycling bins. Smaller side loading trucks pick up compostables. The Fantastic 3 program was one of the first in the United States to scale up collection and composting of biodegradable waste.

Figure 16: Fantastic 3 program using black, blue and green carts for trash, recycling and composting respectively

Garbage and recycling collection rates are structured to incentivize recycling and composting for both Recology and its customers. All customers pay a minimum collection service fee to Recology, plus additional fees based on the volume of garbage they create. For residents, Recology provides recycling and composting services at no additional cost. For businesses, these services are discounted up to 75 percent of trash services to encourage businesses to cut down on the more expensive garbage fee. With this strategy, Recology profits in two ways: first it retains the revenue it receives from recycling and composting services, as well as final sale of recyclables and compost; second, it receives up to a US $2 million bonus based on exceeding company-wide diversion goals and reducing citywide disposal. To help meet goals and increase the value of diverted materials, the company has invested heavily in recycling infrastructure, including mixed recyclables materials recovery facilities (MRF) and several regional composting sites. Notably, it has also developed a market for compost that goes to local farms and gardeners, thereby improving its own return and closing the loop.

Also noteworthy is that San Francisco has a thriving informal recycling sector. The statewide bottle bill places a 5 or 10 cent value on glass and plastic bottles and over 20 recycling centers in the city where residents or collectors can redeem them. The city has a small population of people who make a living collecting cardboard, metal, and e-waste which have higher value markets because of environmentally preferable purchasing rules for state agencies, state laws requiring post-consumer recycled content, and access to robust domestic and international markets.

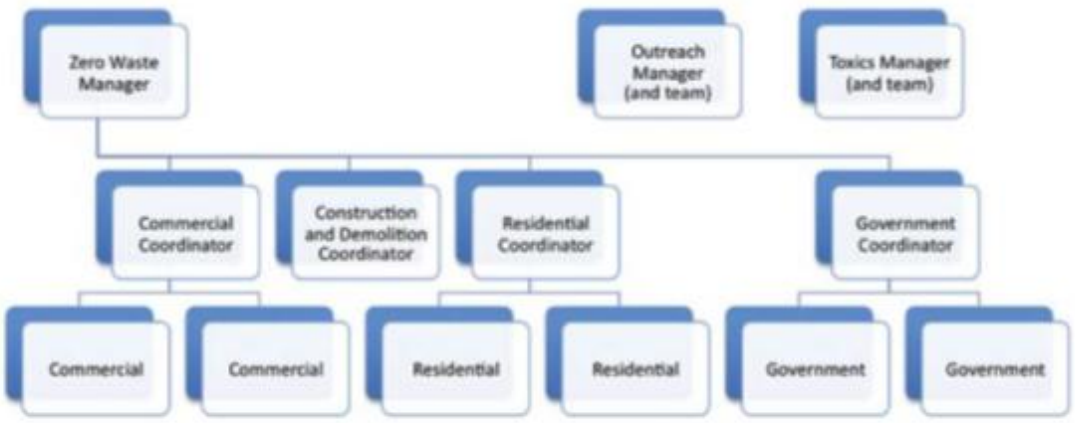
Another benefit of the longstanding relationship with Recology is that the city and company both value local hiring and well paying, union jobs. The agreement between Recology and the Port of San Francisco for leasing land at Pier 96 includes a first-source hiring provision. This requires Recology to fill entry-level jobs first with San Francisco's Workforce Development System, so that these jobs go to economically disadvantaged people from the city. The jobs are well paying, with a starting rate of US $20/ hour compared to the city minimum wage of US $10.24/hour. The city also requires that Recology provide health benefits for workers. For its part, Recology prides itself on employee well-being and ownership; employees bought out the company in 1986 and started an employee stock options plan. Out of 2,500 employees, approximately 80% own shares in the company. Recology drivers and recycling sorters are represented by the Teamsters union.

Shifting to a Culture of Zero Waste

The city of San Francisco has been extremely successful in altering the minds, habits, and culture of its citizens to accept the goal of zero waste. In March 2012, the city marked its millionth ton of organic waste turned into compost. Milestones and metrics like these have been essential in creating the story of zero waste.

The city's Zero Waste division is comprised of 11 employees, assigned to different waste segments. The program has one manager, four experts in commercial waste, three in residential waste, and three focused on the city government (see chart below). In addition, there are several people focused on toxics reduction in a different program, as well as a separate Outreach division. These 11 positions are responsible for all strategies, programs, policies, and incentives to reach zero waste.

Figure 17: San Francisco's Department of Environment Zero Waste Division



Source: San Francisco Department of the Environment

For the commercial sector, one position is focused on construction and demolition waste, working with builders and contractors to deconstruct and recycle building materials at Recology's MRF in San Francisco. Two positions work to help companies fully adopt the Fantastic 3 program and ensure they are in compliance with San Francisco's mandatory recycling and composting law. Out of 18,000 to 20,000 commercial accounts, approximately 80 percent of companies were separating their organics by 2012; SFE's focus is now the remaining 20 percent. The last commercial role is focused on policy initiatives such as Extended Producer Responsibility, statewide legislation, or ballot measures.

In the residential sector, all buildings with fewer than six units separate their organics for collection, as do most of the large-scale multi-family dwellings (7,200 of 9,000). The city is now focusing on the remaining 1,800 buildings of six or more units that may not be composting, estimated to be 20 percent of buildings in San Francisco. This includes public housing, single room occupancy residences, and rent-subsidized buildings.

One goal is for city government, which produces 15 percent of the city's waste stream, to lead by example. For this reason, three people are primarily focused on government waste reduction and management. To help reduce waste, an online virtual warehouse facilitates exchange of surplus supplies among city agencies. It also aids the city in green purchasing.

In addition to the small Zero Waste team, there are separate outreach programs within SFE, employing 20 environmental advocates. Most of these positions come from Environment Now, an annual green job training program run by SFE. Participants in the Environment Now program come from all over San

Francisco, particularly underserved communities. These city employees conduct outreach activities on behalf of all the programs at SFE, including Energy Efficiency, Renewables, Toxics Reduction, Clean Air, and Urban Forestry and Gardening. Because they hail from these areas themselves, the advocates are able to reach traditionally hard-to-reach audiences and improve community participation in environmental initiatives. For the Zero Waste Program, outreach occurs after program rollout, to help create recycling and composting habits once the infrastructure is in place.

Part of the success of SFE can be credited to consistent funding—not from the city, but directly from the rates paid for garbage collection. The overall budget for the Zero Waste Program is approximately US $7 million annually. These funds come out of an account Recology pays into regularly from its collection revenues.

Future Goals and Zero Waste

San Francisco landfilled 15 percent less in 2010 than it did in 2009. Its disposal in 2010 was approximately half what it was in 2000. In 2010, San Franciscans each generated 1.7 kg of waste, 77 percent of which was recycled. The city estimates that of the remaining 23 percent, another 75 percent is recyclable, which would bring the recycling rate up to 90 percent. The city is close to ensuring full adoption of the Fantastic 3 program; it has taken two decades for a behavioral and cultural shift to occur across the city. While SFE goes after adoption by the last 20 percent of larger multi-family dwellings and businesses, it is also setting its sights on a new plant to sort the garbage itself. A low temperature, mechanical/biological separation plant, possibly with anaerobic digestion, would allow sorters to pull apart bags of garbage and recover smaller parts of the waste stream. Ideally, this would be in place before the zero waste dead line of 2020.

Through a unique synthesis of regulation, a long-term partnership, and engaged outreach, San Francisco is creating a model zero waste program.

References

San Francisco, USA,Creating a Culture of Zero Waste, By Virali Gokaldas

NEWS \ GRISTMILL \ CITIES OF THE FUTURE

2.6.12 **Singapore - Integrated thinking in Solid Waste Management**

The small island nation of Singapore - where waste production rose six-fold from 1970 to 2000 - has been facing the challenge of handling waste with limited space. Integrated planning and the goals towards zero waste and zero landfill are now turning the tide on waste.

Singapore is a highly urbanized and industrialized small island nation with a land area of 697 km2 and a population of 4.2 million. It has four waste-to-energy refuse incineration plants and an offshore sanitary landfill for the disposal of non-combustible waste.

Given that the rate of waste disposed by its citizens had risen six-fold between 1970 and 2000, it is no surprise that the nation has set an ambitious target to achieve zero landfill. Indeed, if this growth in waste were not curtailed, Singapore would need to build a new 3000-tonne/day incineration plant every five to seven years and a new 350-hectare landfill every 25 years to cope with the waste.

To address this potential problem, Singapore has set up an integrated solid waste management system in the past three decades that incorporates recycling, collection and disposal. Working hand in hand with key stakeholders in the private and government sectors as well as the general public, Singapore's National Environment Agency (NEA) has formulated a range of strategies and programmes to achieve its objectives for curbing waste growth and supporting sustainable waste management.

Waste minimization

The key objective is to reduce waste production. In this regard, the main portion of Singapore's non-combustible waste comes from construction waste, stabilized industrial sludge and used copper slag from the marine industries, residues and ashes.

Over the years, much of these have been diverted for reprocessing. For instance, 94% of the construction and demolition waste was recycled in 2005. At the same time, the country has also adopted specific measures to minimize waste generation, such as the careful selection of design and construction methods that minimize waste production. For example, contractors who want to tender for large government projects are required to be ISO-14001 certified.

By undertaking these measures, Singapore is taking a big leap forward to achieving the ultimate goal of 'Towards Zero Landfill'. And it is not resting on its achievements so far. The next step is to raise the bar by striving for zero waste. This means moving upstream to avoid waste at source and bringing the producers of waste on board to collaborate with the NEA and the community to reduce waste.

For example, the NEA, the Singapore Environment Council, major supermarkets and the Singapore Retailers Association jointly launched the campaign 'Why Waste Plastic Bags? Choose Reusable Bags' in February 2006.NEA has also initiated a voluntary packaging waste programme with the industry to reduce packaging waste in Singapore. The agreement is scheduled to be finalized and signed by mid 2007 and would last for five years.

Figure 18: The Semakau Offshore island landfill

The Semakau offshore island landfill

The Semakau offshore island landfill receives the non-recyclable, non-combustible parts of Singapore's waste and is designed to be in harmony with the surrounding ecosystem

Recycling

The second strategy the NEA adopted is to promote waste recycling in the industrial and commercial sectors as well as in households.

Recycling commercial and industrial waste

About half the waste disposed of in Singapore comes from the industrial and commercial sectors. These companies have to pay for the collection and disposal of their waste. This approach, coupled with encouragement by the National Environment Agency, has helped to motivate the industrial and commercial sectors to recycle wastes such as metals, construction and demolition waste, horticultural and wood waste, slag, plastic and some types of food waste. In 2005, 94% of construction and demolition waste, 92% of ferrous waste, 51% of horticultural waste and 7% of food waste were recycled.

To promote adoption of innovative environmental technologies, the NEA has set up a SG$20 million (€10 million) Innovation for Environmental Sustainability (IES) Fund. The IES Fund provides financial grants to assist Singapore-based companies to defray part of the cost for trialing innovative environmental technologies that could contribute to environmental sustainability. Recycling projects supported by the IES Fund include:

- Production of pre-cast concrete drainage channels using recycled aggregates
- Conversion of horticultural waste into packaging materials
- Processing of ladle furnace slag, a by-product of the steel-making process, into road construction material.

The recycling industry in Singapore comprises companies with the capability and capacity to recycle and process electronic waste, food waste, wood waste, horticultural waste, used copper slag, construction and demolition waste, ferrous waste and plastic waste.

Recycling in the community

In April 2001, the NEA launched the National Recycling Programme (NRP) to provide a convenient means for residents of public and private housing estates to recycle. Under the NRP, recycling bags or bins are distributed to each household for residents to store their recyclables. The recyclables are collected once every two weeks by the appointed recycling companies.

The participation rate in the NRP was 15% at the start of the programme and reached 56% in 2005. To further enhance the NRP, the NEA is working with its partners to provide all housing estates with recycling bins placed at convenient locations. This will make it even more convenient for residents to recycle as they will be able to deposit their recyclables whenever they want, in addition to the collection every two weeks.

Public recycling bins

Furthermore, almost 6000 public recycling bins have been placed at locations with high human traffic. These include places outside several mass rapid transit (local train) stations, food centres, bus interchanges, airport terminals and pedestrian malls.

Recycling in schools

In September 2002, the Recycling Corner Programme for schools was launched with the aim of educating and inculcating good 3R (reduce, reuse and recycle) habits in young people. Recycling bins for

paper, drink cans and plastic bottles are placed at Recycling Corners within school premises. Students take charge of the Recycling Corners and put up interesting information and displays about the 3Rs.

These activities help generate interest and build a sense of ownership among the students. By the end of 2006, 84% of schools had joined the Recycling Corner Programme.

Highly enthusiastic students are also identified by the schools and trained as Environment Champions to promote recycling in their schools. They are responsible for conducting talks on the environment and assist in planning, organizing and running recycling/environmental activities.

3P partnership and public awareness

The NEA has been engaging grassroots organizations, non-governmental organizations and educational institutions in holding environment-related events and encouraging them to lead in reaching out to the rest of the community. This is referred to as the 3P sectors partnership - referring to the people (general public), private (non-government) and public (government) sectors.

The educational and awareness programmes on the 3Rs are sustained and targeted to the community, schools and the work force. One such awareness campaign is the annual Recycling Day. The aim of the campaign is to keep reminding the public - schools, community, non-governmental organizations and recycling companies - of the importance of recycling. At the opening ceremony of Recycling Day 2006, the Minister for the Environment and Water Resources, Dr Yaacob Ibrahim, launched a new scheme to recover and recycle used drinks cartons. The scheme was a collaborative project with Tetra Pak Singapore and the recycling companies.

Volume reduction through incineration

Given the land scarcity constraint, it is not surprising that Singapore has adopted waste-to-energy as a disposal method. Incineration reduces waste volume by 90% and only the ash remaining after incineration and the non-combustible waste, which constitutes 10% of waste disposed, is sent to Singapore's only landfill - Semakau landfill.

The incineration plants are fitted with advanced pollution control equipment comprising electrostatic precipitators, lime injectors and fabric filters to treat and clean the flue gas from the combustion process. Heat from combustion is used to generate steam in boilers which drives turbines to produce electricity. In 2005, the four plants generated a combined total of 938,284 MW of electricity. Scrap iron is also recovered and recycled at a local steel mill.

Although incineration offers the advantage of high waste volume reduction and helps to conserve landfill space, it is by itself not adequate if more waste is generated each year. This would then put additional demand to build more incineration plants and landfills.

Semakau landfill

The SG$610 million (€305 million) offshore Semakau Landfill extends over an area of 350 hectares and has a fill capacity of 63 million m3. To create the offshore landfill space, a 7 km perimeter bund (embankment) was built to enclose part of the eastern sea area off the island, Pulau Semakau, as well as another small island, Pulau Sakeng. The entire perimeter bund is then lined with an impermeable membrane. Any leachate generated within the site is treated in a dedicated leachate treatment plant to national discharge standards and the effluent is discharged into the sea.

A corresponding marine transfer station, which sits on a seven-hectare site on the western end of the main island of Singapore, receives waste which is dumped into barges. The waste comprises the non-combustible components of Singapore's waste, such as construction and demolition waste, stabilized industrial sludge, and copper slag, as well as ash from the refuse incinerators. The barges then make a 25 km sea journey to the landfill, where the waste is unloaded onto dump trucks for the final journey to the operating cells. Bulldozers and compactors are deployed to spread out and compact the waste.

Figure 19: Marine Transfer station

Figure 20: Dump Trucks

A unique aspect of Semakau landfill is that throughout its planning, design and construction, and since the start of its operation, painstaking efforts have been made to protect the island's ecosystem and preserve its rich natural environment and biodiversity. In July 2005, the landfill was opened for

recreational activities organized by three special interest groups - the Sport Fishing Association of Singapore, the Nature Society of Singapore, and the Raffles Museum of Biodiversity Research (RMBR). The Semakau landfill has since received more than 1300 visitors.

The visits came after extensive surveys lasting more than a year by the RMBR to map out the inter-tidal community present in the western coast of the island of Pulau Semakau, which was protected by special screens at the eastern part of the island during construction to avoid adverse impact on marine life.

Experts were also engaged to ensure that the replanted mangroves in two plots totaling 13.6 hectares grew well. Today, these mangroves, which were planted to replace those uprooted during construction, are thriving. While there is a network of monitoring wells along the perimeter bund of the landfill, the mangroves can help act as second-line indicators of pollution should there be a leak in the impermeable membrane.

Conclusion

By adopting its waste strategies, Singapore has seen an increase in recycling rate from 40% in 2000 to 49% in 2005. Waste growth has also been curtailed. The total waste (domestic and non-domestic) disposed of in 2005 was 7000 tonnes per day, an 8% reduction compared to 2000. As a result, the lifespan of Semakau landfill has increased from 30 years to about 40 years, while the need for additional incineration plants has been reduced from one in every 5-7 years to one in every 7-10 years.

By reducing waste disposal at the incineration plants and landfill, Singapore is striving towards achieving its long-term goals of 'Towards Zero Landfill' and 'Towards Zero Waste'.

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http://www.waste-management-world.com/articles/print/volume-8/issue-1/features/integrated-thinking-solid-waste-management-in-singapore.html

3. SOLID WASTE MANAGEMENT IN BANGALORE

3.1 CURRENT CHALLENGES

Before the economic growth in 1990, the municipal solid waste generated in Bangalore was a resource for the surrounding villages for purpose of agriculture and fodder for cattle/piggeries. However, last two decades of economic growth has changed the composition of waste. The quantity of municipal solid waste generated in Bangalore is increasing rapidly due to high growth in population and changing lifestyles. One of the major changes with economic growth is the tremendous increase in packaging materials (plastics, thermocol, tetra packs, etc.) which is getting mixed with the resourceful organic waste and creating a havoc of this simple municipal service.

Due to mixing of all the waste generated in the city, the entire waste becomes unusable and has to be dumped in the landfill sites. The dumping has been ongoing and with increased un-segregated waste reaching the landfill sites/ dump sites, objections have been raised by the surrounding villages for the nuisance created by the dumping – mainly smell, ground water contamination, flies, etc. The problem in managing the huge quantities of solid waste management generated every day is the result of non-segregation of resourceful waste. BBMP on the directions of the Hon. High Court has initiated a series of steps to remediate the existing dump/land fill sites and also prevent more un-segregated waste reaching the landfill/dump sites.

3.2 KEY STATISTICS RELATED TO SOLID WASTE MANAGEMENT

Based on the secondary data collected from BBMP, the following facts and figures on solid waste management were gathered:

- Population (Census 2011): 8.4 million
- Area (BBMP): 800 sq.km
- Total number of wards: 198
- Total number of households:25 lakhs (approx.)

- Commercial Properties: 3.5 lakhs (approx.)
- Total road length: 14,000 km
- Estimated Municipal Solid Waste generation projection from all sources for BBMP zones: 4000 MTPD
- Annually about Rs.250 crores is spent on solid waste management (BBMP pourakarmikas salary, contract payment, tipping fees)

The current practice of solid waste management at BBMP is, about 70% of the MSW (Municipal Solid waste) activity starting from primary collection to disposal has been outsourced & 30% is managed by BBMP. Around 70% of the waste generated is organic. The balance is accounted for inorganic and hazardous waste.[24]

The current practice of primary collection (door to door) as well as the secondary collection and transportation is in place. The waste is disposed in the dump / landfill sites at the end.

3.2.1 Primary Collection (Door to Door collection)

- The primary collection is performed using pushcarts & auto tippers
- There are around 11,000 pushcarts & 650 auto tippers for Door -to-Door collection
- There are about 4,300 Pourakarmikas (Sweepers) of BBMP & 10,000 Pourakarmikas (Sweepers) from contractors who perform door-to-door collection & sweeping activities.
- In some of the residential areas the Residential Welfare Associations (RWA's) are involved in door-to-door collection & decentralization of composting the waste.
- Waste is collected in unsegregated form as segregation is not practiced at source.

3.2.2 Secondary collection and Transportation

- There are about 600 MSW transportation vehicles including Compactors, Tipper Lorries, Dumper placers & Mechanical Sweepers both BBMP and contractors.
- The waste collected from the households is brought to a common point i.e., secondary locations from where it is shifted to the treatment sites through compactors & tipper lorries.
- Segregation at source & at secondary storage is not happening hence unsegregated waste reaches the disposal site.

[24] *http://bbmp.gov.in/web/swm/welcome*

3.2.3 Street Sweeping

Street sweeping is performed both manually & mechanically. In some of the highly commercial activity areas sweeping is done at night & in the VIP areas the sweeping is done mechanically. The street sweeping waste is carried along with the primary collection waste to the land fill sites.

3.2.4 Decentralized processing plants

Some of the areas where RWA's are performing door-to-door collection, the waste is segregated at source & the organic waste is composted in the community at a small scale.

BBMP had established a decentralized one ton capacity aerobic composting unit at Malleshwaram market (West Zone) using organic waste convertor. However it is in the process of shifting to a location close to the dry waste collection center, due to temporary shifting of the market for renovation works.

3.3 CURRENT PRACTICES OF SOLID WASTE MANAGEMENT IN BANGALORE

3.3.1 Policy and Legislative

In order to handle the solid waste, the State of Karnataka has taken an important initiative towards long-term solutions to SWM based on MSW Rules 2000. Karnataka has formulated the State policy for implementation of Integrated Solid Waste Management (ISWM) laying down guidelines for all the activities under MSWM, defining roles and responsibility of all the stakeholders namely, ULBs, elected representatives, waste generators, NGOs, CBOs, SHGs, etc. It created the post of Environmental Engineers in 123 local bodies to build technical capability. SWM Action Plan and Management Plans for 56 cities were prepared based on data pertaining to concerned ULBs. The State also prepared technical manuals on (a) design and specifications of the tools and equipment for SWM and (b) treatment and landfill operations.

A series of workshops was conducted for the local body officials, elected representatives, NGOs, etc., for preparation of action plan, adoption of State policy, identification of best practices, carrying out of Information, Education and Communication (IEC) activities and identifying suitable landfill sites for treatment and disposal of waste.

The State has issued orders for transfer of government land free of cost to the 226 local bodies for sanitary landfills, issued guidelines for identification and purchase of private land for this purpose and, if required, provides 100 per cent financial assistance to purchase the identified land from a budget

allocation of Rs.16.1 crore. The government initiated action to develop scientific landfill sites in eight class 1 cities on BOT basis.[25]

3.3.2 SWM Policy - Bangalore

Policy of Integrated Solid Waste Management 2012 for BBMP was prepared by the Department of Environmental Cell. The policy indicates the plan of action for separate collection and management of bulk waste, door-to-door collection and street sweeping, processing and land filling. It also includes the responsibility of BBMP towards plastic waste, bio-medical waste, hazardous waste and e-waste rules. The policy gives the plan to implement the actions by involving various stakeholders; zone wise action plan for scientific waste management; financial sustenance of SWM activity; administrative structure and; targets and monitoring mechanism. The policy includes ways of involvement of private sector for MSWM through appointment of independent private agency for bulk waste producers; house-to-house collection contracts to waste pickers/NGOs or SHGs; comprehensive contracts with contractors providing their own vehicles and responsible for Labour Laws; performance oriented contracts based on outputs and not inputs. A guideline for PPP in waste processing is also part of the SWM Policy for Bangalore. The SWM Policy for Bangalore includes the normative standards for door-to-door collection, street sweeping, secondary storage and for segregation bins/bags for storage on premises. It lists the schedule of fines on general public for not abiding by the rules and penalty for collection and transportation by the service provider.[26]

3.3.3 Current Administrative Structure for MSWM in BBMP

All the wards in BBMP are grouped into small packages for contract purposes. Each contractor is given the responsibility of 2-3 packages depending upon the economics and scale. A comprehensive contract is awarded to the successful bidder for collection, transportation and final disposal of solid waste.

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[25] *Asnani, P. U., 2006. Solid Waste Management, Chapter 8 in India Infrastructure Report. Oxford University Press, New Delhi.*

[26] *2012, Policy on Integrated Solid Waste Management, Department of Environment Cell, BBMP http://218.248.45.169/download/engineering/iswmp.pdf*

Role of Pourakarmikas or contract workers:

There are two types of workers involved in these packages. Permanent employees of BBMP called pourakarmikas and contract workers. If there are Corporation pourakarmikas already assigned in a package, that many number of workers are reduced from the contract. These workers sweep the roads in addition to the door-to-door collection from the households in a prescribed area using pushcarts. The workers transfer the collected wet or mixed waste to an auto tipper or to a designated place in the ward. They also take the separately collected dry waste to the dry waste collection centres or to the junk shops.

Role of Supervisory Staff:

Junior Health Inspector is there for every ward. His role is to supervise the work of the BBMP pourakarmikas and also the contract workers. He has to supervise the sweeping, collection of waste from households and transfer of waste to the trucks or compactors.

In some of the wards the Junior Health Inspector is supervised by a Senior Health Inspector. However, not all the wards have Senior Health Inspectors. In those wards the Junior Health Inspector reports to the Assistant Engineer or Junior Engineer of the ward. There are Assistant Executive Engineers in each sub-division to whom Assistant Engineer or Junior Engineer reports about the activities of solid waste.

At the zonal level there are Superintendent Engineer, Chief Engineer and Additional Commissioner to monitor the activities of solid waste management.

Advantages:

Based on the SWM (M&H) Rules 2000, the posts for environmental engineers have been created. The responsibility of day-to-day monitoring of solid waste services has been decentralized and entrusted to supervisory staff working at the ward level.

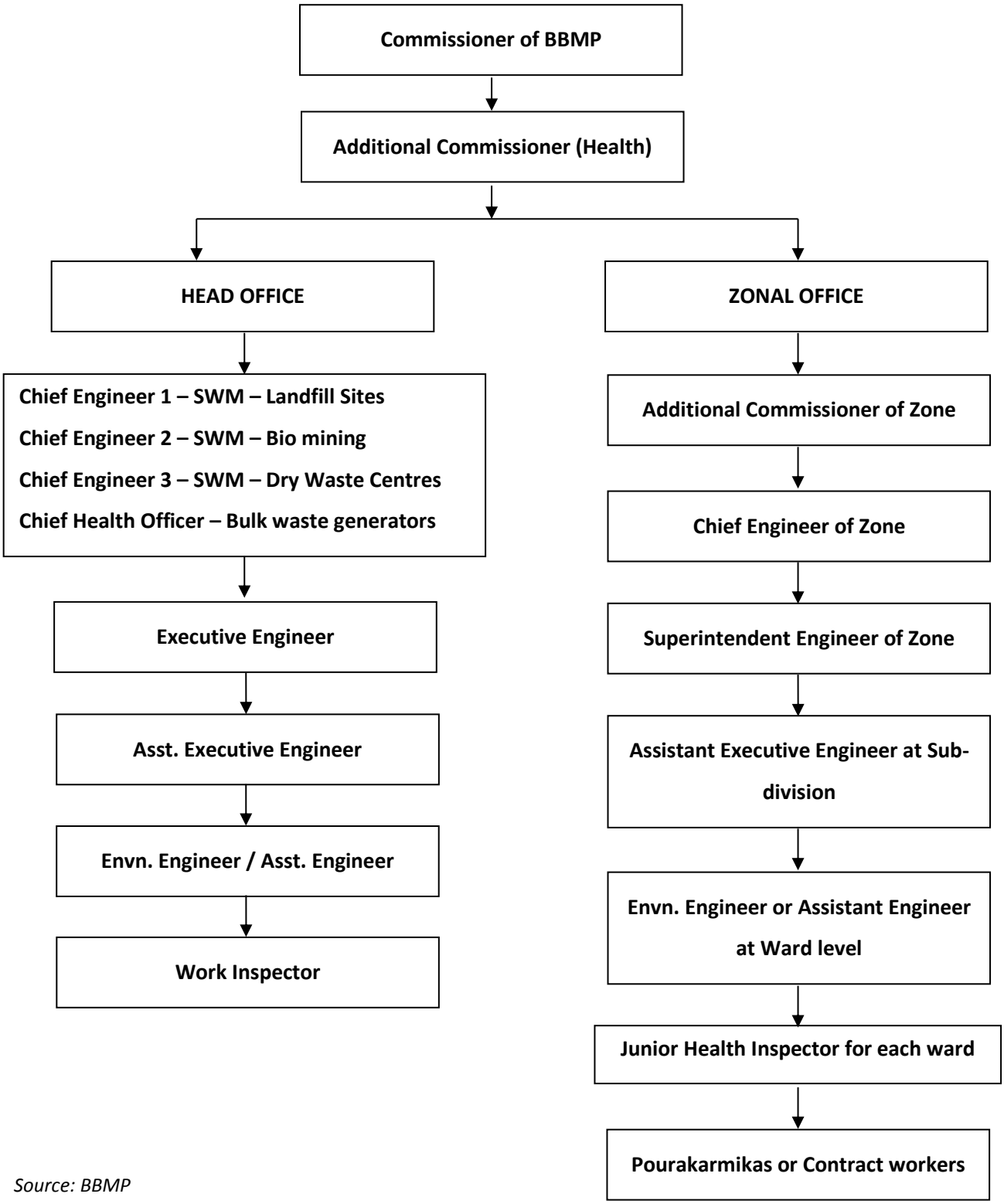
Limitations:

As per the SWM policy suggestion, Environmental Engineers for every sub division is required to monitor the day to day activities of SWM. However BBMP failed to get so many Environmental Engineers. At present civil engineers are assigned the task of monitoring. Also inadequacy in career growth avenues for qualified / specialized staff is demotivating.

Solid Waste Management activity has been decentralized. Due to this, the monitoring at each ward depends upon individual chief executive and the success in implementation of solid waste management rules also depend upon his extraordinary championship. As soon as this champion is transferred, the effort seems to get dissolved.

At the zonal level and ward level, in addition to the monitoring work of SWM activities, the Engineering Department has other engineering works like maintenance of roads, drains, potholes, sanctioning of building plans and monitoring the construction of buildings. These activities take most of the time of the senior supervisory staff and hence they are unable to give sufficient time to SWM activities. Effectively only the Junior Health Inspector who is at the bottom of the organizational structure, with his limited knowledge and experience, is the only one completely in charge of solid waste management for the ward.

Figure 21: Administrative Structure of SWM in BBMP



Source: BBMP

3.3.4 Contract Agreement – Salient features and limitations

BBMP has appointed the Service Providers for various packages (each package consisting of 2-3 wards) to carry out Municipal Solid Waste Management services from registered partnership firms/NGOs/public limited companies on a lump sum basis. A sample contract document is attached in Annexure 3. The period of contract is three years. The following are the activities assigned to the Service Provider:

a) Door-to-door collection of segregated Municipal Solid Waste (MSW) - wet waste, dry waste and sanitary waste etc. separately on a daily basis and dry waste exclusively on two days a week basis. Collection of Municipal Solid Waste from the bulk waste generators is not a part of this service contract.

b) Clearing of street litterbins is also part of this contract and the successful bidder is responsible for timely clearing of the street litter bins and transporting the same to the designated location.

c) Sweeping of roads, streets, footpath and pavements, removing of MSW from open tertiary road side drains and shoulder drain, uprooting of vegetation and transportation of the same to designated locations.

Figure 22: Process Map for SWM

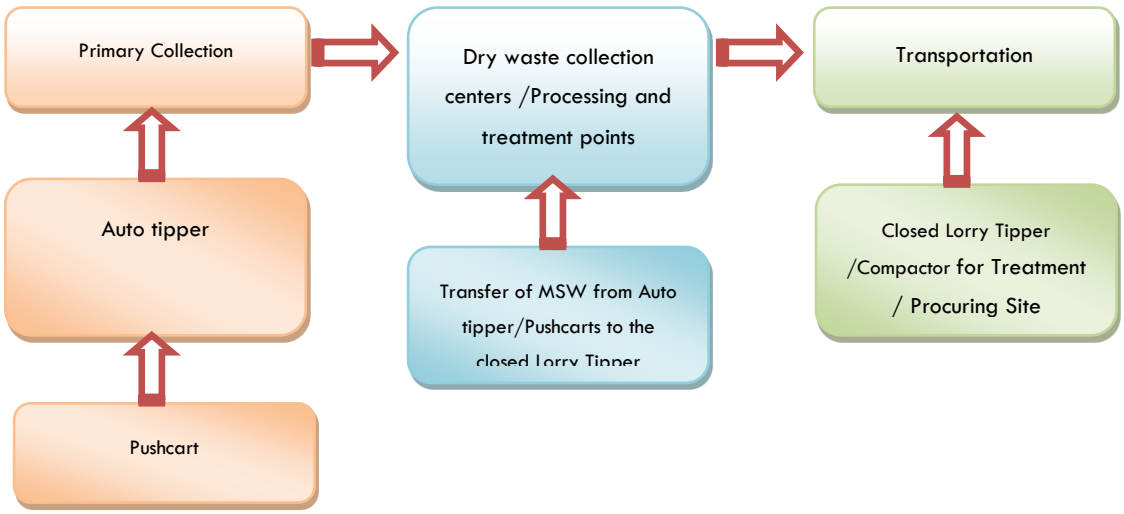


Figure 23: Waste flow proposed in contract document

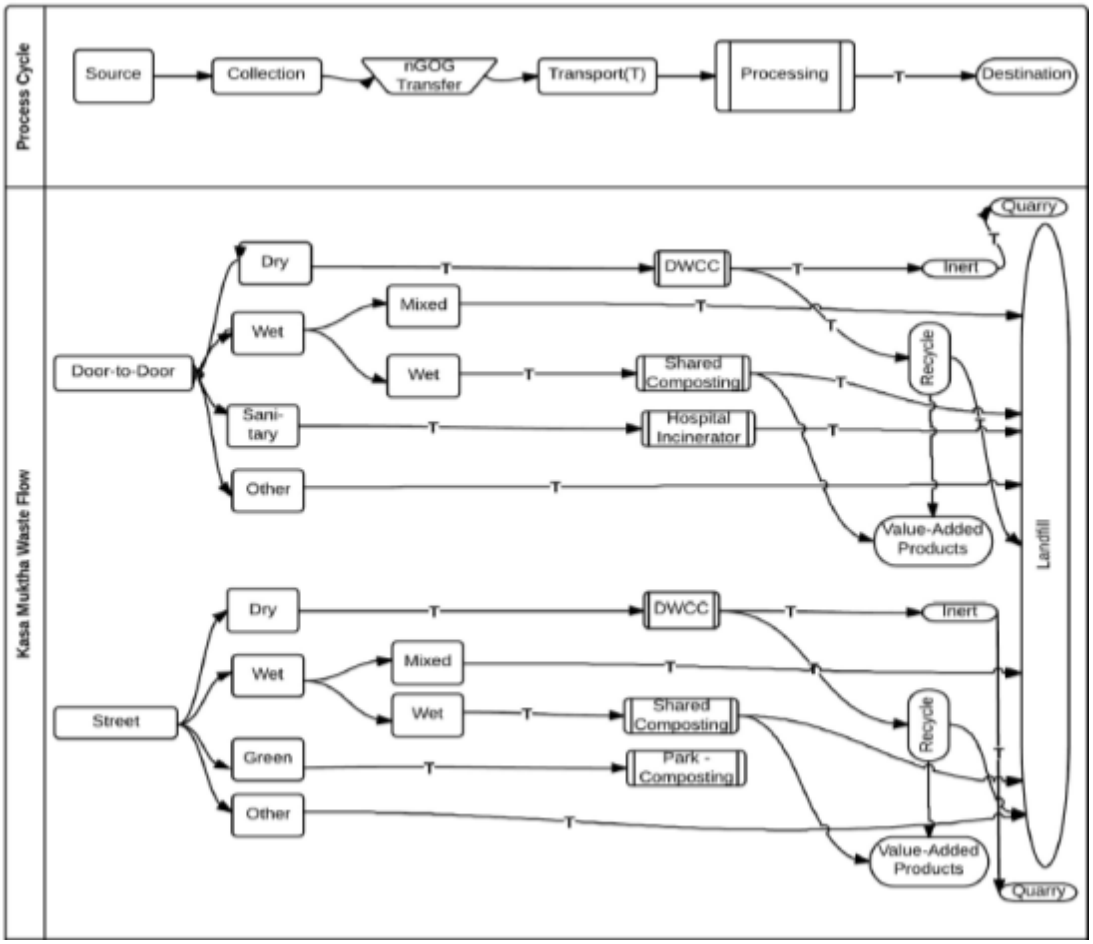
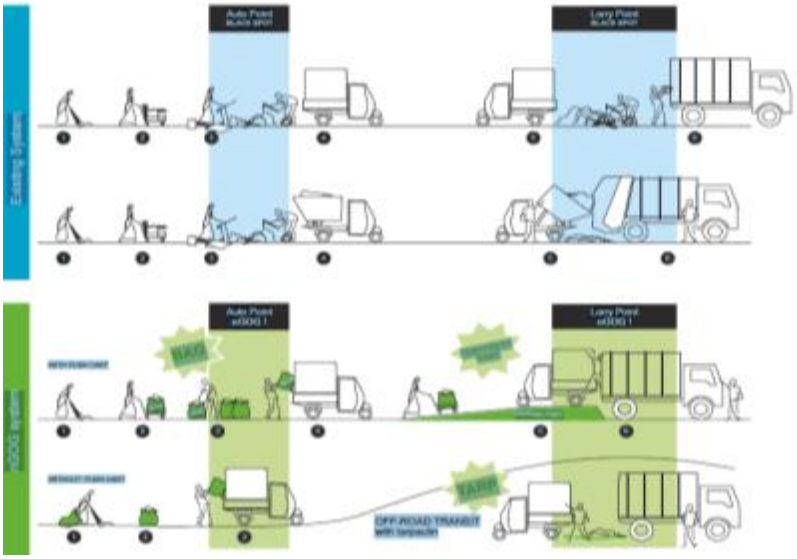


Figure 24: Proposed No Garbage on Ground (nGoG) Method of SWM



In the present system the waste in transferred to the ground and then transported to another vehicle for transportation.

It is proposed that no waste should touch the ground and should be directly transported to bigger vehicles.

Collection, Storage and Transportation of waste:

a. Collection of Wet MSW on daily basis and Dry MSW twice in a week.
b. Sanitary waste separately collected shall be transported to the designated Hospital/Nursing Home notified as sanitary collection centre for the package that will be within 10 KM from the jurisdiction of the package.
c. The Service Provider shall collect the dry waste in the award area twice in a week from each household and transport the same to the designated Dry Waste Collection Center (within 10 KM from the jurisdiction of the package)
d. The wet waste shall be transferred from Pushcarts/specially designed Auto Tippers to the decentralized composting units/processing units through closed tipper lorries/compactors and the dry waste shall be transferred to the designated waste collection centres. The Service Provider shall transport inert waste to the designated location. The waste should not touch the ground during the transfer from small vehicle to bigger one.
e. The Service Provider contractor shall weigh the waste at the weighbridge set up by BBMP/processing unit operator. If such facilities are not available, the Service Provider contractor must weigh the waste in the intermediate weighbridge (electronic) at his own cost. The records of weighment should be submitted along with the monthly bills.
f. Promote MSW Segregation at household level through awareness campaigns and other suitable means.
g. Wet waste and dry waste shall not be mixed either at the time of collection or transferring the same to processing site.
h. Collection of waste from doorstep by following a fixed time schedule as intimated to the households in advance.
i. Use of appropriate door to door collection vehicles like pushcarts, tricycles, Goods Auto and specially designed SWM Auto Tipper with separate bins / bags depending on the condition, width of the street for making the collection and shifting operation easy and efficient.
j. Auto tippers should have an inbuilt mike system to announce about the door-to-door collection. Pushcarts shall have to carry appropriate bell ringing/ whistle system of permissible decibels to draw attention of the community.
k. The waste from shop keepers, vendor and street hawkers shall be compulsory collected in segregated form without allowing them to throw the waste at untimely hours near the secondary storage points.

l. The personnel deployed for door-to-door collection of segregated waste shall be provided with appropriate protective gears like uniforms, gloves, masks etc.

MSW Collection and Transportation

The scope of the work under this proposal will not include collection of waste from commercial & residential bulk generators.

Table 20: Time Schedule for Implementation of daily work schedule

Sl. No	Activity	Time Schedule
1	Daily Door-to-Door collection of MSW from Various Households and small commercial establishments	6.30 AM to 2. 30 PM with break in between
2	Daily Street Sweeping and Drain cleaning Lanes /Conservancy, Regular Road and Sub-Arterial roads, markets, other than specified. Footpaths, open grounds, public places, government building surrounding, open areas, cleaning of shoulder drains, drains shall be cleaned from MSW / swept during day time.	6.30 AM to 2. 30 PM with break in between
3	Burial ground/ electrical crematorium and play grounds	6.30 AM to 2. 30 PM with break in between
4	Markets	6.00AM to 2.00PM 10.00PM to 6.00AM
5	Evening shift sweeping for Selected roads/Areas	4.00 pm to 8.00pm
6	Collection of e-waste from households and other establishments	Last day of every month, as per the time schedule prescribed by the BBMP officials
7	Collection of Discarded waste generated at households and other establishments.	Once in every 3 months, as per the time schedule proposed by the BBMP officials
8	Transportation of segregated MSW to Dry waste collection center/ processing centre /landfill site	As per the time schedule prescribed by the BBMP officials

Other conditions

a. The Service provider shall provide trained Labours, vehicles (Make -2008-2013) and equipment for carrying out the activities involved in municipal solid waste management. The vehicles to be used are Auto tippers, compactors, closed Tippers and pushcarts. The Service Provider shall be

responsible for maintaining the labour force, vehicles etc., as per the labour rules and motor vehicle acts of Government of Karnataka and shall adhere to MSW Rules 2000.

b. The Service provider shall engage supervisors for every 30 labourers and provide them with mobile phones so that they can be contacted by BBMP officials. The Service Provider shall also engage an Engineer with solid waste management/Public health background, preferably Environmental Engineer for each of the package.
c. All the pushcarts must be of new make
d. The Service Provider shall engage laborers only between the age of 18 and 60 years
e. Prompt attention to complaints, grievances, and emergency situations including festival seasons.
f. Under no circumstances the Service provider shall collect any user fee from any person. Complaints in this regard will be viewed very seriously and may result in cancellation of the contract.
g. There should be Co-ordinated efforts to create public awareness and civic sense/order through IEC activities.
h. The Service Provider should actively involve and seek the guidance of Non-Governmental Organizations (NGOs), Residents Welfare Associations (RWAs) and other interested private individuals/organizations wherever required for door-to-door collection and other related aspects for effective management of MSW
i. Prompt attention to complaints, grievances, and emergency situations including festival seasons.
j. The Service provider shall have to maintain the GPS system installed to the Secondary Transportation vehicles and the smart cards that would be provided by BBMP. Vehicles that are not fitted with GPS will not be entitled for payment, even if alternative evidence of waste disposal is produced
k. Service provider shall provide biometric recording system. Biometric attendance is compulsory at muster places for all labours/supervisors while reporting as well as after completing the work.
l. Report non-compliance of MSW management practices by waste generators to the Environmental Engineer/DEO/AEE of BBMP.
m. Maintain a complaint register for registering the grievances of the waste generators and other stakeholders and also common e-mail ID for both Service provider and BBMP official shall be created and to be circulated to the Public to register the complaint if any

n. The Service provider shall provide Photo identity cards for all his employees indicating the name and address, age, package number, ward number, etc.

Terms for Payment

a. The payment decided as a lump sum fee based on the number of pushcarts, vehicles and equipment provided along with the respective manpower for each package. Any default in the provision of same shall bring a penalty and thereby reduction of the lump sum payment by BBMP to the service provider is calculated.

b. The Service provider should pay monthly salary, ESI, EPF and other benefits to the Pourakarmikas within 5th (Fifth) of every month without fail. The Service Provider should not wait for BBMP monthly payment. The Service Provider should submit monthly bill within 5thof every month, failing which BBMP will not be responsible for any lapses in future.

c. No objection certificate from representatives of "Residents Welfare Association" and "SuchiMitra" is to be obtained before release of payment on the monthly bills.

d. Without prejudice to any other right or remedy which the BBMP may have, upon the occurrence of an event of default on the part of the Service Provider the BBMP may terminate the arrangement by issuing a termination notice setting out the underlying Event of Default and the termination date which will be normally taken to be within 24 hrs of the notice. The BBMP will be at liberty to start immediate operations to provide SWM disposal.

Table 21: Penalties: Service Provider Event of Default

Sl No	Item	Penalty in Rupees
1	Complaint of non-collection of Segregated MSW (wet & dry separately) even for a single day from households, commercial establishments etc. (10% of the total households, commercial establishments)	5% of the day contract value
2	Complaint of Non collection of MSW from designated locations and transportation to Dry waste collection centre/compost facility and / landfill, even for a single day.	5% of the day contract value
3	Complaint of Not carrying out sweeping of streets, footpaths, pavements, and cleaning of roadside drains and transportation of the same to the designated locations even for a single day.	5% of the day contract value
4	Complaint of Non collection of MSW from bulk generators and transportation to designated locations, even for a single day	5% of the day contract value

Sl No	Item	Penalty in Rupees
5	Not providing the vehicles and equipment as specified and non-wearing of the uniform and non-using of safety equipment by the workers even for a single day.	5% of the day contract value
6	Cleaning of burial grounds, removal of MSW from vacant sites open space, of BBMP owned buildings etc., as per implementation plan per instance.	5% of the day contract value
7	Transportation of carcasses of dead animals within 2 hours after notification by BBMP per instance.	5% of the day contract value
8	Burning of MSW or Plastic	5% of the day contract value
9	Non Collection of e-waste and bulk waste generated from households and other establishments as specified.	5% of the day contract value
10	Non-performance of any other obligation under the agreement for a continuous period of 3 days	5% of the day contract value
11	If the Penalty amounts as payable by the Service Provider is equal or greater than 10% of the monthly Contract Value for continuous period of three months or more.	Termination of the contract by forfeiting the Performance security, black listing the contractor.

Advantages:

- As per data gathered from BBMP, there are around 91 packages covering 198 wards of the city. This system of giving small and multiple contracts is easy and quick to implement. The advantage of such a public private partnership is that private entrepreneurs are willing to invest in collection and transportation equipment, as well as providing labour, tools, equipment, etc. In this system the local body (BBMP) is able to cover the city even with in-house limited resources.
- The clause of obtaining No Objection Certificate from representatives of "Residents Welfare Association" and "SuchiMitra" before release of payment on the monthly bills is a step towards having a tab on performance of the service providers.
- The service providers are responsible for labour laws.

Limitations / Bottlenecks:

- The system of giving small and multiple contracts has a major disadvantage of fragmenting the accountability. Whenever the city is not clean, the tendency is to pass the blame between the contractors / multiple staff. Segregation of waste in this system is also impossible with passing of blames between the generators and contractors/BBMP. It is difficult to determine whether

mixed waste was collected from the generators or it got mixed during transportation. Even though the city has all the requisite staff and machinery, it looks dirty and unkempt with garbage being visible all over the city.

- Emphasis on waste segregation in order to reduce the waste reaching the final disposal point is limited. As a result of which most of the waste generated, collected and transported to the landfill is mixed waste.
- Incentivizing waste segregation and reduction of the same by channelizing dry waste to dry waste collection centres set up by BBMP and wet waste to composting units like KCDC would help in bringing down the cost of SWM. A detailed study to find the amount of dry and wet waste generated should be conducted. This would help in estimating the cost of SWM which should be lesser than the present cost of lump sum contracts.
- In order to get effective service delivery by the service provider based on the contract, a lot of monitoring from BBMP's end is required. Lack of effective monitoring might lead to payment without getting the desired results.
- Technology has not been adequately utilized for monitoring purposes.
- Role of NGOs and RWAs is limited due to the current system of contracts.
- The payment seems to be based on inputs and not on outputs due to which there is lack of accountability of maintaining cleanliness by the contractors. There is limited freedom given to the contractor to decide how to do the assigned work and limited scope to improve efficiency thereby bringing down the cost.

3.3.5 **Dry Waste Collection Centres (DWCCs)**

The idea behind establishing DWCCs was to facilitate the stream lining of the entire process of waste management in the city, by concentrating exclusively on Dry Waste. The DWCCs are equipped with appropriate infrastructure capable of purchasing, collecting, aggregating and processing both high value and low value dry waste like plastics, papers, glass, tetrapaks etc.

There is a plan to set up dry waste collection centres in all the 198 wards. Till October 2013, dry waste collection centres have been set up in 148 wards of which 100 are functional, out of which working of 57 DWCCs have been entrusted to NGOs.[27]

[27] *http://www.bangaloremirror.com/bangalore/civic/Wake-up-Blore-and-segregate-garbage/articleshow/26537910.cms*

3.3.6 Registration of waste pickers - formal recognition of their role by BBMP

Following the Lok Adalat's direction in 2011, the BBMP became the first municipality in the country to register waste-pickers and enumerate scrap dealers.

Several community based initiatives were initiated in the late 1980s, stressing the need for public participation in solid waste management. Center for Environment Education (CEE) started the Committee for Clean Bangalore in partnership with various organizations in 1989, to promote segregation at source. Twenty years later, in 2009, the Solid Waste Management Roundtable (SWMRT), a group of individuals and organizations got together to promote decentralized waste management in the city for efficient waste handling. SWMRT engaged with the Lok Adalat, (People's court) a system of alternative dispute resolution (non-adversarial system) from mid-2010 which led to certain significant directions to the BBMP to implement decentralized waste management across the city. In 2011, the Alliance of Waste-pickers filed an affidavit for recognition of waste-pickers. The Lok Adalat then issued the landmark directive to the BBMP to register and enumerate the waste-pickers and scrap dealers.[28]

Following the directive, the BBMP Commissioner issued an official circular to register waste-pickers and itinerant buyers and enumerate scrap dealer, which is hailed as the first step towards formal recognition of their role. The BBMP also attained the unique distinction of being the country's first urban local body to initiate this process. On 9th August 2011, at the first Waste-pickers Convention, 200 waste-picker ID cards were distributed following the registration, a step towards officially acknowledging the indirect contribution of waste-pickers to the city. As of 2013, the BBMP has distributed over 5000 ID cards and have sanctioned additional 7000 registrations.

3.3.7 Evaluation of Technology for processing existing waste at seven landfill sites of BBMP

Due to problems faced by BBMP on dumping large quantities of waste on the landfill site at Mavallipura in year 2012, it invited expression of interest from various organizations to select appropriate technology to process existing waste contained in the landfill sites and recover the land. A technical committee to evaluate the EOI and make recommendations for the choice of technology for the 7 landfill sites of BBMP was formulated (table below).

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[28] *PinkyChandran, NaliniShekar, Marwan Abubaker, Akshay Yadav, 2012, Study on 'Informal Waste Workers Contribution Bangalore*

Table 22: Quantity and Area of landfill sites

S.No.	Name of the landfill site	Quantity in lakh tons	Area in acres
1	Mandur North	6.0	95
2	Mandur South	4.0	40
3	Mavallipura	7.0	46
4	Anjanapura	1.0	5
5	Cheemsandra	3.0	10
6	Kannahalli	1.05	25
7	S.Bingipura	1.45	20

The Technical Committee after doing the overall assessment suggested Bio mining techniques as a feasible option, which involve the processing of waste stabilization of landfill by separation and extraction of the RDF, recyclables and making of construction related bricks or tiles. They suggested this technology due to its advantages of low end technology with low investment costs while providing effective results. [29]

The committee recommended speedy implementation of clearance and processing of waste at the existing dump sites by Bio-mining techniques for the following sites:

1. Mandur North
2. Mandur South
3. Mavallipura
4. Anjanapura
5. Cheemsandra

And waste-to-energy projects were suggested for the remaining sites:

1. Kannahalli
2. S.Bingipura

In addition to the above proposals which are underway, setting up of decentralized Biomethanation plants in 16 wards are in progress. Among those 16 wards, Yelahanka has started generating power and the same is being utilized in 25 street lights. The other 15 plants are in the process of generating power.

[29] *Technical committee Recommendations on EOI application, 03-01-2013, Report on Evaluation of Technology for processing existing waste at Seven Landfill sites of BBMP, Bangalore*

3.3.8 **Karnataka Compost Development Corporation (KCDC)**

Karnataka Compost Development Corporation was established in 1975 as one among thirteen such plants in India. This was based on World Health Organizations technology as per the directions of Government of India to 22 States in accordance with the recommendation of Shri Sivaraman Committee constituted on the subject. KCDC is floated by Karnataka Agro Industries Corporation (51%), Bangalore Mahanagara Palike (24.5%) and Karnataka State Co-operative Marketing Federation Limited (24.5%). It was set up in 15.10 acres area. KCDC is involved in eco-friendly treatment of city garbage and agriculture waste through production of compost based organic manure and vermi-compost.[30]

This is the only plant running successfully unlike other twelve plants, which closed down their operations within one year due to unsuitability of technology to Indian un-segregated garbage conditions and lack of economic viability. This Corporation has become successful because of adoption of indigenous, simple low cost maintenance technology, which is found to be commercially viable.

The plant was receiving 50 tpd in the early years and it was set up to receive 200 tpd after its expansion program under Bangalore Mega City Scheme. From September 2008 onwards the receipt of garbage was stopped at instance of local public and elected representatives in view of environmental problems. During this time KCDC was processing only the already stocked garbage. Simultaneously, to establish a new plant for receipt and treatment of garbage from BBMP, land allotment was under active consideration of the Government of Karnataka. It is now spread over an area of 15 acres and development of another 3 acres land is in progress.

Process / Methodology

KCDC adopted aerobic decomposition windrow method. When organic materials are decomposed in the presence of oxygen, the process is called aerobic. The garbage received is arranged in windrows before segregation into different categories i.e A, B, C based on the size. An inoculant is sprayed to speed up decomposition and reduce odours. The windrow is turned with the help of Auger and Front end loaders for proper aeration once in 7 days so that aerobic process continues un-interrupted.

Water is sprayed as and when required depending on the moisture content. Composting is completed within 7 to 8 weeks and the degraded compost is fed to the screening plants to produce different grades of organic manure.

[30] *http://kcdc.in/about/*

Vermi-composting is also carried out and KCDC has about 200 pits for vermi-composting.

Consultancy Services

KCDC with its expertise and experience has developed a simple, indigenous, low power oriented, low investment technology. Before 2008, many States in the country were contacting KCDC to set up the units based on KCDCs technology.

- KCDC has provided consulting services for over 8 years.
- It was formalized with the setting up of a dedicated consulting cell at KCDC. A team consisting of in-house experts and consulting experts was formed to provide consulting. The consultancy cell provided consulting which included project report preparation, hand holding for project execution and operation & maintenance training.
- With implementation of a demonstration centre, awareness creation and other training support could also be provided.
- The consultancy center would be a profit center and have a positive contribution to the KCDC.

Performance

Sales, Revenue, Expenditure and Profit / Loss for the period from 2001-02 to 2010-11 are as under:

Sl No	Year	Production (in M.tons)	Sales (in M.tons)	Revenue (Rs. in lakhs)	Expenditure	Profit
1	2001-2002	10500	8587	219.98	218.69	1.29
2	2002-2003	11163	13719	247.77	241.73	6.04
3	2003-2004	17516	15369	227.10	220.25	6.85
4	2004-2005	20151	16293	247.05	242.73	4.32
5	2005-2006	7962	4897	239.87	239.07	0.80
6	2006-2007	15024	10829	260.50	236.77	23.73
7	2007-2008	12963	9886	290.95	263.63	27.32
8	2008-2009	8121	8219	265.70	260.70	5.00
9	2009-2010	8754	8760	204.39	191.41	-13.48
10	2010-2011	7528	8060	159.89	204.08	-43.84

Source:http://kcdc.in/activities/

Current Status of KCDC

Karnataka Compost Development Corporation was revived in 2013 after five years of inaction. In June 2013, BBMP started sending KCDC around 100 tons of vegetable waste a day, from Madivala and city market. Currently it treats about 450 tonnes of waste every day i.e 300 tons of the existing waste and

150 tons of segregated wet waste. As per KCDC, BBMP plans to increase the incoming wet waste from 150 to 350 tonnes within next few months and by the end of 6 months, they target to send 700 tonnes of wet waste to KCDC.

Without any budgetary support, KCDC has managed its activities with revenues from the sale of manure produced through aerobic and vermi-composting. The manure produced is sent to the Department of Agriculture and is sold at 50 percent subsidy to farmers across Karnataka and India.

The KCDC will also set up another composting plant of 500 tons capacity at a cost Rs. 4 crores at Chikkanagamangala (off Sarjapur Road, Anekal Taluk). Land area of 31.21 acres has been handed over to KCDC for establishing the plant.

KCDC plans to initiate a training center at the Haralukunte site at a cost of Rs.150.29 lakh with training programmes to be open to all. This programme will include demonstration and training on how to segregate and vermi-compost waste. This project is still waiting for its approval from BBMP[31].

3.3.9 **Kasa Muktha Programme launched on 24th July 2013**

Kasa Muktha is an at-source segregation initiative at ward level developed jointly by BBMP & Wake Up Clean Up. It was launched on 24th July 2013 with a view to introduce destination bound processing of wastes and to be scaled City wide once the program is stabilized. This initiative is the resultant of the support from many Organizations, Associations and individuals over a sustained period of time in order to create a sense of commitment of civil society and the contribution of common people to a chronic issue plaguing the City.[32]

The initiative was planned to start in 22 pilot wards with the following arrangements:

- Daily collection of door-to-door segregated waste by Pourakarmikas - 100% coverage(Door to door and Petty shops)
- Apartments under 50 units who leave segregated waste separately in 2 bins will have waste collected from common point

[31] *http://bangalore.citizenmatters.in/articles/karnataka-composting-firm-back-in-the-limelight, June 11th 2013*

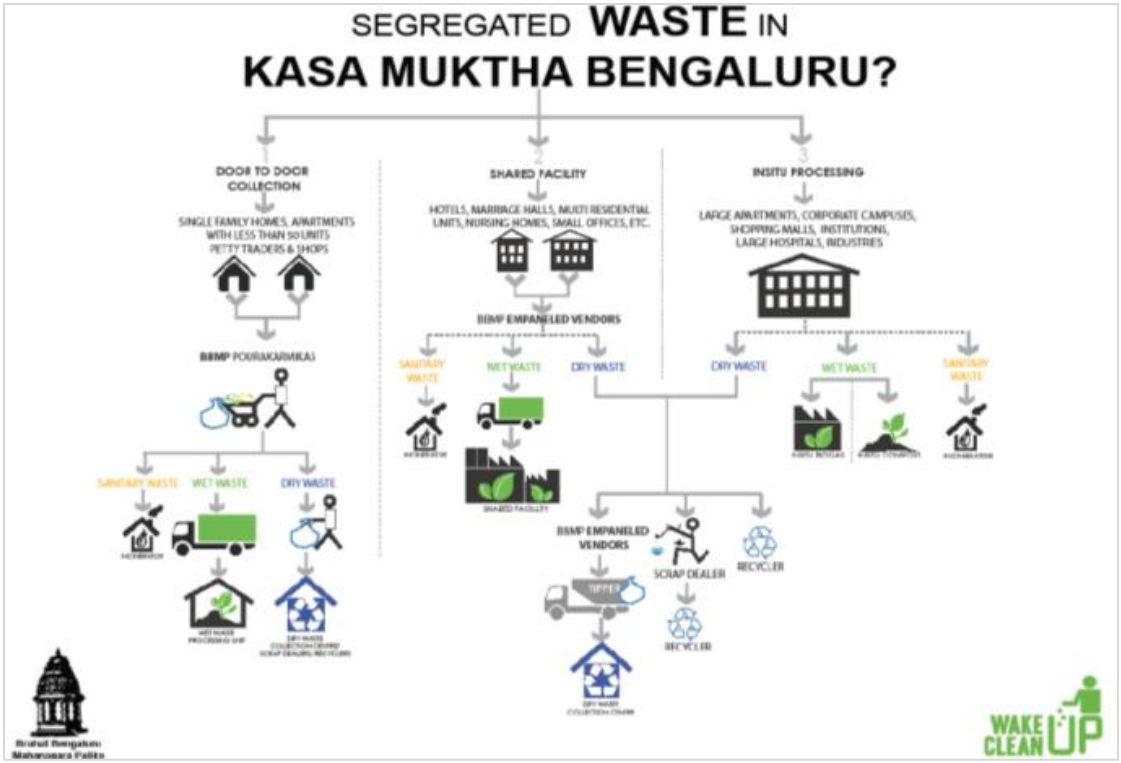
[32] *http://bangalore.citizenmatters.in/articles/kasa-muktha-waste-segregation-22-wards-pilot; http://www.wakeupcleanup.in/Kasha-Muktha.html*

- Waste in plastic bag not accepted and mixed waste not accepted - 2 days a week dry waste collection by pourakarmikas; penalties levied for non-compliance
- Monitoring at Collection Points to transfer waste from small to larger vehicle : nGOG method to be deployed (no Garbage on Ground)
- No Black spots and visual cleanliness to improve
- Waste from street litter bins clearance and street sweepings separated at-source
- Twice daily clearance in key areas
- Independent Third party monitoring and data analytics to improve the system and scale it up

Figure 25: Categories of waste for segregation under KasaMuktha program[33]

[33] http://www.bpac.in/wp-content/themes/churchope/pdf/What%20is%20Kasa%20Muktha@ward.pdf

Figure 26: Proposed Process Map in Kasa Muktha wards



3.4 PROCESS MAPPING OF SOLID WASTE MANAGEMENT IN BANGALORE

3.4.1 Process Mapping

The purpose of process mapping is to understand the collection system right from the generation, collection to disposal of solid waste from various domains. This would give an insight into the problems faced during collection of solid waste from households, institutions, bulk generators, etc.

3.4.2 Explanation of process mapping for waste management from households - Issues

The waste that is generated at the household level is collected from the door by the BBMP pourakarmikas or contract workers. The workers sweep the road in addition to door-to-door collection from the households in a prescribed area using pushcarts with four containers.

As per the BBMP - SWM norms, waste segregation is compulsory. BBMP has started the awareness drive to educate the citizens to segregate the waste at source. At many places dustbins were distributed by some of the ward offices as part of pilot projects to segregate the waste into dry and wet category. Dry Waste Collection Centres are functional in 100 wards, 57 of which are run by NGOs. The idea is to

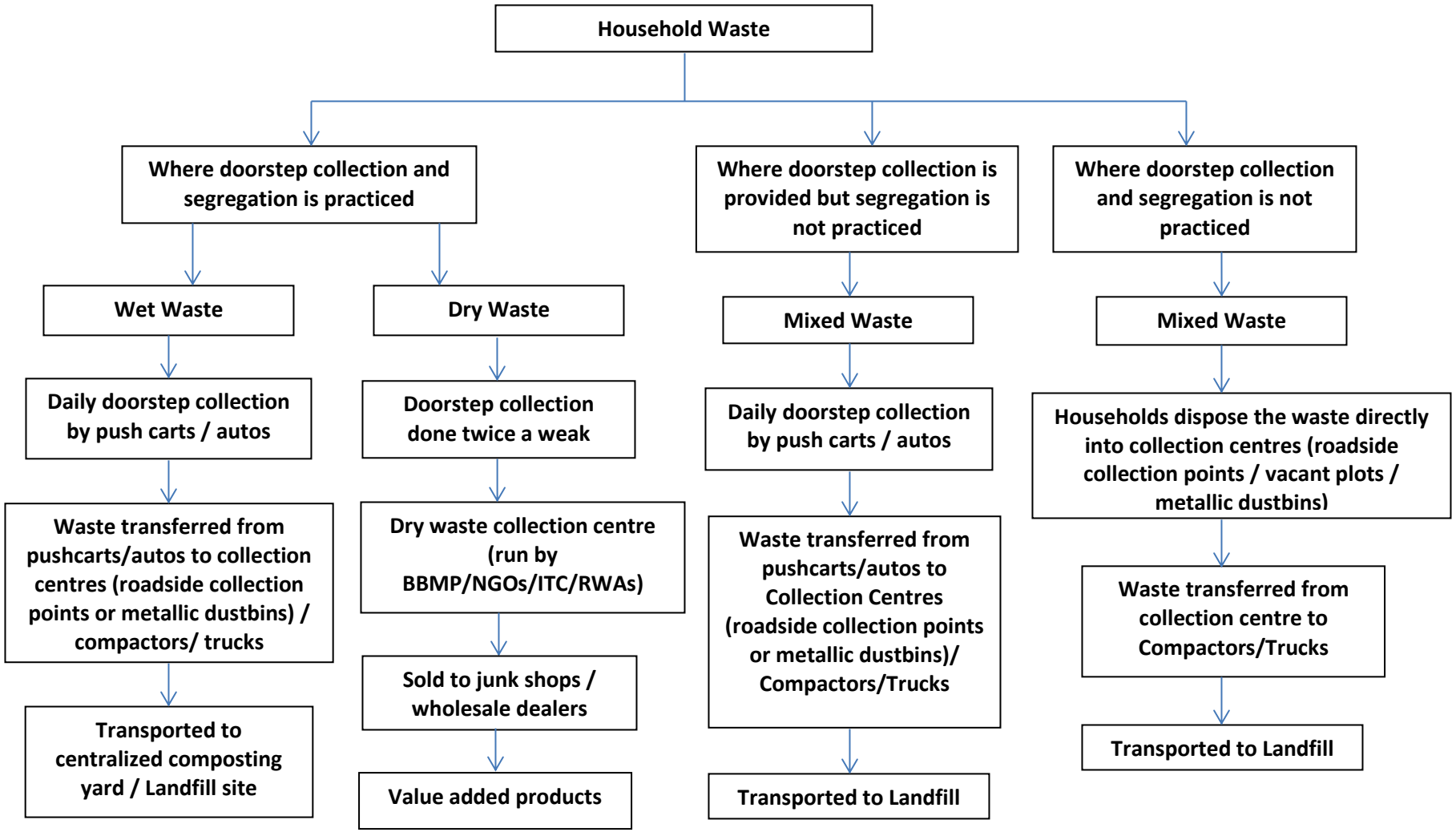
collect the segregated dry waste twice a week and brought to these Centres directly to be segregated further, weighed and sold to the recycling units.

Ideally wherever segregation is taking place, the segregated waste is to be collected by door-to-door collection method. The wet waste is to be taken to collection points from where it will be taken to the centralized composting unit and the dry waste will be taken to the DWCC. However, at many places segregation of waste is not done by the households. The workers while collecting the waste from such households pick up the recyclable materials and sell them at junk shops to earn extra income or bring it to the DWCCs. They dump the remaining mixed waste at the collection points from where it goes to the landfill on compactor/lorry.

The wet waste or the mixed waste which is collected by door-to-door collection system using pushcarts is transferred to an auto tipper or brought to these designated spots. Some of these designated places on the road are also the transfer points where the waste from the pushcarts or autos is manually loaded on the tractors/lorries/compactors using buckets or drums. From this waste the workers segregate the useful material like glass, metal, cardboard, plastic, etc. that can fetch them added income. Bags with segregated waste usually are seen hanging on the sides of the garbage trucks/lorries. The mixed waste is transported to the landfill sites. At many places open autos and trucks are used to transport the waste. The autos and trucks used are in bad condition with their covers torn and broken flaps. They do not seem to have obtained the yearly Fitness Certificate (FC) from the RTO.

Due to lack of proper door-to-door collection in some of the wards, the waste is dumped directly by the residents at the designated place on the road side or vacant plot or areas near substation. The dumping of waste by the residents is done at any time during the day or night and may not necessarily match with the timing of collection by the autos / compactors / trucks. As a result the spot remains dirty most of the time.

Figure27: Process map for waste management from the households



3.4.3 Explanation of Process mapping for waste management from bulk generators - Issues

As per the Section 256, 257 and 260 of the Karnataka Municipal Corporations Act, 1976 and in continuation of the Public Notice dated 15/09/2012 the definition of bulk generators is:

'Bulk generator means any hotel/restaurant, choultry, mall, shopping complex, marriage hall, convention hall, temple, residential apartments (10 units and above), institutions, public offices, railway stations, bus stands or any other residential, commercial or a public entity which generates 100 kg and more wet waste per day and any other such entity that is specifically identified and notified by the Commissioner as bulk generator.'

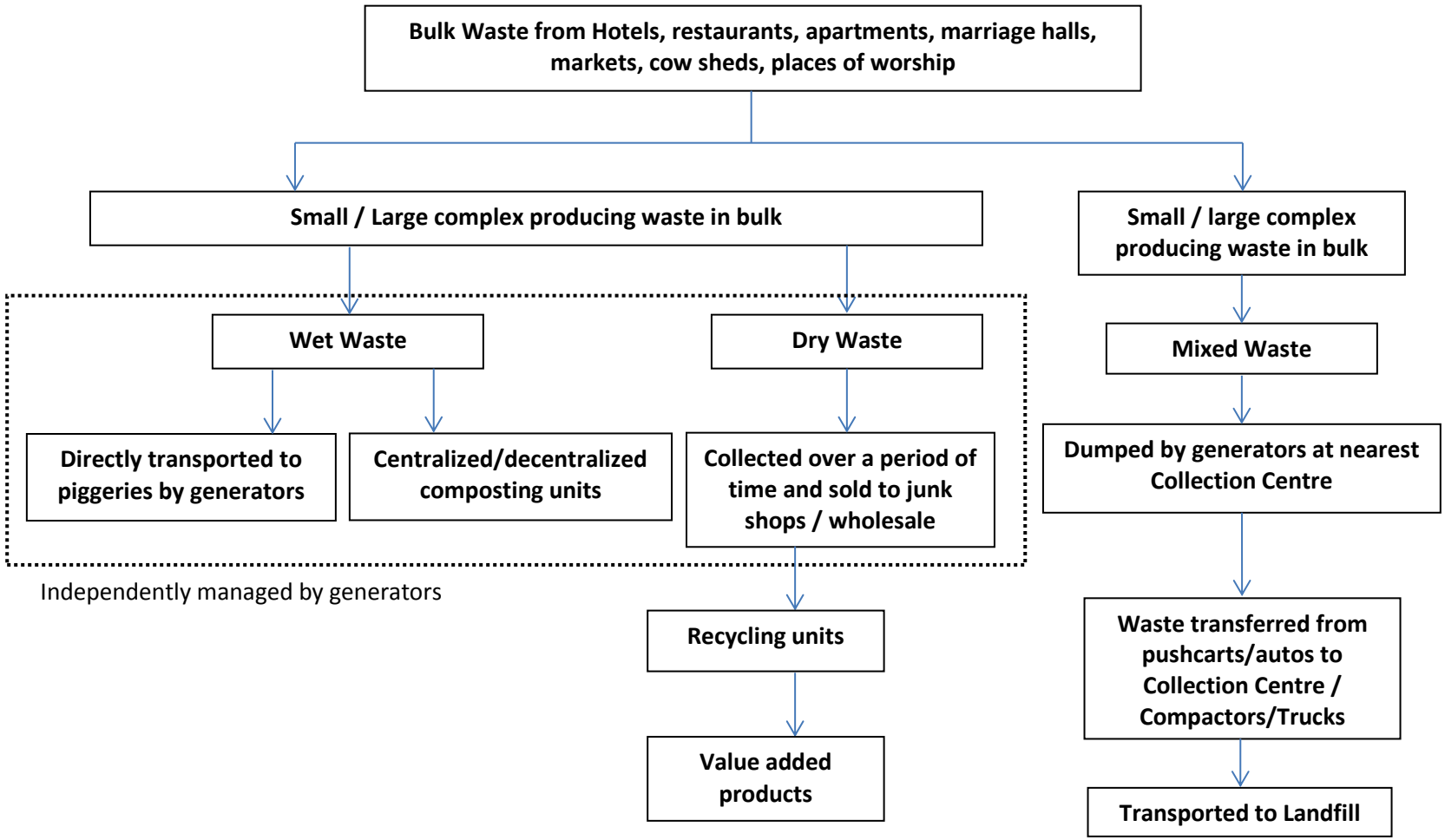
The waste from bulk generators usually accounts to 30% of the total city waste. Currently the bulk generators have individual tie up with private contractors to collect the waste on a daily basis, some of which were introduced by BBMP since 2005. BBMP has stopped collecting waste from the bulk generators from the past three years. Depending upon the size of the business, the waste generated on an average varies from 50kg to 200kg per day. The contractor charges Rs.4500 per month for picking up around 200kg per day of wet waste. Broadly the waste is segregated into wet and dry waste. The dry waste is collected by BBMP contracts or *kabadiwalas* and sold at the junk shops / wholesale dealers. The wet waste is collected by private contractor and taken to Terra Firma Biotechnologies ltd (TFBL) unit at Gundlahalli near Doddaballapur. There are 3 more projects of waste treatment that are in the proposal stage:

- Maltose Agri Product, Doddabalapur
- Nobel Exchange Environment Technology Private Limited, Pune

BBMP has handed over 5 acres of land at Kanahalli to Bruhat Bangalore Hotel Association (BBHA) to treat 250 tonnes of wet waste by anaerobic composting.

Those bulk generators who have ample space in their premises store the waste and have tie ups with the private contractors. In case of other smaller hotels/restaurants/marriage halls, the generators dispose the waste at a nearby collection centre (mostly at night). The waste is then collected by the contractor/BBMP trucks during the usual collection time at day and taken to the landfill sites at night.

Figure28: Process map for waste management from the bulk generators



3.4.4 Explanation of Process mapping for waste management from selected 10 wards - Issues

The process of waste management in all the wards is more or less the same with the difference in scale of ward. Due to the variation in the size of the ward and number of households / shops & commercial areas, the infrastructure like, pushcarts, autos, lorries/compactors/trucks, workers, etc. provided for solid waste management service varies. In all the wards, BBMP has contractual arrangement with private sector partners for the segregation, collection and transportation of waste. The contract document has been explained in the earlier section of this chapter. Even though the contract specifies the tools/ safety equipment[34] to all workers once in 3 months and uniform twice in a year, none of the ward has all the equipment as specified. Seven out of the 10 wards, have their own dry waste collection centres set up by BBMP. For ward 91-Bharathi nagar, the DWCC of Sampangiramnagar is used for collection of dry waste. Ward 15 – T.Dasarahalli and ward 85-Doddanekkundi do not have DWCC and hence the dry waste is separated by the workers and sold to the wholesale dealers directly.

Some of the dry waste centres that are run by the NGOs are self-sustainable. In such areas, the NGOs are also part of the group collecting dry waste from the households and commercial establishments. They buy the waste and hence incentivize the generator to segregate the waste at source. The rate of the dry waste is lesser if it is mixed dry waste and is higher, if segregated, depending upon the value of the dry waste. The mixed dry waste thus collected is segregated at the centre by the workers who are rag pickers mobilized by the NGOs. The dry waste at the centre is sold on a regular basis to the wholesale dealers and the income from that provides for the salaries of the workers. The vehicle for collection of the dry waste is provided by the NGO or in some cases by BBMP and the operation and maintenance cost of the same is borne by the NGO. Some of the centres that were visited and those managed by the BBMP do not seem to be functional on a day-to-day basis. The dry waste in such centres is collected over a period of few months and then segregated and sold to the scarp dealers.

Door-to-door collection of waste is mandatory as per the BBMP contractual agreement. However in none of the wards 100% door-to-door collection is observed. On an average the door-to-door collection efficiency of surveyed wards is 71% which includes collection of waste from households and commercial establishments. Wards like Kadu Malleshwaram, T.Dasarahalli, Sarakki, HSR layout seem to be better

[34] Gloves, masks, caps, gumboots, slippers, cleaning tools & equipment, long handle broom, scrapers, collection plate, *ghamela*, long back hoe, drain cleaning equipment, spade and weed cutting machine

performing than other wards. The performance across the wards varies and mainly depends upon (a) effective monitoring by BBMP staff; (b) Active MLA / corporator; (c) active RWAs / NGOs / citizens than the resources. Effective monitoring by BBMP, people's awareness and participation might help in improving the door-to-door collection by the contractors.

Figure 29: Process map for ward no. 110 Sampangiramnagar

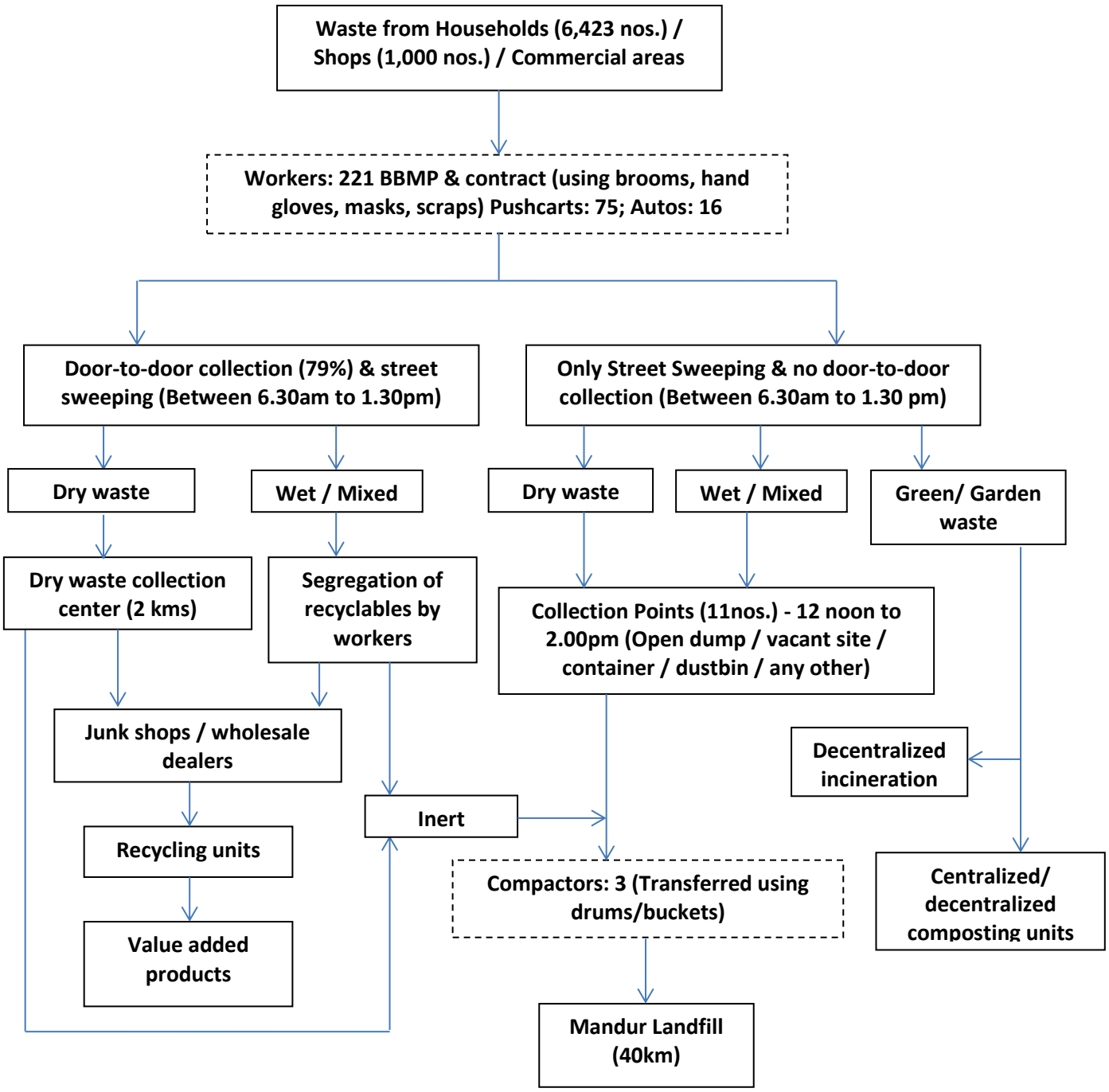


FIGURE 30: PROCESS MAP FOR WARD NO. 91 BHARATHI NAGAR

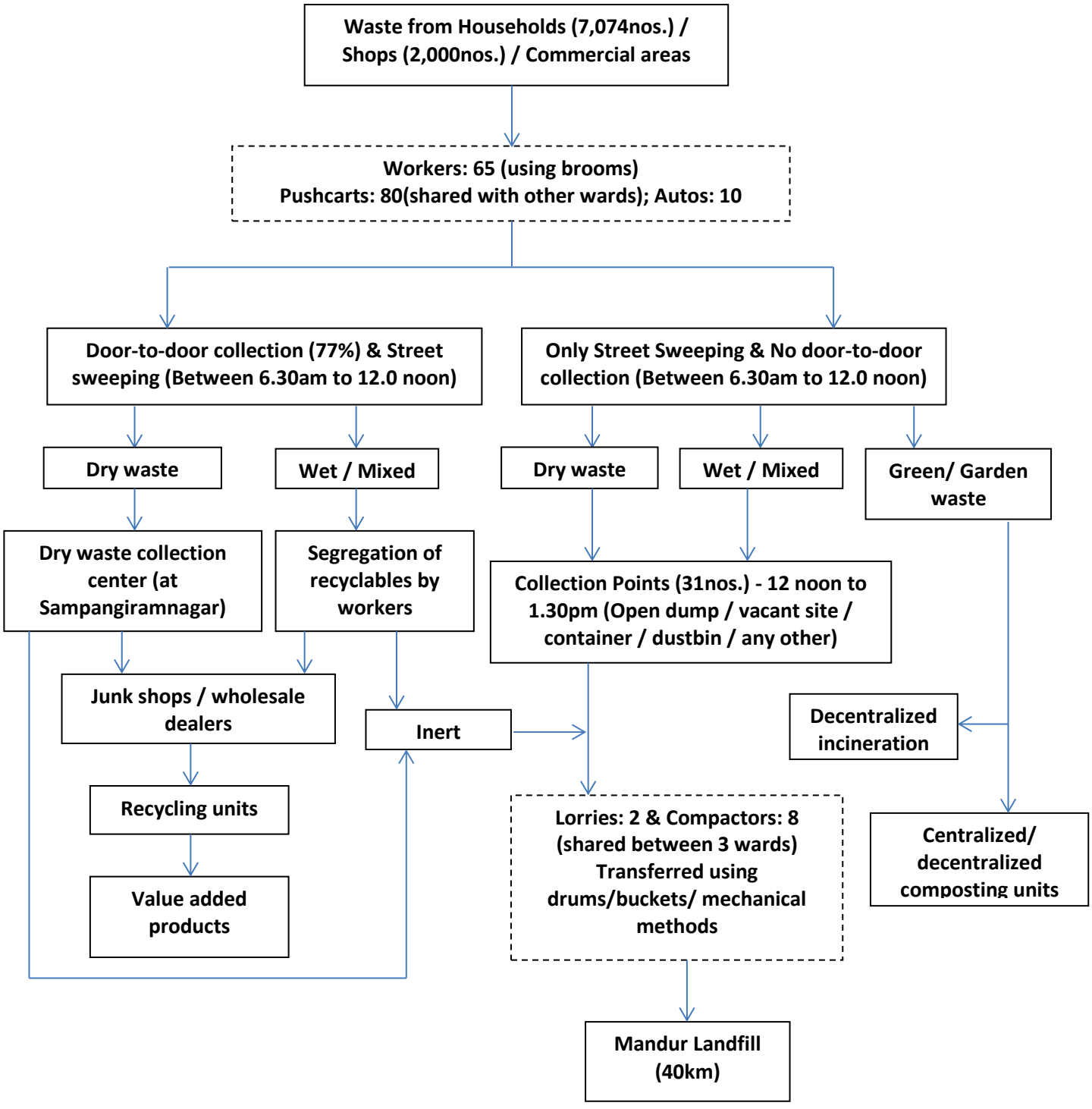


Figure 31: Process map for ward no. 65 Kadu Malleshwaram

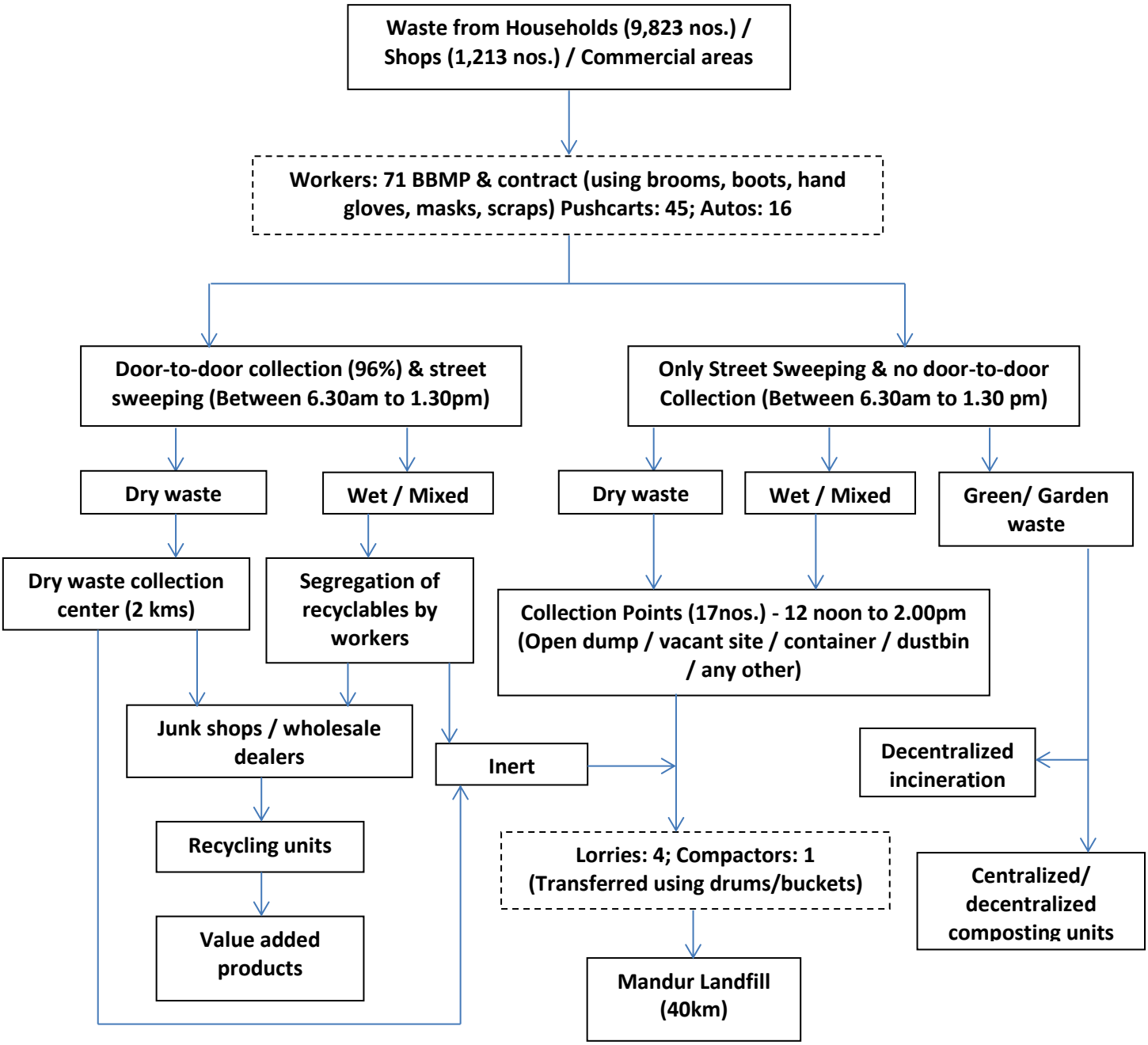


Figure 32: Process map for ward no: 94 Gandhi Nagar

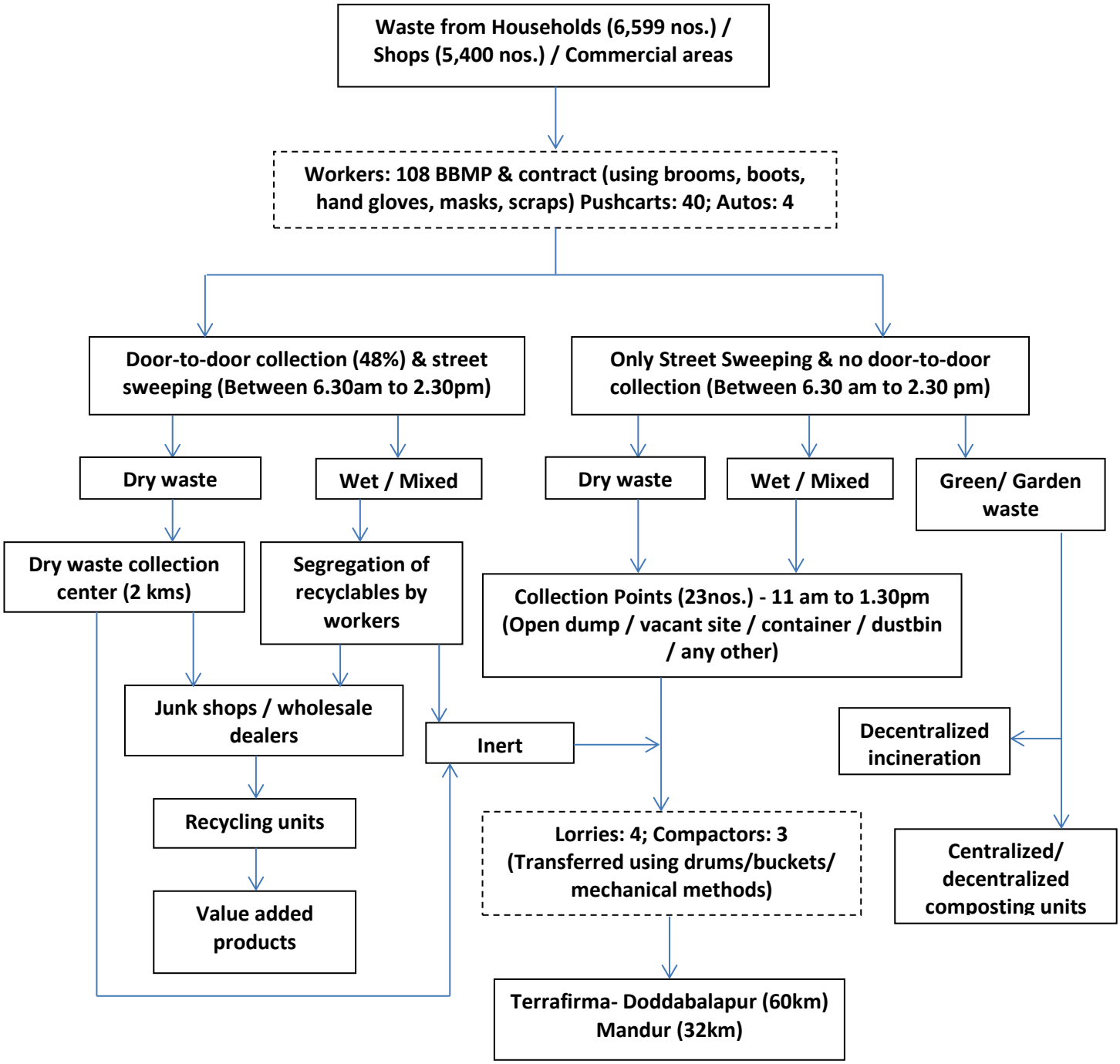


Figure 33: Process map for ward no. 178 Sarakki

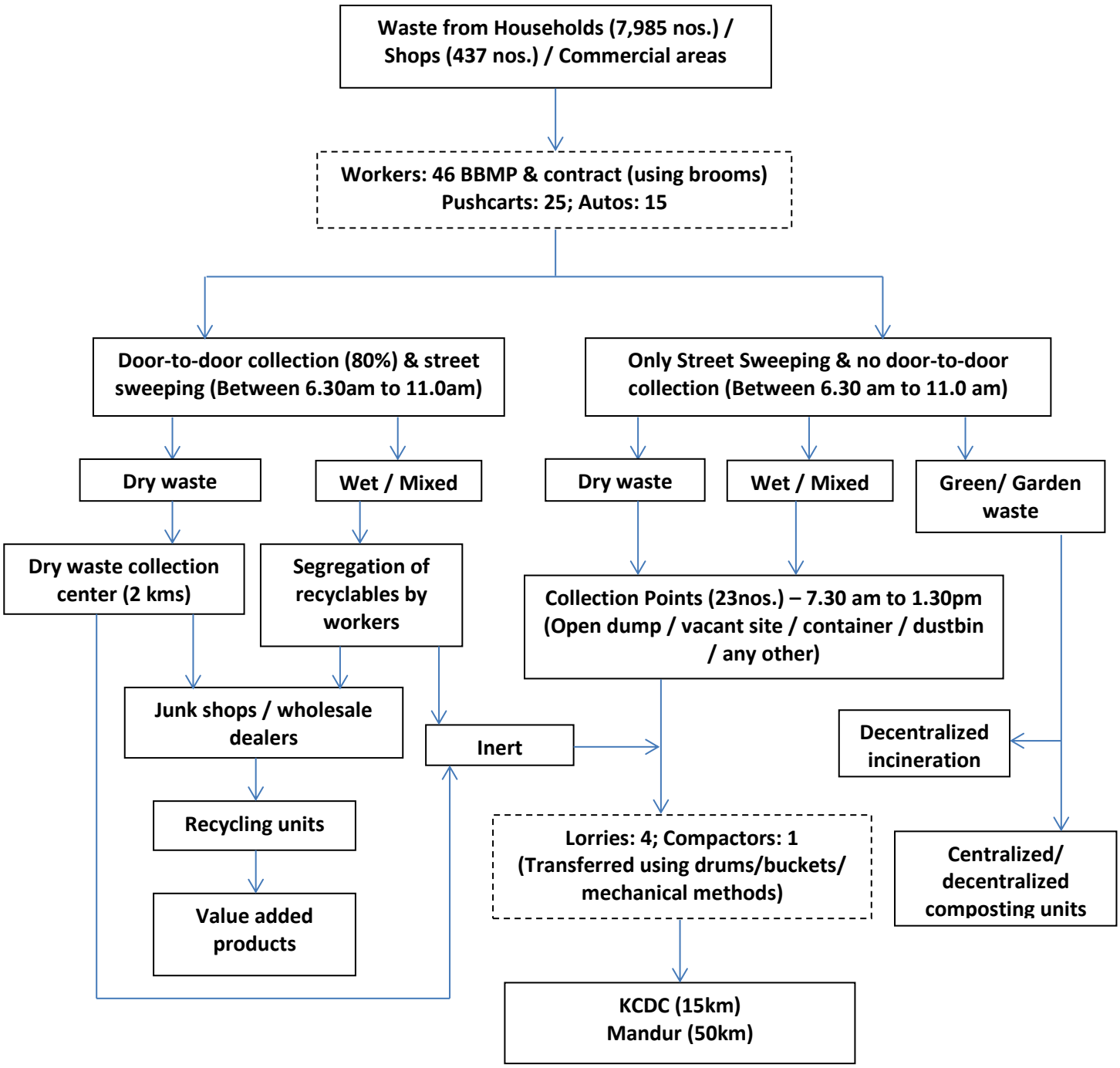


Figure 34: Process map for ward no. 160 Rajarajeshwari Nagar

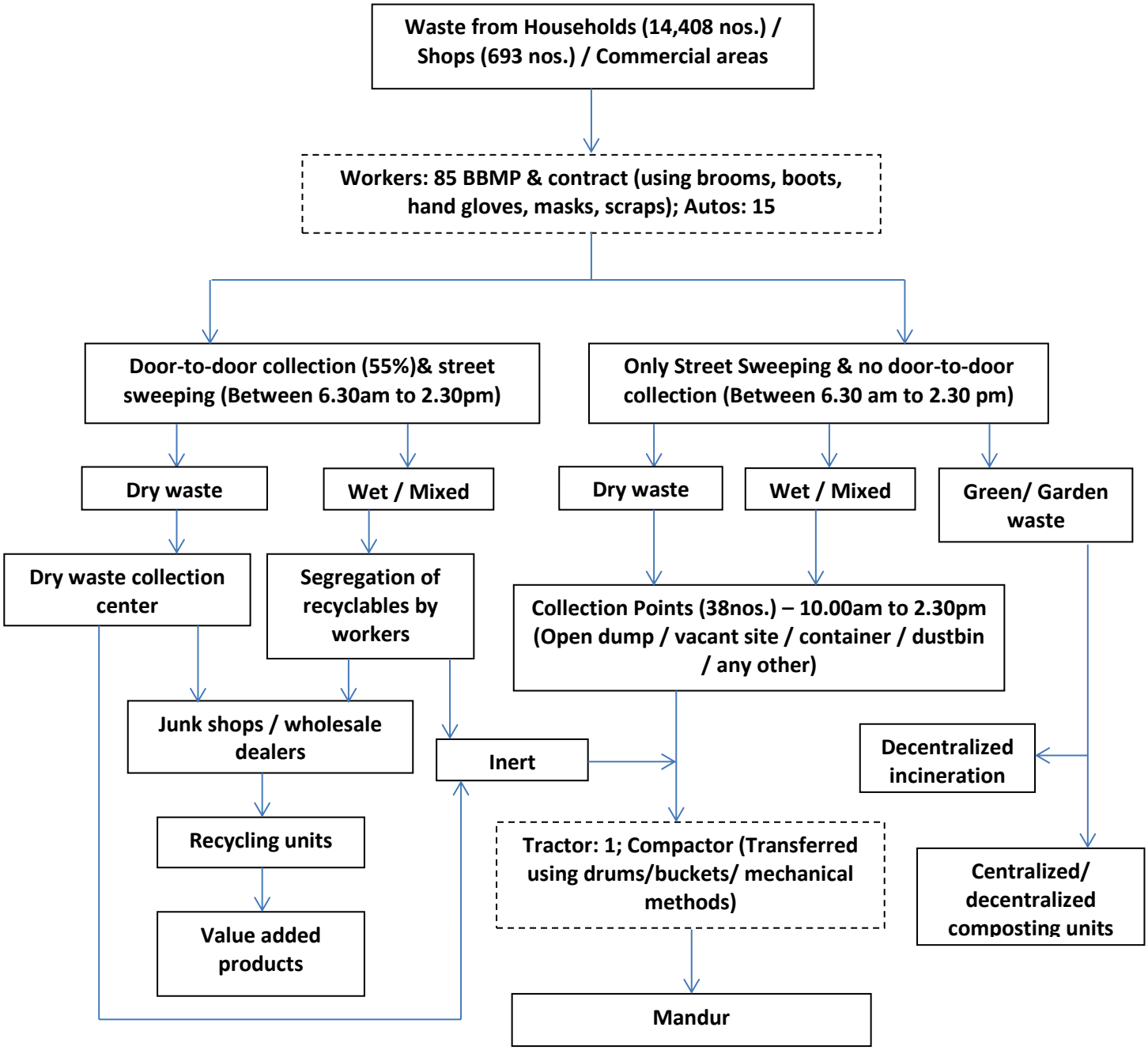


Figure 35: Process map for ward no. 174 HSR Layout

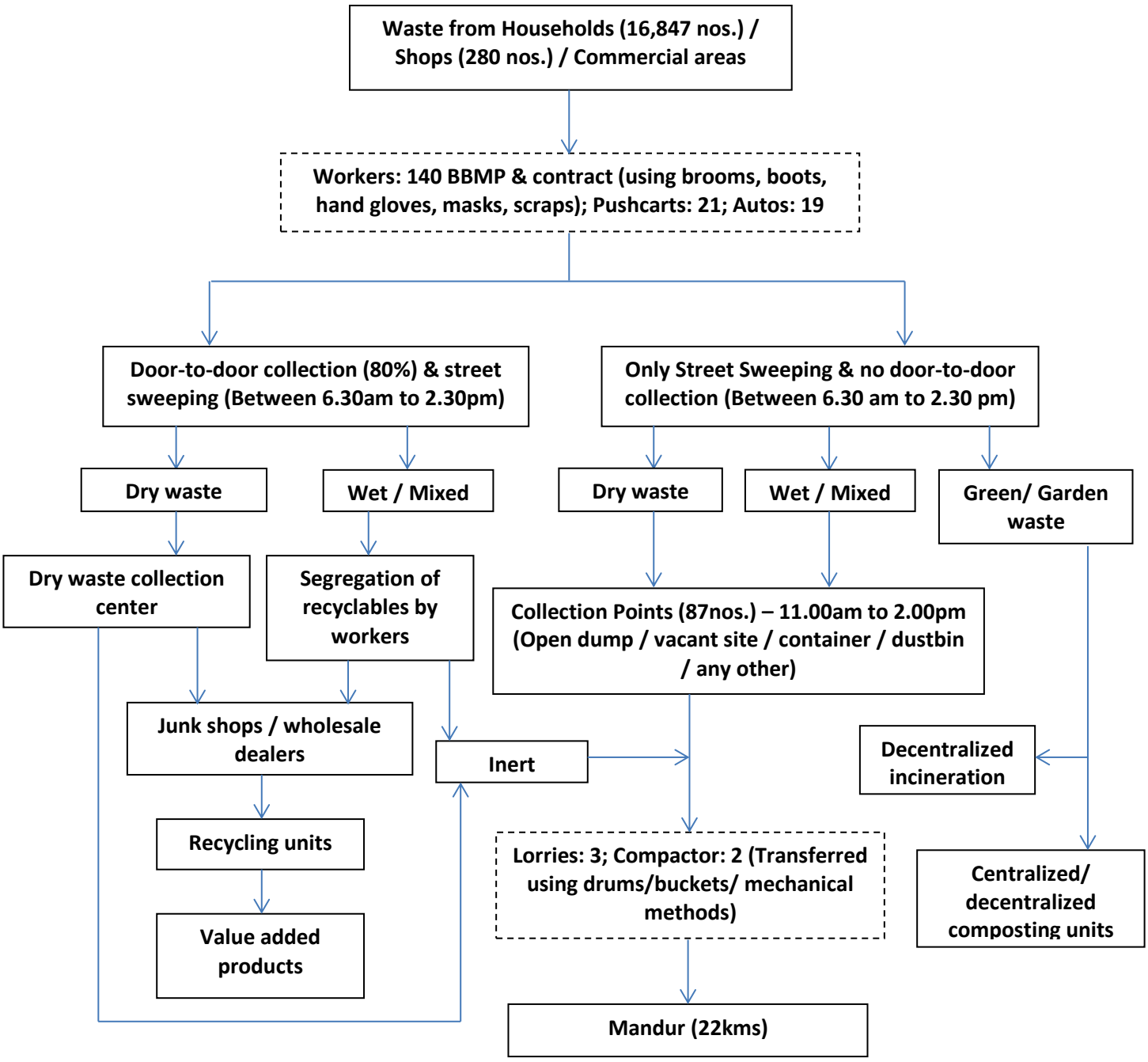


Figure 36: Process map for ward no. 3 Atturu

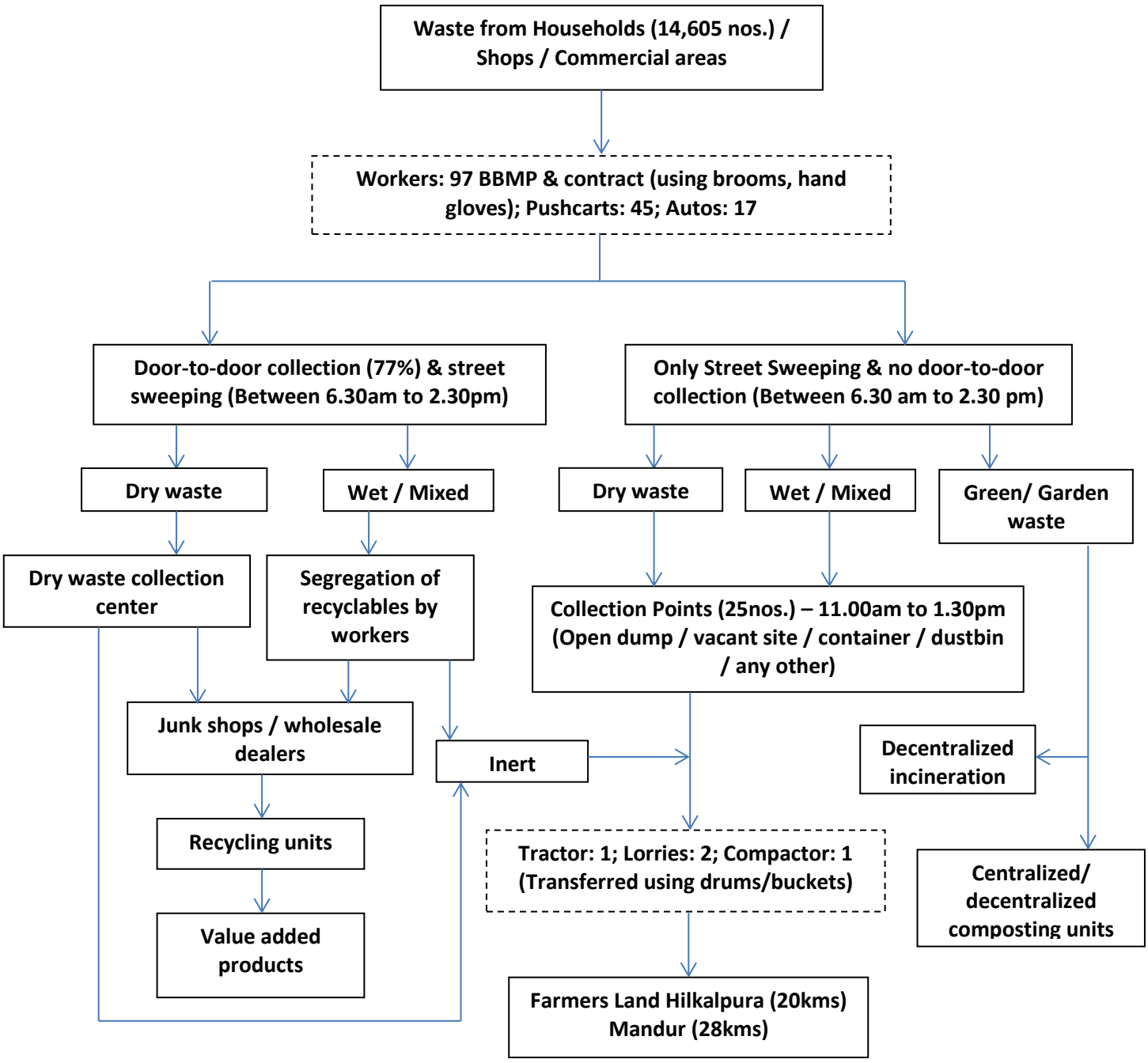


Figure 37: Process map for ward no.15 T.Dasarahalli

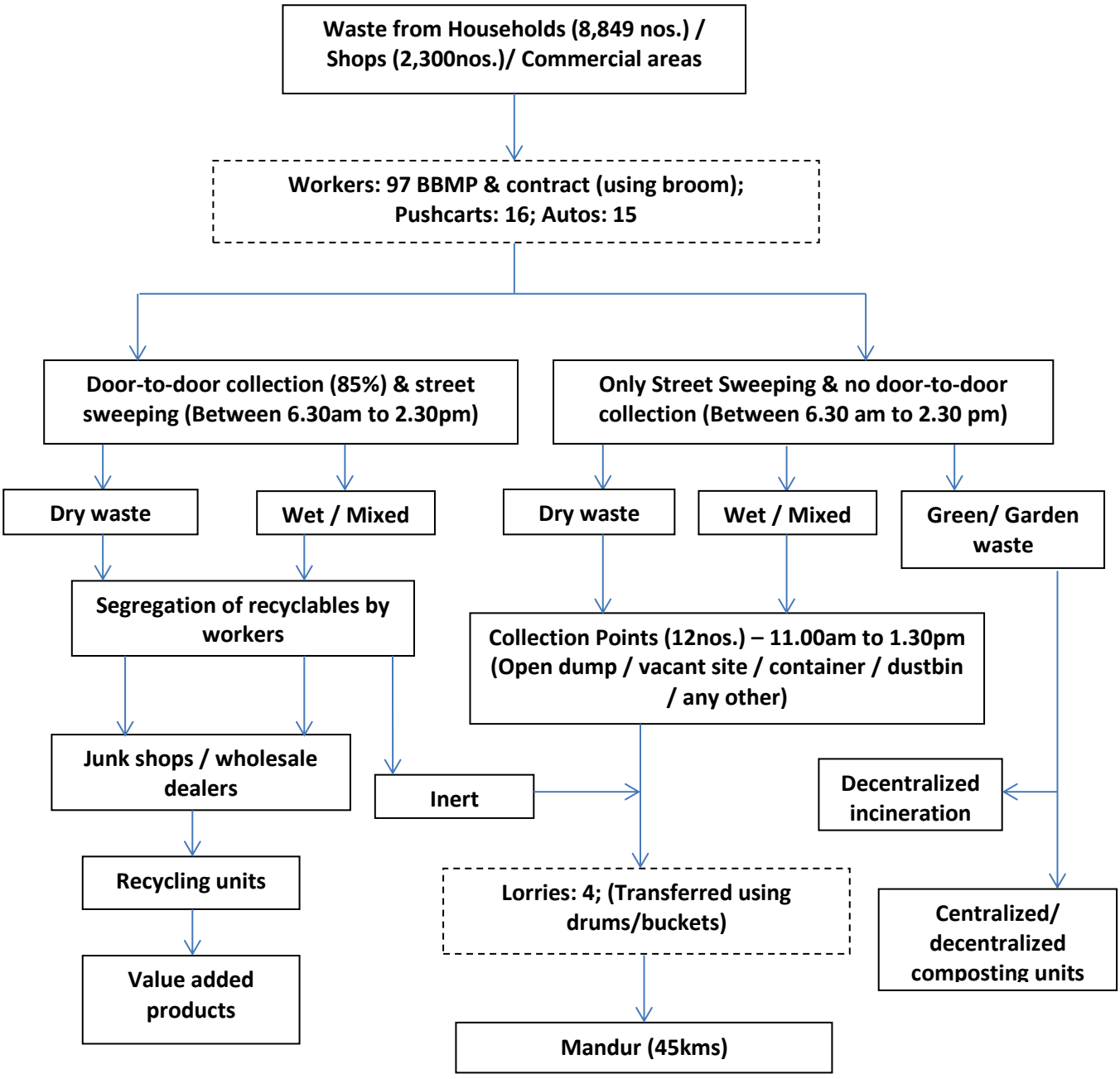
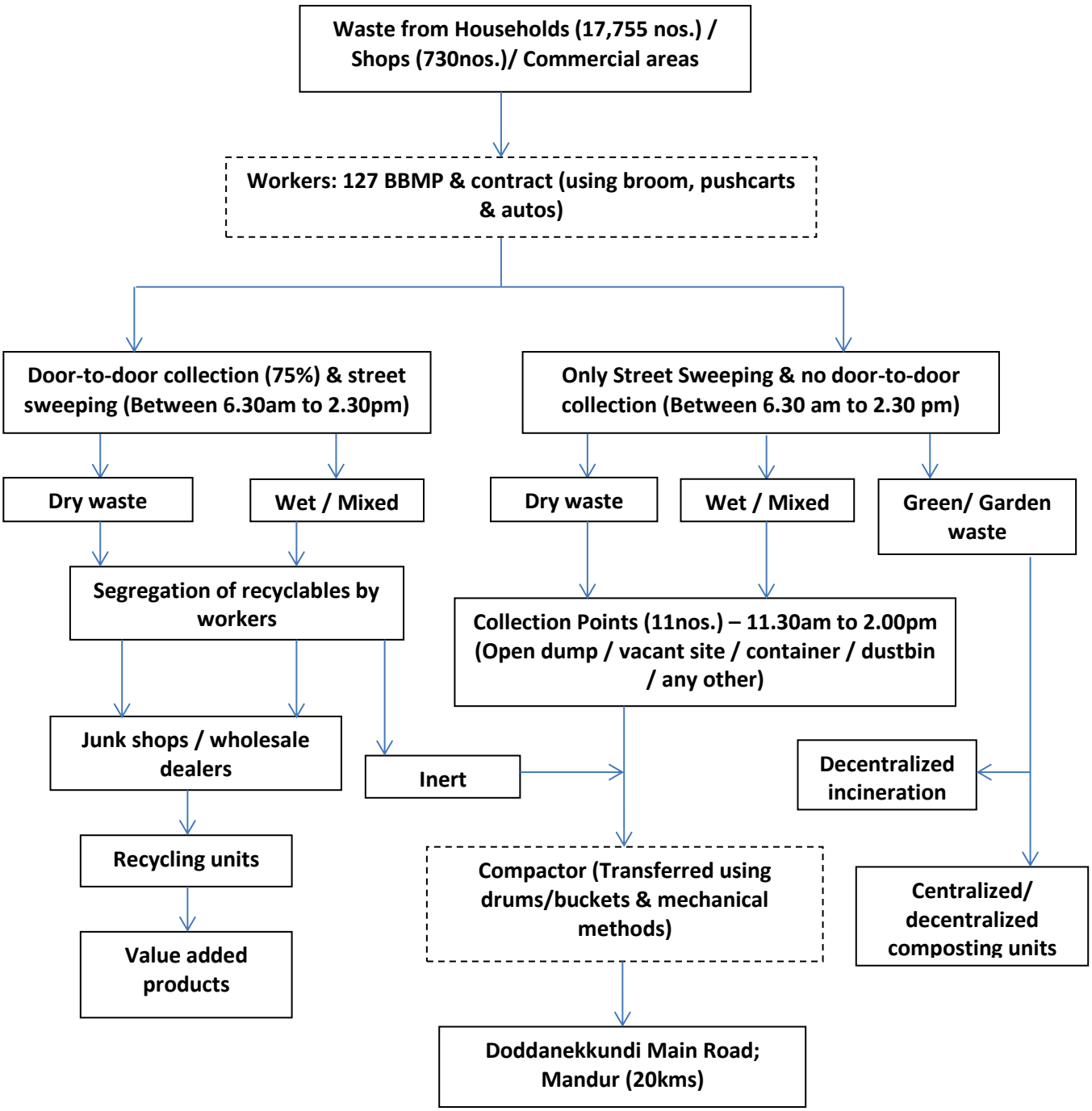


Figure 38: Process map for ward no. 85 Doddanekkundi



3.5 ISSUES AND PROBLEMS

- Irrespective of so many initiatives taken with respect to solid waste management, (like framing the SWM policy specific to Bangalore, changes in the administrative structure based on SWM policy guidelines, service contracts awarded and other initiatives like opening of DWCCs, giving recognition to the waste pickers, involving NGOs and RWAs, effort to separate the waste collection from bulk waste producers), there is lack of proper segregation, door-to-door collection and sweeping.
- There is irregular dumping of waste on roads, drains, vacant sites and any place possible outside the premises. Due to which the common areas of the city always remain dirty until the service providers clean them up.
- Even though the contract document gives proper guidelines on no Garbage on Ground (nGOG), the temporary waste storage depots necessitate multiple handling of waste.
- The transportation system in timely clearance of the waste is also inadequate.
- Due to lack of 100% door-to-door collection and segregation, not all the dry waste produced reaches the DWCCs
- Even though the contract specifies the tools/ safety equipment to all workers once in 3 months and uniform twice in a year, none of the ward has all the equipment as specified.
- Due to the protest of the villagers in the areas surrounding the dump sites, the waste collected in compactors/tipper lorries is taken only at night after 11.00 p.m. This results in decay of the wet waste thereby causing more problems at the sites.

4.ASSESSMENT OF QUANTUM & COMPOSITION OF WASTE

4.1 COMPOSITION OF WASTE IN BANGALORE[35]

As per the study conducted by iDeCK in 2008 on Integrated MSW Strategy for Bangalore City, primary surveys were conducted for indicative waste streams, composition of waste etc. based on waste sampling techniques across the city. Following is the physical composition of waste derived from the study:

Table 23: Statement of Physical Composition of Waste

STATEMENT OF PHYSICAL COMPOSITION FOR BBMP AREA	
Vegetable	0.30
Paper	0.09
Plastic	0.12
Cardboard	0.04
Textiles	0.04
Grass / leaves / wood	0.06
Leather	0.00
Battery	0.00
Electronic item	0.02
Metal	0.01
Organic	0.23
Glass	0.03
Debris	0.05
Biomedical	0.02
Total	1.00

[35] *IDeCK, 2008, Master Plan for Municipal Solid Waste Management in Greater Bangalore*

From the above it can be observed that on an average 50 - 53% of MSW is organic and biodegradable and 37 - 45 % is inorganic; out of this inorganic, 14 -18 % is recyclable; 20 -23 %is combustible and suitable as RDF material. Accordingly the landfill will be restricted to 6 -10%.

Bangalore City Waste composition

Reviewing waste characteristics from all eight zones, it is observed that

- The per capita household waste generation is about 225.70gpcd. Excluding slum areas per capita waste generation is 248.80gpcd
- The waste generation from Bangalore is high in organic content
- Highest fraction is constituted by kitchen waste, vegetable, followed by grass, leaves
- The decomposable fraction is about 60-70%. Recyclable around 15-30%
- Paper, plastic, metal, glass is segregated for recycling
- Waste from commercial areas depends on the activity; hotel wastes are highly organic with high moisture content. The carbon, nitrogen , potassium and phosphorus content analysis indicate good possibility of biological treatment
- Wastes from shopping complexes and shops are basically packaging cardboards, papers and plastics. The calorific value of such waste is high
- As family size increases per capita generation in a household decreases

Table 24: Chemical Composition of MSW

S.No.	Constituent / Property	Minimum	Maximum
1	Carbon	13.00	42.60
2	Nitrogen	0.28	1.23
3	Phosphorus Pentoxide (P_2O_5)	0.46	0.92
4	Potassium Oxide (K_2O)	0.45	1.07
5	Moisture %	13.80	40.90
6	Bulk Density	341.00	491.00
7	Calorific Value	684.00	1240.00

4.2 QUANTUM OF WASTE IN BANGALORE[36]

As per the study conducted by iDeCK in 2008 on Integrated MSW Strategy for Bangalore City, waste generation in year 2008 was approximately 5033 MT of waste per day. This figure on quantum of waste was based on secondary data collected from BBMP. The estimated waste generation in the years to follow is provided in the table below.

The annual population growth rate has been assumed to be 4.1% in line with the CDP prepared for Bangalore City taking the base figure from the population as per census 2001. The growth in population over the period of next 40 years is set out in table below.

Year	Population Projection at 4.1 % Growth Rate	MSW generation - TPD
2008	7806914	5033
2013	9544057	7129
2018	11667738	10093
2023	14263967	14310
2037	25035170	41889
2047	37416041	84262

Source: IDeCK, 2008, Master Plan for Municipal Solid Waste Management in Greater Bangalore

Assumptions for quantification of waste:

- The increase in per capita waste generation every year has been assumed to be 3%.
- The MSW generation by commercial establishments has been assumed to be approximately 2-3 kg/units.
- The MSW generation from bulk generators such as hotels, marriage halls, function halls, restaurants has been assumed to be 50 kg/unit.
- The total estimated quantum of bulk waste generated for 2008 is 1905 TPD with 3% annual increase up to 2047.
- The quantum of street sweeping & slit generated in the city is assumed to be 50 gpcd in 2008 with 3% annual increase up to 2047 of the total MSW generated.
- Quantity of household waste generated as of 2008 is considered as 350gpcd.
- MSW generation rate is approximately 50 kg per larger establishment per day and 3 kg per smaller establishment per day.
- As of 2008 the per capita waste generation of street sweeping is 50gm per day.

[36] *IDeCK, 2008, Master Plan for Municipal Solid Waste Management in Greater Bangalore*

4.3 QUANTUM OF HOUSEHOLD WASTE IN BANGALORE

Meanwhile, using the study conducted by iDeCK in 2008 on Integrated MSW Strategy for Bangalore City, an attempt has been made to arrive at the organic and inorganic quantities of waste generated at household level. The composition of waste in the study was derived by taking the waste generated by the selected households as the sample for the study. It was carried in 8 zones of Bangalore and the selected households contained the various categories, i.e., HIG, MIG, LIG and slum area. The sample waste generated was collected from 128 households for 7 days (896 samples).

4.3.1 Waste Composition

The table below shows a breakdown of municipal solid waste based around the main constituent. Examples of materials which fall into each of the categories are also shown in the table. This breakdown has been developed to highlight parts of the waste stream that can be recycled, composted or recovered. These classifications will enable the comparison of data between categories and can be used for the purpose of benchmarking and aggregation of data.

The constituent listed can be further categorized into decomposable, non-decomposable, recyclable and non-recyclable, hazardous and non-hazardous categories. Waste under category vegetables, grass and leaves, organics are decomposable fractions. Paper, plastic, cardboard, glass and metals form recyclable fractions. All above listed are non-hazardous in nature. Biomedical, battery forms the hazardous fraction of the waste. Debris forms the non-useable fraction.

Table 25: Material category for the analysis of household wastes

S.No	Categories	Description of material
1	Vegetable	Raw vegetables, fruits waste
2	Grass And Leaves	Garden waste, flowers, banana leaves (as it is frequently used in Bangalore)
3	Organics	Cooked food items, highly decomposable
4	Plastic	All kinds of plastics, all grades of polythene , pet bottles, disposable glass, plates
5	Paper	All kinds of papers, packaging paper, newspaper, glazed paper, office, mixed paper, tissue
6	Cardboard	Packing , corrugated cardboards
7	Textiles	All kinds of cloth
8	Leather	Leather products
9	Battery	Batteries like pencil cells, button cells, dry cell etc. non-

		recyclable and non-acid batteries
10	Electronic Items	Discarded watches , digital items , toys etc.
11	Metal	Ferrous and non-ferrous metals , foils, nails, screws, stands, etc.
12	Glass	All kinds of glass
13	Debris	Hairs, household sweeping waste, sandy, soil undefinable fraction.
14	Biomedical/Hazardous	Medicines, mosquito repellant- coils, mats, pesticides, insecticides, sanitary disposals, diapers ,napkins

4.3.2 Interpretation of results

The results under head weight collected per day indicate:

• Quantity of weights collected from different households for seven consecutive days.

• The weights are further divided on the sorted weights of each component in the sample.

• The categories are decided on the basis of most frequent appearance of types.

• The content organic indicate readily decomposable waste directly from kitchen.

• The raw vegetable and food contents are categorized under category vegetables.

• Garden waste and characteristic banana leaves found in Bangalore waste are kept under category grass/leaves and woods.

• Papers of all kinds are included in paper. Cardboard is formed by corrugated cardboards and glazed cardboards and other packing cardboards. All these are under the recyclable categories.

• Metals and glass forms the recyclable categories.

• Batteries and electronics items are also present.

• Medicines, mosquito repellants, biomedical / sanitary disposal are categorized as hazardous.

The results of each area are detailed below.

Table 26: MSW Composition - Physical Characteristics[37]

Composi-tion	Zones of BBMP								Aver age	%age
	East	West	South	Byatara nyapura	Mahad evapur a	Bomm anahall i	RR nagar	Dasar ahalli		
Vegetable	0.31	0.27	0.26	0.30	0.39	0.22	0.25	0.35	0.29	29.38
Organics	0.19	0.22	0.14	0.21	0.37	0.27	0.24	0.18	0.23	22.75
Grass And Leaves	0.09	0.09	0.07	0.05	0.01	0.04	0.09	0.06	0.06	6.25
Paper	0.10	0.11	0.07	0.10	0.08	0.09	0.06	0.10	0.09	8.88
Plastic	0.12	0.14	0.13	0.11	0.10	0.13	0.09	0.13	0.12	11.88
Cardboard	0.05	0.05	0.04	0.04	0.02	0.06	0.02	0.03	0.04	3.88
Textiles	0.01	0.02	0.05	0.05	0.01	0.01	0.06	0.10	0.04	3.88
Leather	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.38
Metal	0.00	0.01	0.00	0.03	0.00	0.01	0.03	0.01	0.01	1.13
Glass	0.07	0.03	0.03	0.02	0.00	0.02	0.04	0.00	0.03	2.63
Battery	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.13
Electronic Items	0.01	0.01	0.09	0.00	0.00	0.02	0.01	0.00	0.02	1.75
Debris	0.03	0.02	0.08	0.08	0.00	0.11	0.09	0.02	0.05	5.38
Biomedical	0.01	0.02	0.03	0.01	0.02	0.02	0.02	0.01	0.02	1.75
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	100.00

Source: IDeCK, 2008, Master Plan for Municipal Solid Waste Management in Greater Bangalore

The findings of the study indicate that the per capita household waste generation is about 225.70gpcd. Per capita waste generation excluding slum areas is 248.80gpcd. The population as per Census 2011 is

[37] *IDeCK, 2008, Master Plan for Municipal Solid Waste Management in Greater Bangalore*

8,425,970. Taking the figure of per capita waste generation excluding slum areas (248.8gpcd), the total household waste generated in Bangalore is 2100 tonnes.

Table 27: Quantity of organic and inorganic waste generated at household level

Broad Category	Percentage	Quantity of waste (tonnes)
Organic	**58.33**	**1225**
Vegetable	*29.38*	*617*
Organics	*22.76*	*478*
Grass And Leaves	*6.19*	*130*
Inorganic (Recyclable)	**32.66**	**685**
Paper	*8.88*	*186*
Plastic	*11.88*	*250*
Cardboard	*3.88*	*81*
Textiles	*3.88*	*81*
Leather	*0.38*	*8*
Metal	*1.13*	*24*
Glass	*2.63*	*55*
Inorganic (Landfill/Biomedical/Hazardous)	**9.01**	**190**
Battery	*0.13*	*3*
Electronic Items	*1.75*	*37*
Debris	*5.38*	*113*
Biomedical	*1.75*	*37*
TOTAL	**100**	**2100**

Source: IDeCK, 2008, Master Plan for Municipal Solid Waste Management in Greater Bangalore

The findings of the study by iDeCK indicate that the per capita household waste generation is about 225.70gpcd. Per capita waste generation excluding slum areas is 248.80gpcd. The population as per Census 2011 is 8,425,970. Taking the figure of per capita waste generation excluding slum areas (248.8gpcd), the total household waste generated in Bangalore is 2100 tonnes.

The break-up of this waste into 3 categories – Organic, Inorganic (Recyclable) and Inorganic (inert, biomedical, hazardous) is done.

- Organic waste generated from the households is 1225 tpd (58.33%),
- Recyclable component is 685 tpd (32.66%) and
- Non-usable inorganic including inert, debris, biomedical and hazardous waste is 190 tpd (9.01%).

If the organic and recyclable waste is separated from the waste stream at the point of generation and collected in a segregated manner, the remaining 190 tpd (9.01%) is the waste that the authorities need to find a solution for.

As per the SWM Policy document prepared by the Department of Environmental Cell in year 2012, the household waste forms 54% of the total waste generated in the city. Considering total household waste of 2100 tpd as 54%; the remaining 46% i.e. 1788 tpd is the waste from commercial establishments, markets and function halls, institutions and others.

Hence the total waste generated in the city as per our calculations is 3888 tpd (based on study conducted by iDeCK in 2008).

5. PRIMARY COLLECTION OF MSW IN SELECTED WARDS

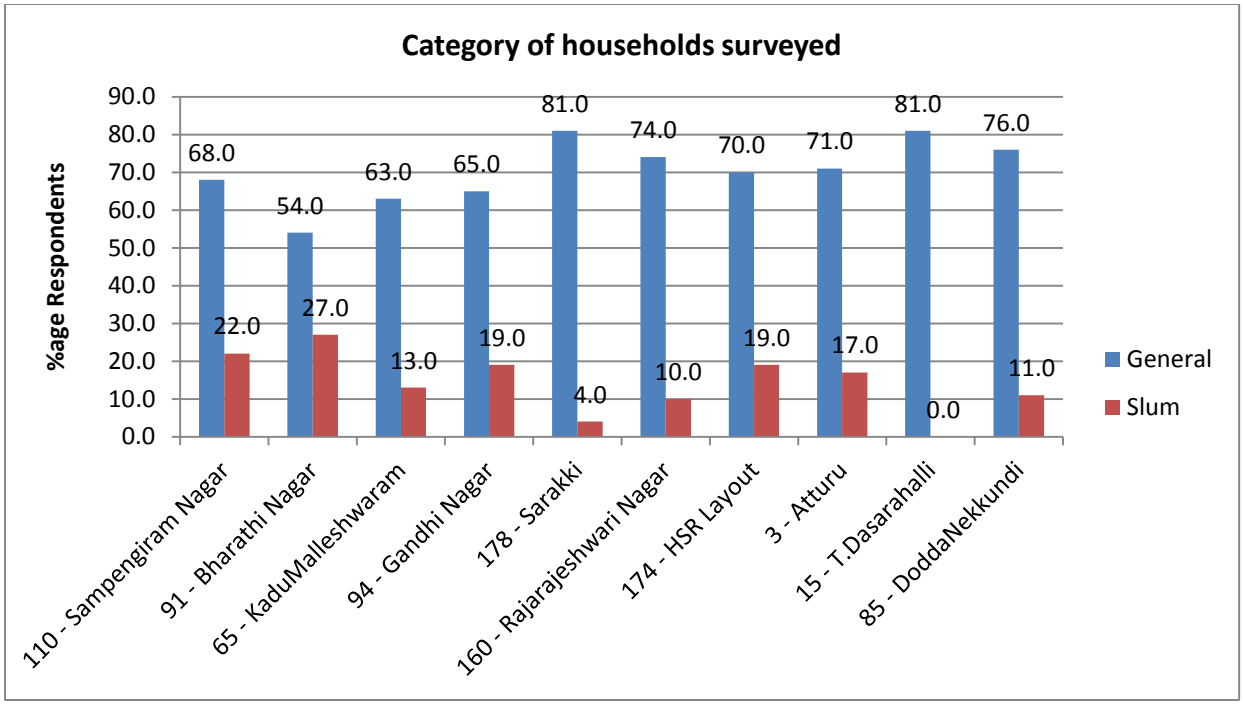
In order to achieve the two objectives of understanding the primary collection systems of MSW in selected wards, and identifying the key issues and gaps hindering the collection process, citizen's survey was conducted in the 10 wards selected for the study.

The data collected from the survey was tabulated and compiled based on the data analysis plan indicated in Chapter 1. The following pages describe the same.

5.1 COMPARISON OF WARDS WITH RESPECT TO EFFICIENT SERVICE DELIVERY IN PRIMARY COLLECTION OF WASTE FOR HOUSEHOLDS

While doing the survey for the selected 10 wards, households of both general and slums categories were surveyed. The chart below depicts that all the households of ward no. 15 T.Dasarahalli were general category and maximum slums surveyed was in ward no. 91 Bharathi Nagar.

Figure 39: Category of households surveyed



5.1.1 Indicators for examining the due diligence of the primary collection of waste in selected wards

Household level coverage of SWM services through door-to-door collection of waste

The ward with maximum door-to-door collection service is ward no. 65 Kadu Malleshwaram with 96.1% of households disposing waste by doorstep collection method. And the ward with minimum number of households with doorstep waste collection service is ward no. 94 Gandhi nagar (48.8%) where other prominent methods of disposing the waste is roadside (21.4%) and community bins (22.6%). **The average doorstep collection service for all the wards calculated is 75.3%.** The maximum portion of rest of the households is disposing the waste on road side amounting to an average of 16.6% households. The disposal at community (3.3%) bins, vacant site (3.0%) or any other method (0.6%) is minimal. (Refer chart below).

Figure 40: Method of waste disposal

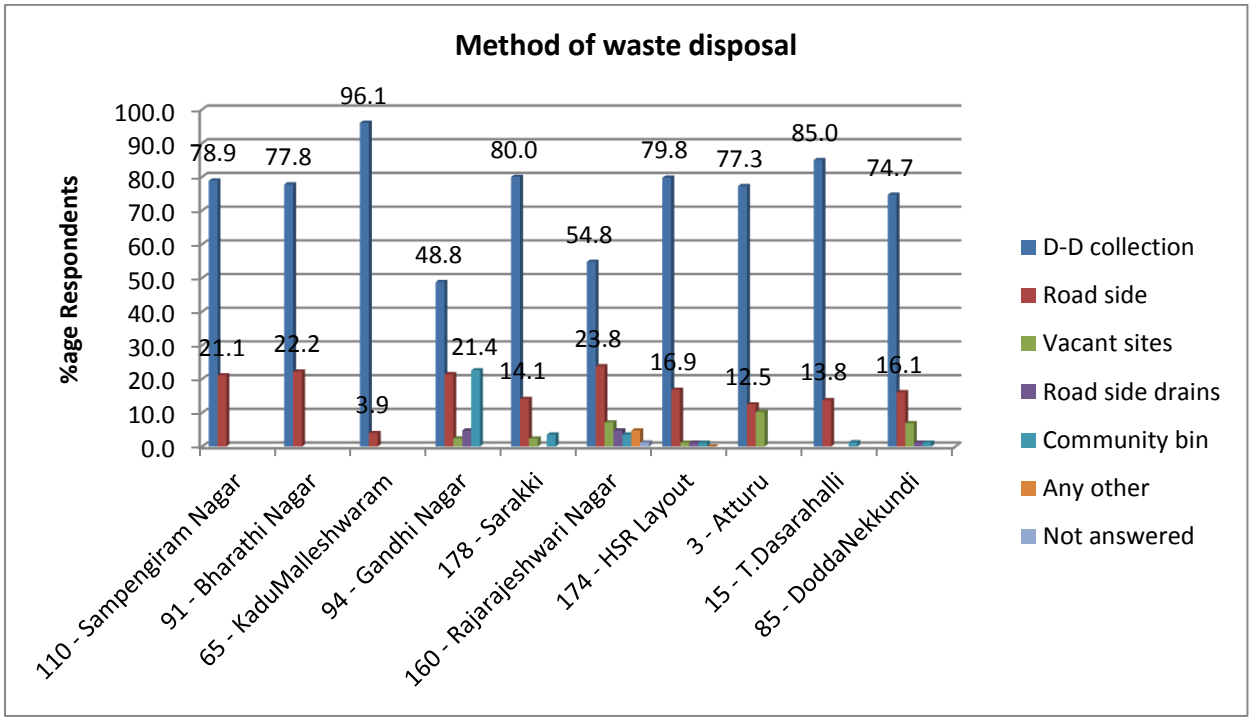


Table 28: Method of waste disposal

Method of waste disposal	D-D collection	Road side	Vacant sites	Road side drains	Community bin	Any other	Not answered
AVERAGE (%)	75.3	16.6	3.0	1.2	3.3	0.5	0.1

Frequency of door-to-door collection of waste

Ward no. 174 HSR layout has the maximum frequency of doorstep waste collection with 80.3% households covered daily including Sunday. **Average number of households covered under daily doorstep collection is 59.6%, covered 6 days a week is 17.9% and covered daily excluding Sundays and public holidays is 3.6%.**There are 12% households that are covered by doorstep collection every alternate day. Around 5% households do not have a fixed schedule of doorstep waste collection. **(Refer chart below)**

Figure 41: Frequency of doorstep waste collection in a week

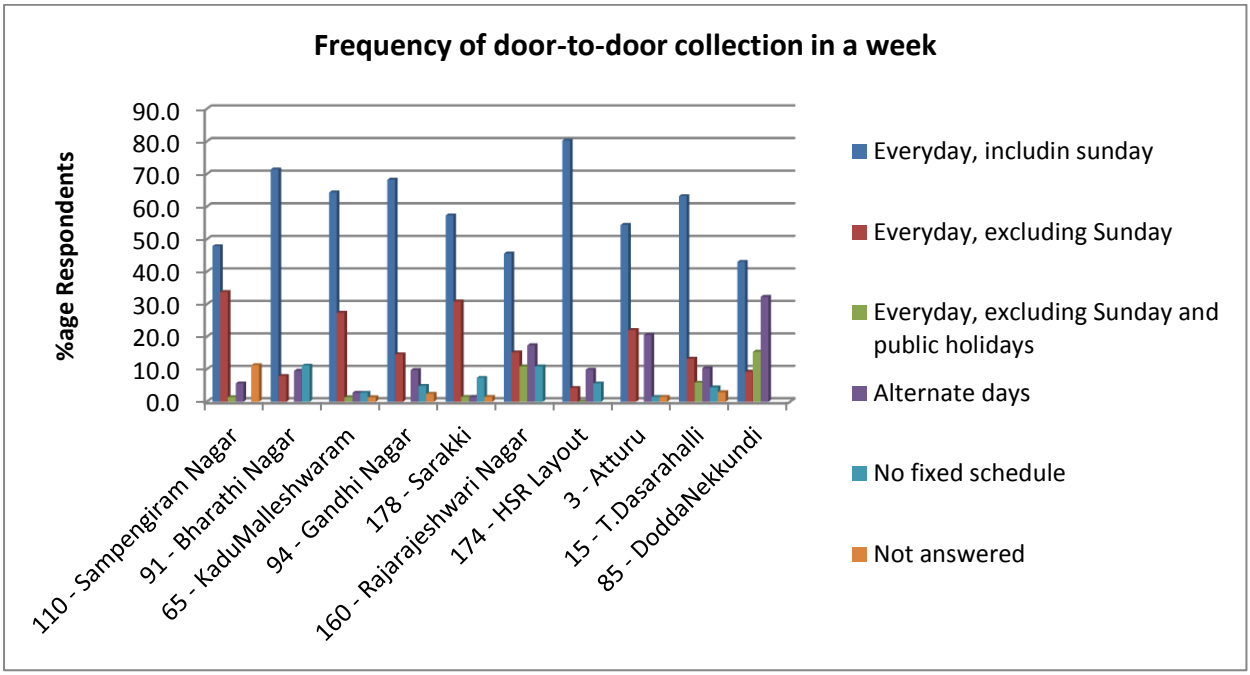


Table 29: Frequency of doorstep waste collection in a week

Frequency of door-to-door collection	Every day, including Sunday	Every day, excluding Sunday	Every day, excluding Sunday and public holidays	Alternate days	No fixed schedule	Not answered
AVERAGE (%)	59.6	17.9	3.6	12.0	4.8	2.1

Time of collection of waste from doorstep

Most of the houses where door-to-door collection is provided are covered between 6a.m. to 10a.m. There is minimal collection after 10 a.m. The idea seems that the people store the waste and handover the waste stored to the pourakarmika in the morning. **(Refer chart below)**

Figure 42: Time of collection of waste from doorstep

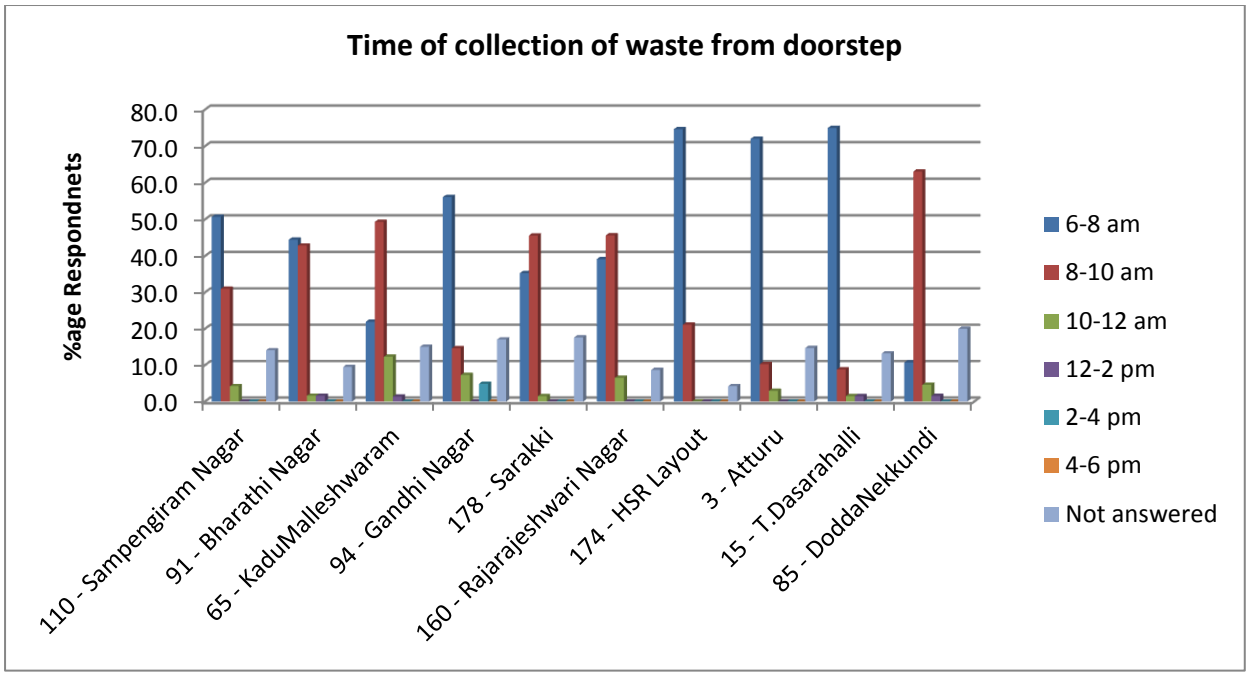


Table 30: Time of collection of waste from doorstep

Time of collection of waste from doorstep	6-8 am	8-10 am	10-12 am	12-2 pm	2-4 pm	4-6 pm	Not answered
AVERAGE (%)	48.0	33.2	4.2	0.6	0.5	0.0	13.4

Efficiency in collecting waste at a fixed time

Seven out of 10 wards surveyed have more than 75% efficiency of doorstep collection at a fixed time. The ward with the poorest service in this parameter is ward no. 85-Doddanekkundi with 32% households where doorstep collection never takes place at a fixed time and 23% households have a fixed time of doorstep collection sometimes. **The average efficiency of doorstep collection at a fixed time for the 10 wards surveyed is 73.7%. (Refer chart below)**

Figure 43: Efficiency of doorstep waste collection at a fixed time

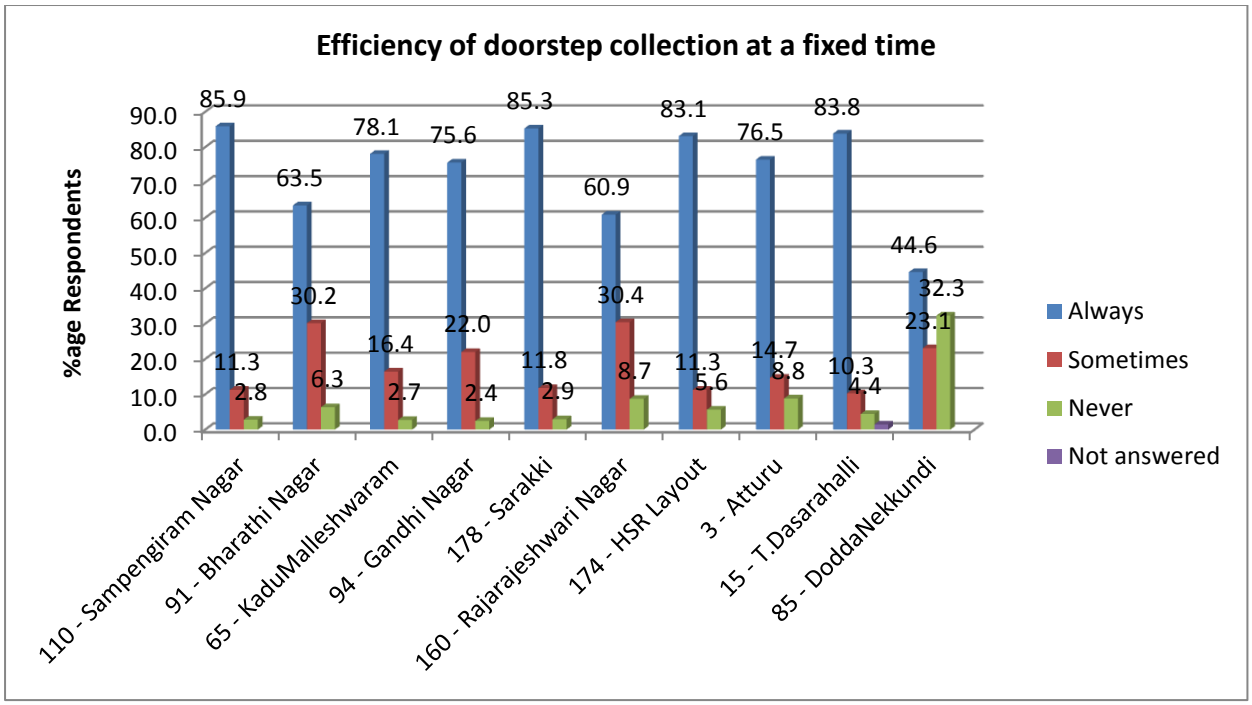


Table 31: Efficiency of doorstep waste collection at a fixed time

Efficiency of doorstep collection at a fixed time	Always	Sometimes	Never	Not answered
AVERAGE (%)	73.7	18.1	7.7	0.1

Frequency of street cleaning

The frequency of street cleaning is poor compared to other parameters for all the 10 selected wards. The only ward with more than 75% efficiency in street cleaning is ward no.110-Sampengiram nagar. **The average frequency of street cleaning for all the 10 wards is 56.5%. (Refer chart below)**

Figure 44: Frequency of street cleaning

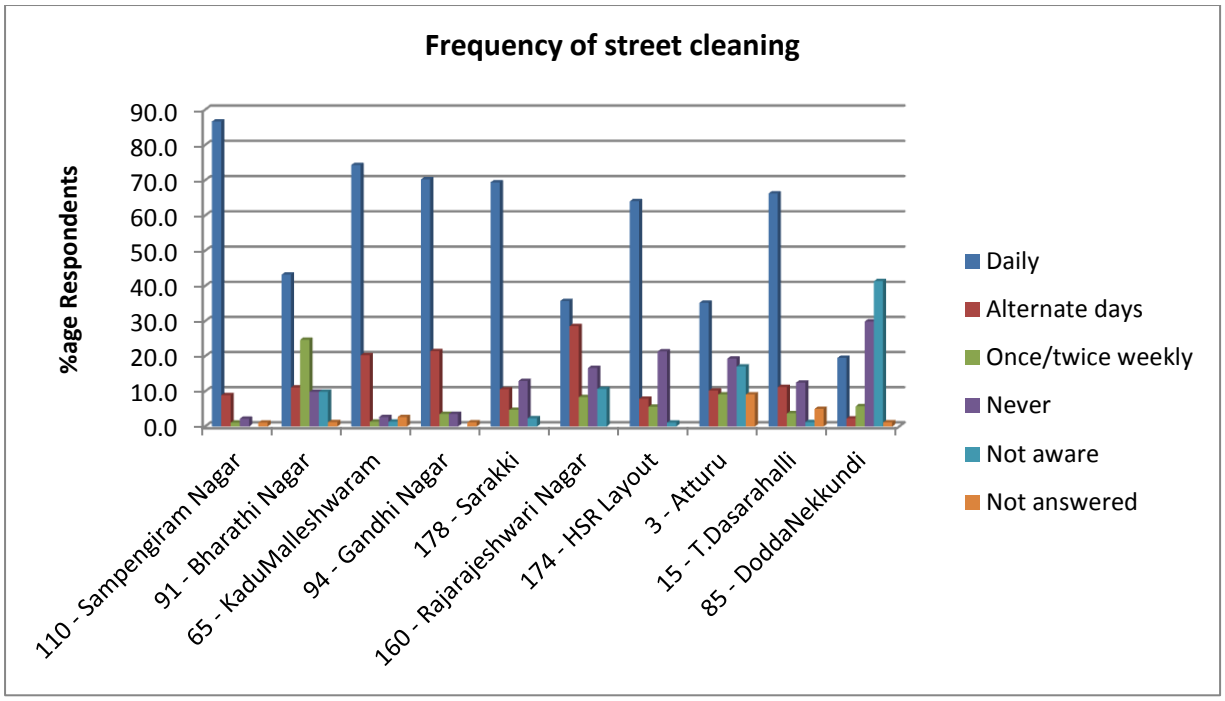


Table 32: Frequency of street cleaning

Frequency of Street cleaning	Daily	Alternate days	Once/twice weekly	Never	Not aware	Not answered
AVERAGE (%)	56.5	13.2	6.8	13.1	8.5	2.1

Time of collection of waste from the streets

Most of the streets in the selected wards get cleaned in the morning hours between 6.0 a.m. to 12 noon. Street sweeping in most of the commercial areas are also over by noon. Lack of street cleaning in evening is one of the reasons of untidy look of the city. Significant percentage (20%) of persons chose not to answer the question since they were not aware of street cleaning timings. **(Refer chart below)**

Figure 45: Time of collection of waste from streets

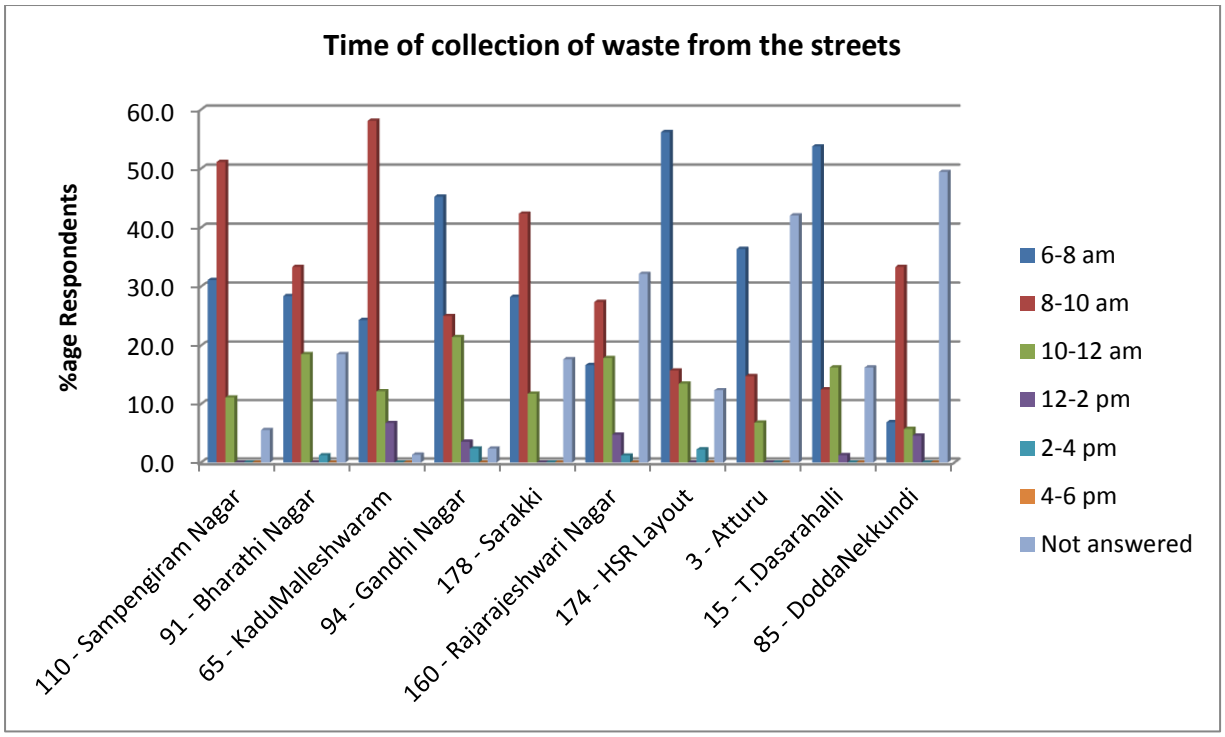


Table 33: Time of collection of waste from streets

Time of Collection of waste from the streets	6-8 am	8-10 am	10-12 am	12-2 pm	2-4 pm	4-6 pm	Not answered
AVERAGE (%)	32.7	31.4	13.5	2.1	0.7	0.0	19.8

5.1.2 Indicators for studying the behaviour of citizen and their concerns and issues in storage, segregation and disposal of waste

Method of disposal of waste by the households and establishments when there is no doorstep collection in their presence

Close to 70% of households keep their waste bags near the gate so that the workers can collect the same while collecting waste from the door. Around 15% of the households dispose the waste on the street / road sides themselves or give it to the maid for disposal. **(Refer chart below).**

Figure 46: Method of waste disposal when there is no doorstep waste collection

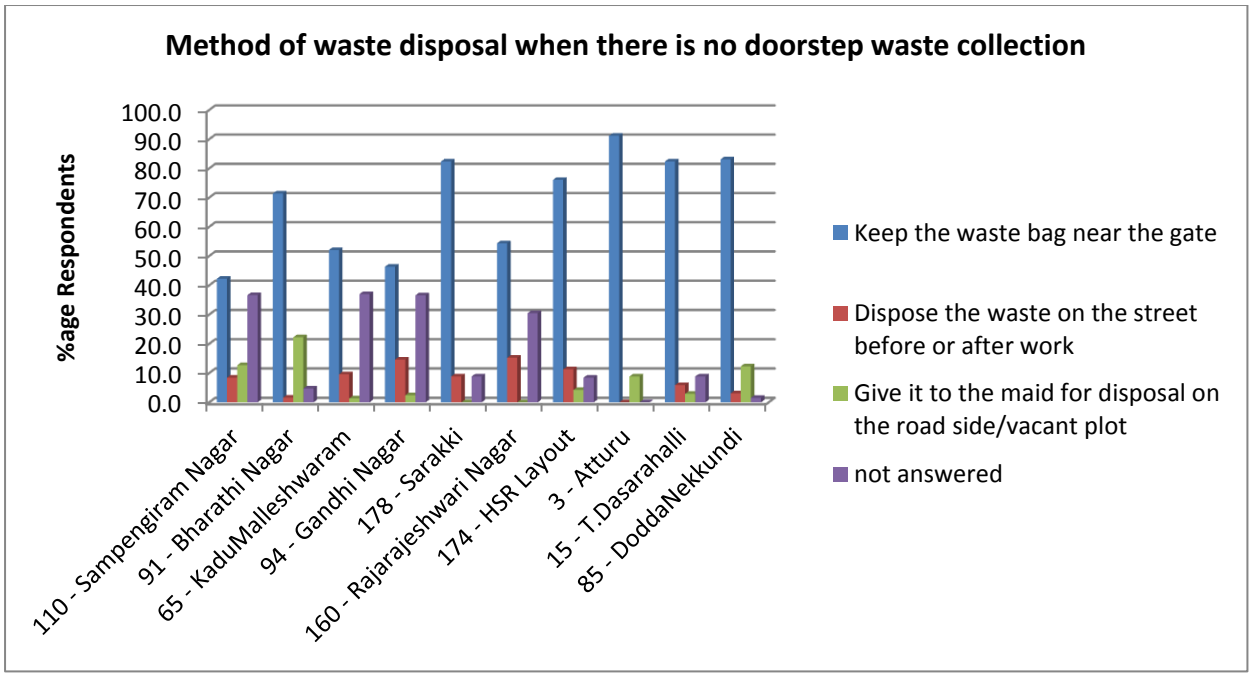


Table 34: Method of waste disposal when there is no doorstep waste collection

Method of waste disposal when there is no doorstep waste collection	Keep the waste bag near the gate	Dispose the waste on the street before or after work	Give it to the maid for disposal on the road side/vacant plot	not answered
AVERAGE (%)	68.1	7.9	6.7	17.3

Extent of segregation of waste

Segregation of waste is practiced by 40% of the residents, which is good news if BBMP wants to improve this with the help of creating awareness and involving NGOs/SHGs. In wards like Doddanekkundi, Atturu, and HSR layout the extent of segregation is more that 58%. **(Refer chart below).**

Figure 47: Households segregating the waste into wet and dry

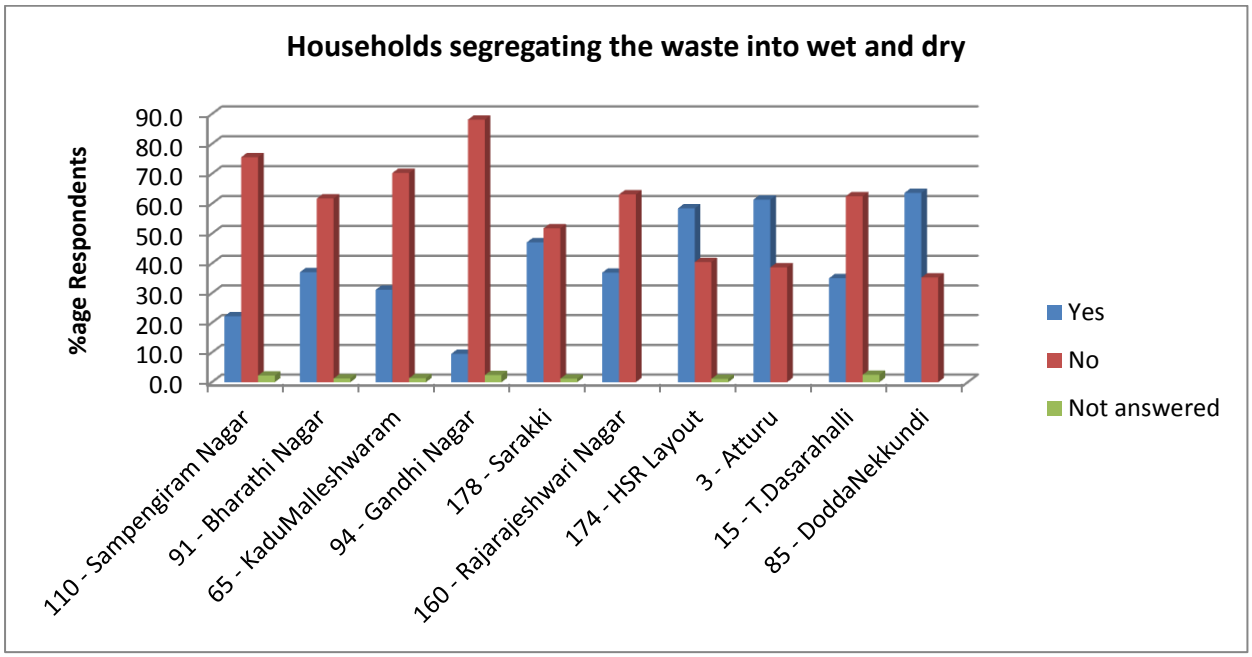


Table 35: Households segregating the waste into wet and dry

Extent of waste segregation	Yes	No	Not answered
AVERAGE (%)	40.2	58.7	1.2

Percentage of segregated waste at source being collected in a segregated manner by the service provider

Out of the 40% of households segregating waste (as shown in the above figure), 70% said that their segregated waste gets collected in a segregated manner by the pourakarmikas. However, a substantially large number i.e., 30% of segregated household waste gets mixed at the time of collection. This points to the fact that awareness creation & training is needed not only for the residents but also the employees handling the waste. **(Refer chart below).**

Figure 48: Percentage of segregated waste collected in a segregated manner

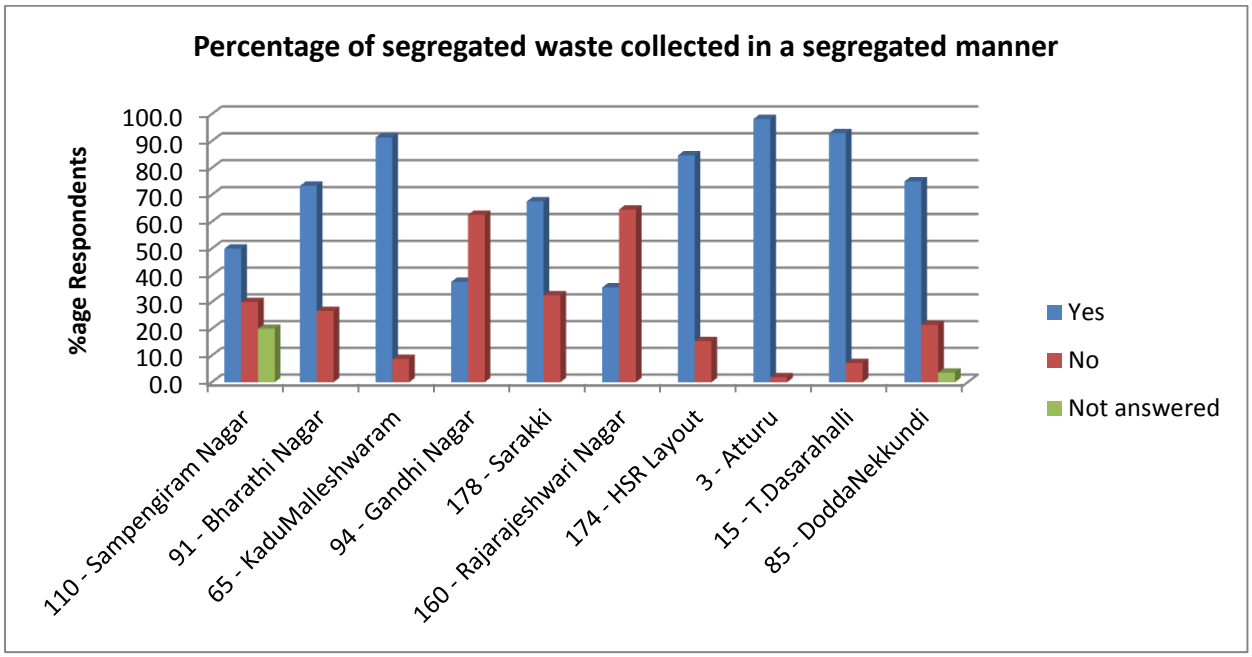


Table 36: Percentage of segregated waste collected in a segregated manner

Percentage segregated waste collected in a segregated manner	Yes	No	Not answered
AVERAGE (%)	70.6	27.1	2.4

Graph showing various reasons by households & establishments for not segregating the waste at source

The result shows that most of the residents chose not to answer this question (almost 50%). Out of the remaining who answered a large number (30%) gave the reason as lack of awareness for not segregating the waste and 14% did not segregate as no one else segregates in the locality. This result indicates that segregation is a habit which can also catch up among residents if a considerably decent number of residents do it regularly. Around 6% of the household stated that they do not practice segregation since it does not get collected in the same manner indicating that to some extent pourakarmikas can be trained to encourage waste segregation at one to one level.

Figure 49: Reasons for non-segregation of waste

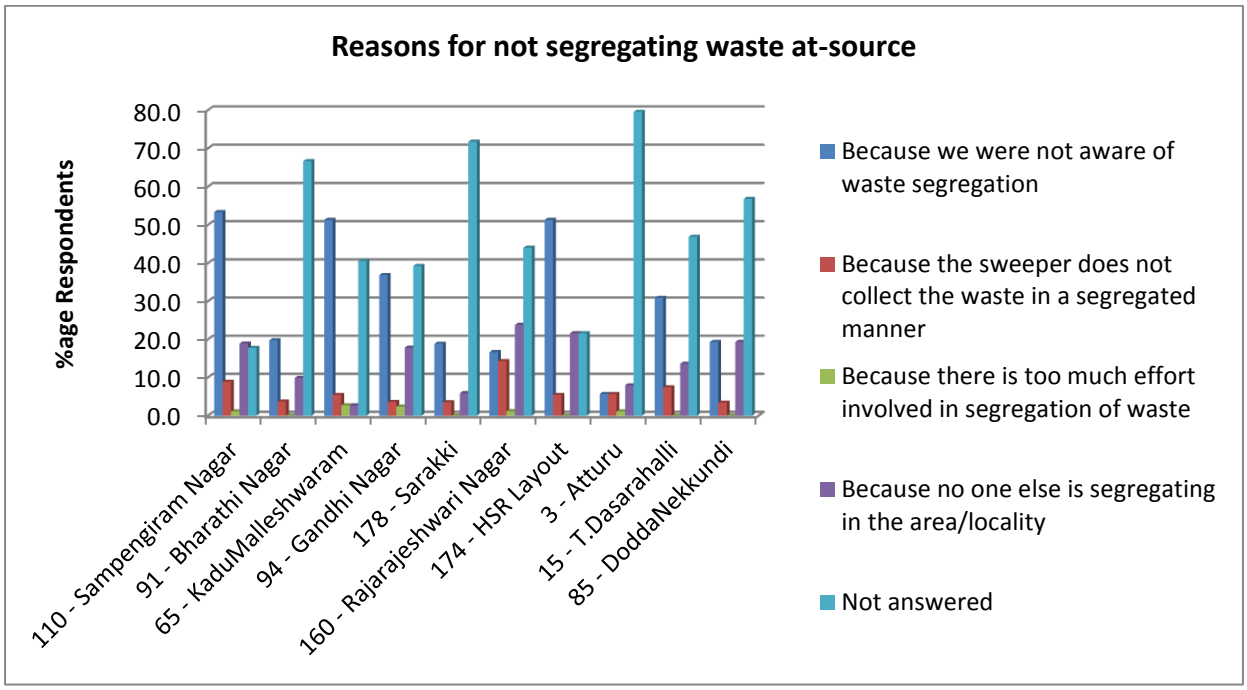


Table 37: Reasons for non-segregation of waste

Reasons for not segregating waste at-source	Because we were not aware of waste segregation	Because the sweeper does not collect the waste in a segregated manner	Because there is too much effort involved in segregation of waste	Because no one else is segregating in the area/locality	Not answered
AVERAGE (%)	30.4	6.1	0.9	14.1	48.5

Satisfaction level of the people with respect to doorstep collection of waste

Wards T.Dasarahalli, HSR Layout, KaduMalleshwaram, Atturu and Sampangiramnagar have more than 50% households fully satisfied with the door-to-door collection. Poorest satisfaction level is seen in Doddanekkundi and Rajarajeshwarinagar wards in the same order. These two wards have a fairly large area and also are comparatively newer areas. **(Refer chart below).**

Figure 50: Satisfaction level w.r.t. doorstep waste collection

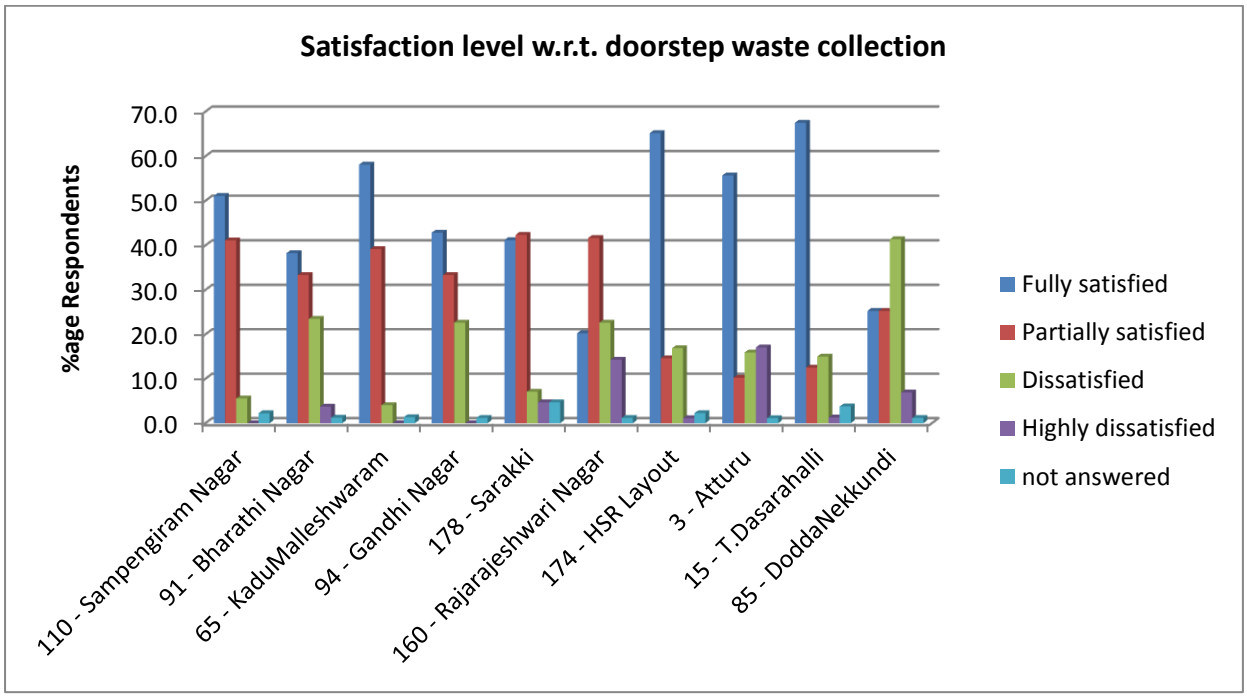


Table 38: Satisfaction level w.r.t. doorstep waste collection

Satisfaction level w.r.t. doorstep waste collection	Fully satisfied	Partially satisfied	Dissatisfied	Highly dissatisfied	not answered
AVERAGE (%)	46.5	29.4	17.5	4.9	2.0

Satisfaction level of the people with respect to collection of waste from the street in their locality

Compared to door-to-door collection the satisfaction level with respect to waste collection from the streets is poor. T.Dasarahalli, KaduMalleshwaram and HSR layout have more than 50% fully satisfied households. Households in Doddanekkundi ward are the least satisfied with this service. **(Refer chart below).**

Figure 51: Satisfaction level w.r.t. collection of waste from streets

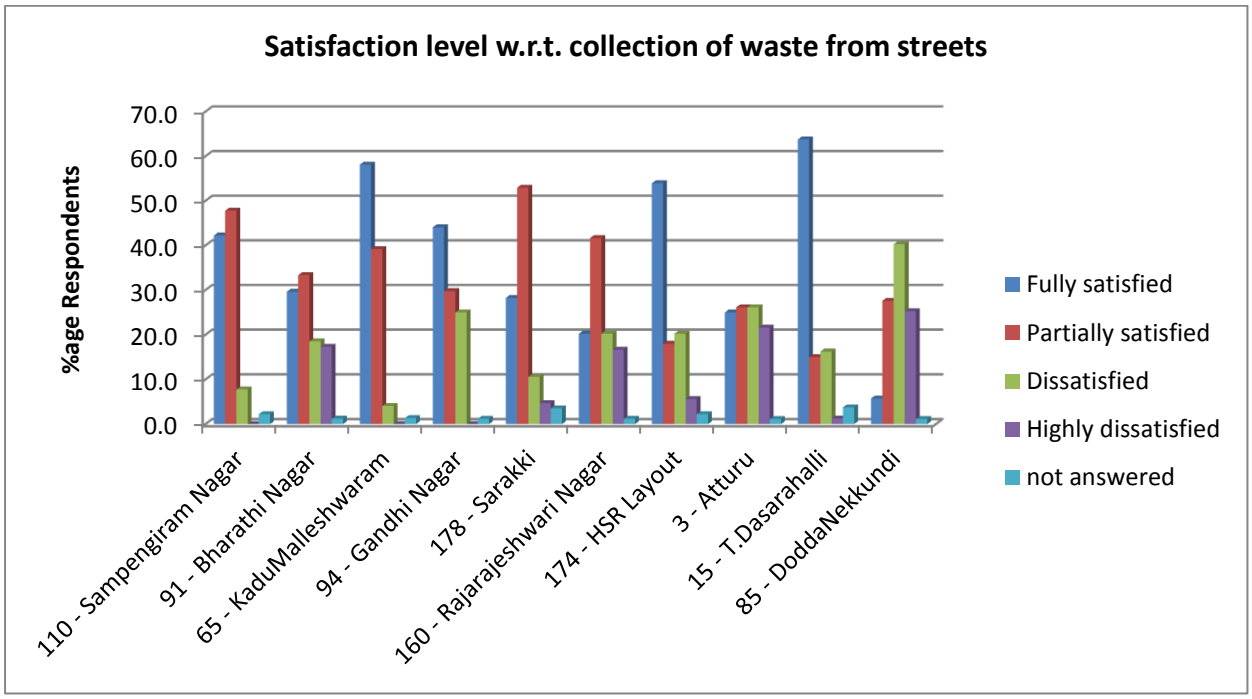


Table 39: Satisfaction level w.r.t. collection of waste from streets

Satisfaction level w.r.t. collection of waste from streets	Fully satisfied	Partially satisfied	Dissatisfied	Highly dissatisfied	not answered
AVERAGE (%)	37.1	33.1	18.9	9.2	1.9

Satisfaction level of the people with respect to street sweeping in their locality

Results of satisfaction level for street sweeping in the locality are similar to those of collection of waste from the streets with most satisfaction levels observed in Kadu Malleshwaram, HSR layout and T.Dasarahalli. Overall, the result of street cleaning indicators seems to be poor compared to door-to-door collection. **(Refer chart below)**

Figure 52: Satisfaction level w.r.t street sweeping in locality

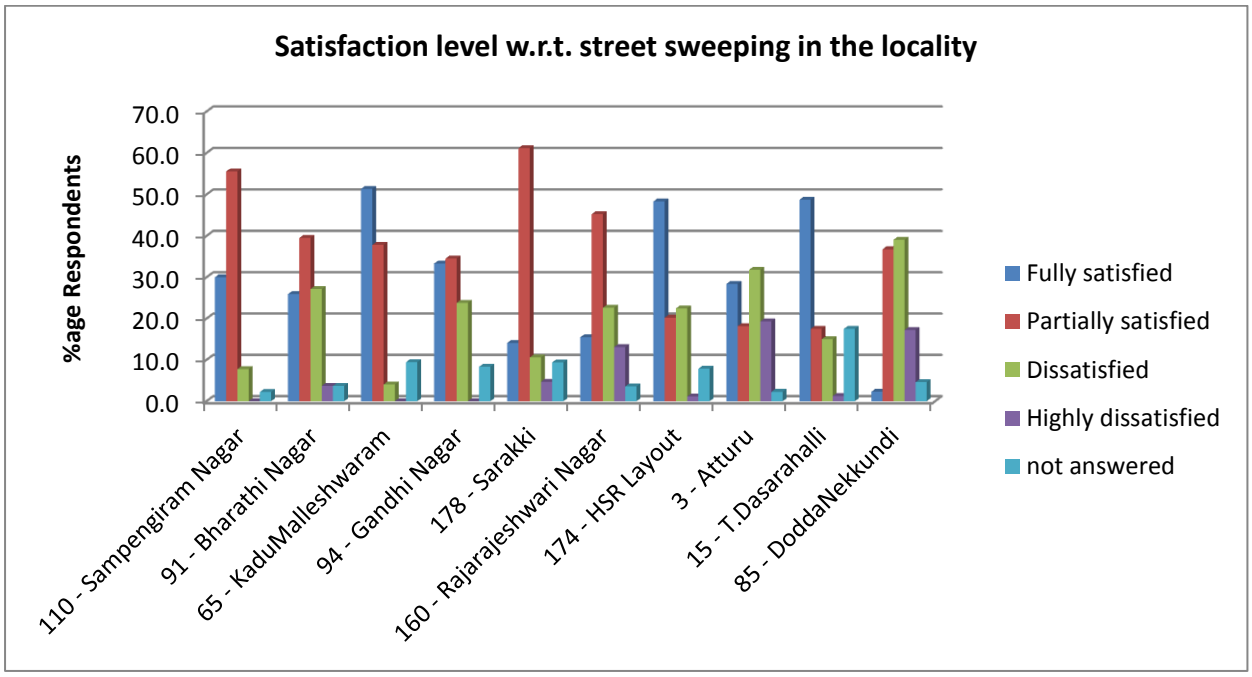


Table 40: Satisfaction level w.r.t. street sweeping in the locality

Satisfaction level w.r.t. street sweeping in the locality	Fully satisfied	Partially satisfied	Dissatisfied	Highly dissatisfied	not answered
AVERAGE (%)	29.8	36.7	20.4	6.0	6.9

5.1.3 Indicators for people's awareness and participation

Percentage of households and establishments participating in any form of awareness program

A very poor people's participation of merely 15.6% is observed in the 10 wards selected for the study. **(Refer chart below).**

Figure 53: People's participation in SWM awareness program

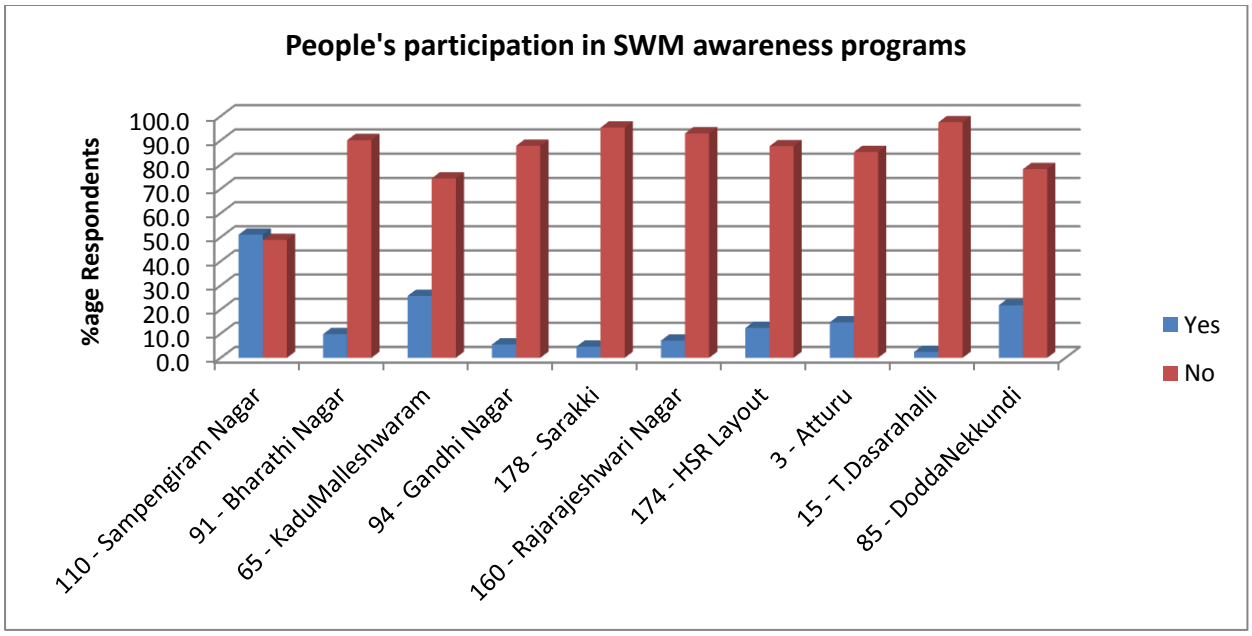


Table 41: People's participation in SWM awareness programs

People's participation in SWM awareness programs	Yes	No
AVERAGE (%)	15.6	83.8

Different awareness programs in which households and establishments have participated

Out of the 15% participants, around 86% have registered complaint regarding waste management, 12 % have attended any of the seminar/conference and just 1% has participated in RWA meeting related to waste management. **(Refer chart below).**

Figure 54: Amount of people's participation in various awareness programs

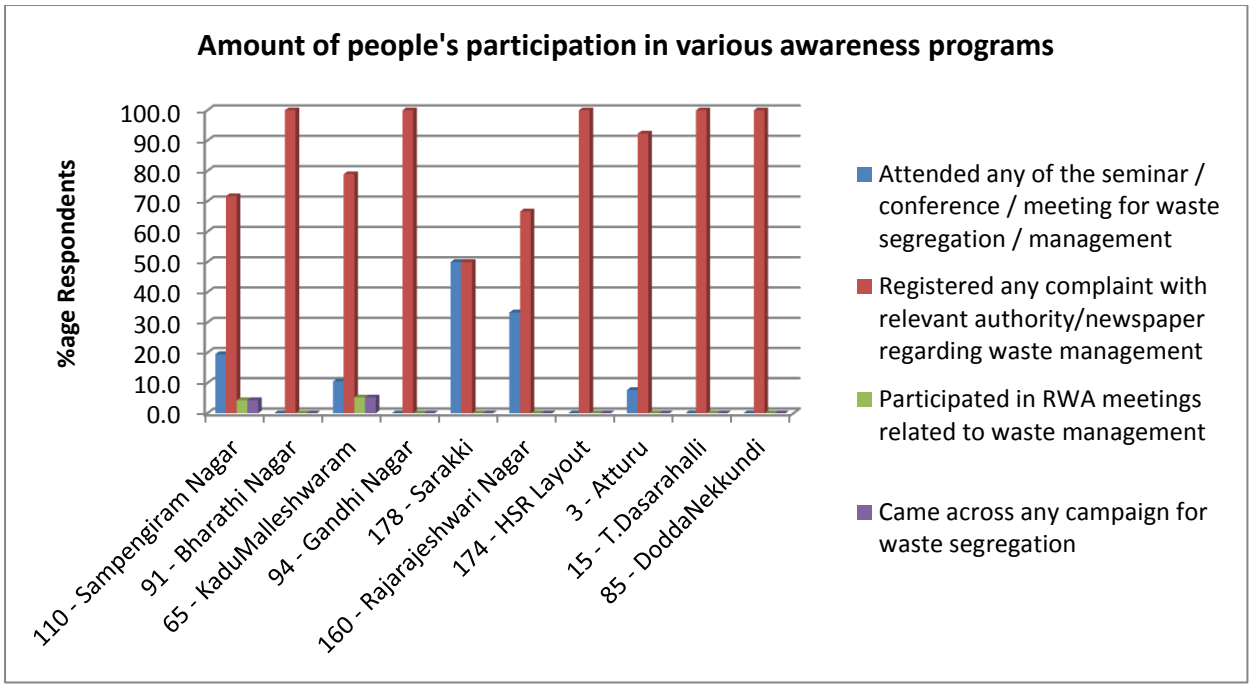


Table 42: Amount of people's participation in various awareness programs

Amount of people's participation in various awareness programs	Attended any of the seminar / conference / meeting for waste segregation / management	Registered any complaint with relevant authority/newspaper regarding waste management	Participated in RWA meetings related to waste management	Came across any campaign for waste segregation
AVERAGE (%)	12.1	86.0	1.0	1.0

Level of awareness and interest in participation by households and establishments in improving the solid waste management at Bangalore

The awareness level indicators suggest that most of the people in Bangalore are aware about garbage as a problem and that a change is required to improve the waste management in their locality. More than 85% of the households are aware about the importance of waste segregation at-source. More than 63% households are ready to pay for better waste management. More than 75% households are of the view that wet waste can be treated at community level for effective waste management.

Figure 55: Awareness about extent of solid waste management problem in Bangalore

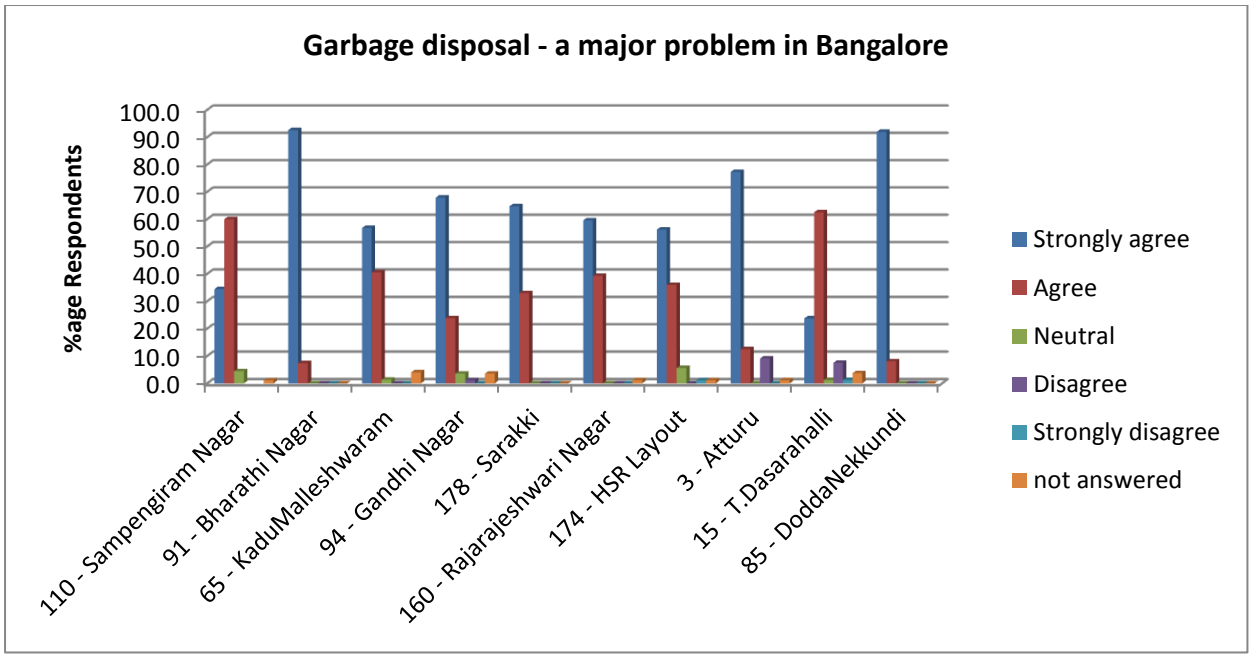


Table 43: Awareness about extent of solid waste management problem in Bangalore

Garbage disposal - a major problem in Bangalore	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	not answered
AVERAGE (%)	62.5	32.3	1.6	1.8	0.2	1.6

Figure 56: Awareness about change in the way waste is managed

Table 44: Awareness about change in the way waste is managed

A change is required in the way waste is managed in your locality	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	not answered
AVERAGE (%)	46.8	47.5	1.8	1.9	0.4	1.7

Figure 57: Awareness about the importance of waste segregation at-source

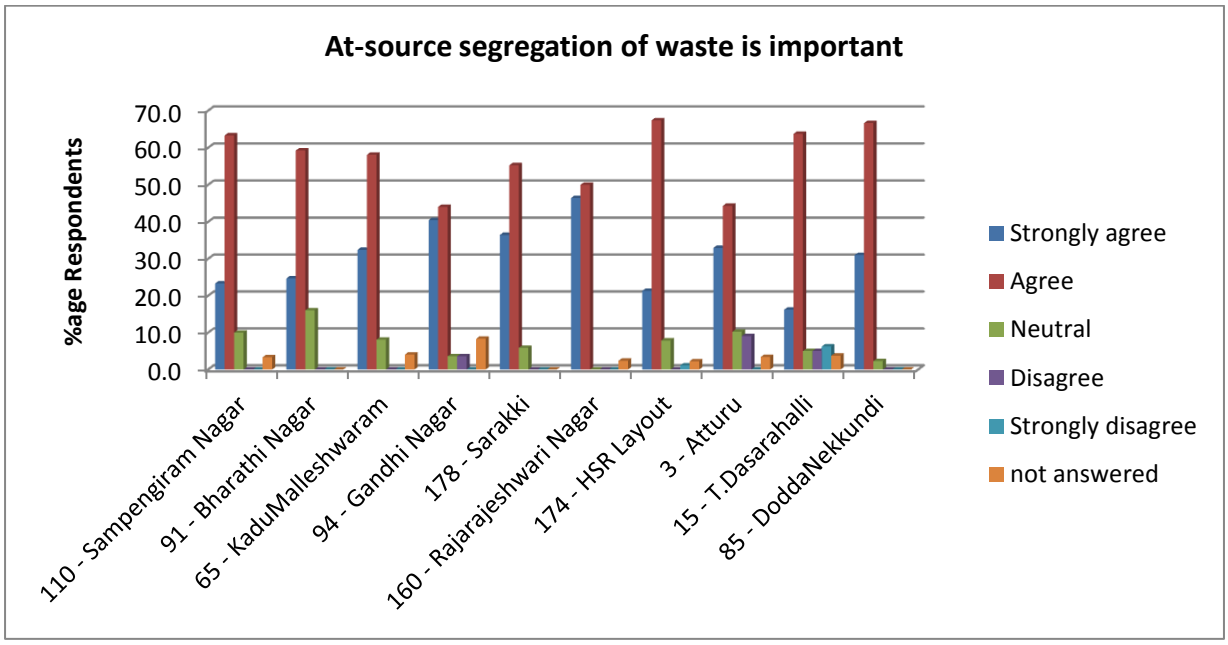


Table 45: Awareness about importance of waste segregation at-source

At-source segregation of waste is important	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	not answered
AVERAGE (%)	30.5	57.2	6.9	1.8	0.7	2.8

Figure 58: Willingness to pay for better waste management

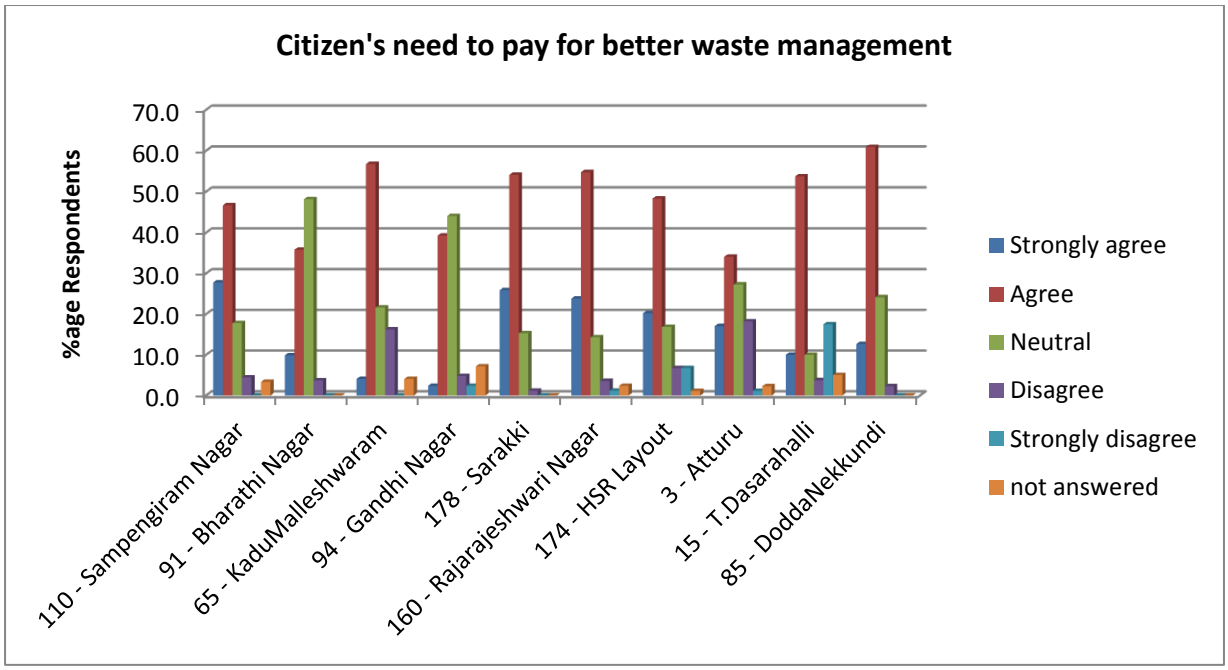


Table 46: Willingness to pay for better waste management

Citizen's need to pay for better waste management	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	not answered
AVERAGE (%)	15.4	48.4	23.9	6.5	2.9	2.5

Figure 59: Awareness about citizen's responsibility in keeping the city clean

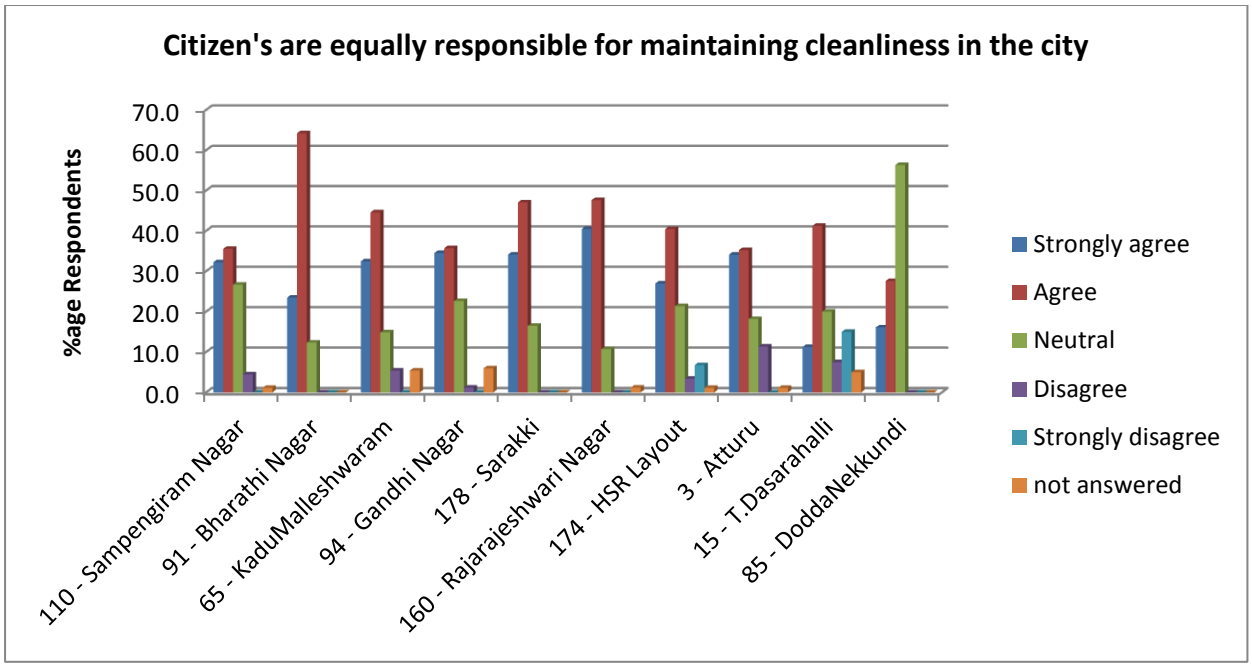


Table 47: Awareness about citizen's responsibility in keeping the city clean

Citizens are equally responsible for maintaining cleanliness in the city	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	not answered
AVERAGE (%)	28.6	41.9	22.0	3.3	2.2	2.1

Figure 60: Opinion on ways of ensuring effective waste segregation

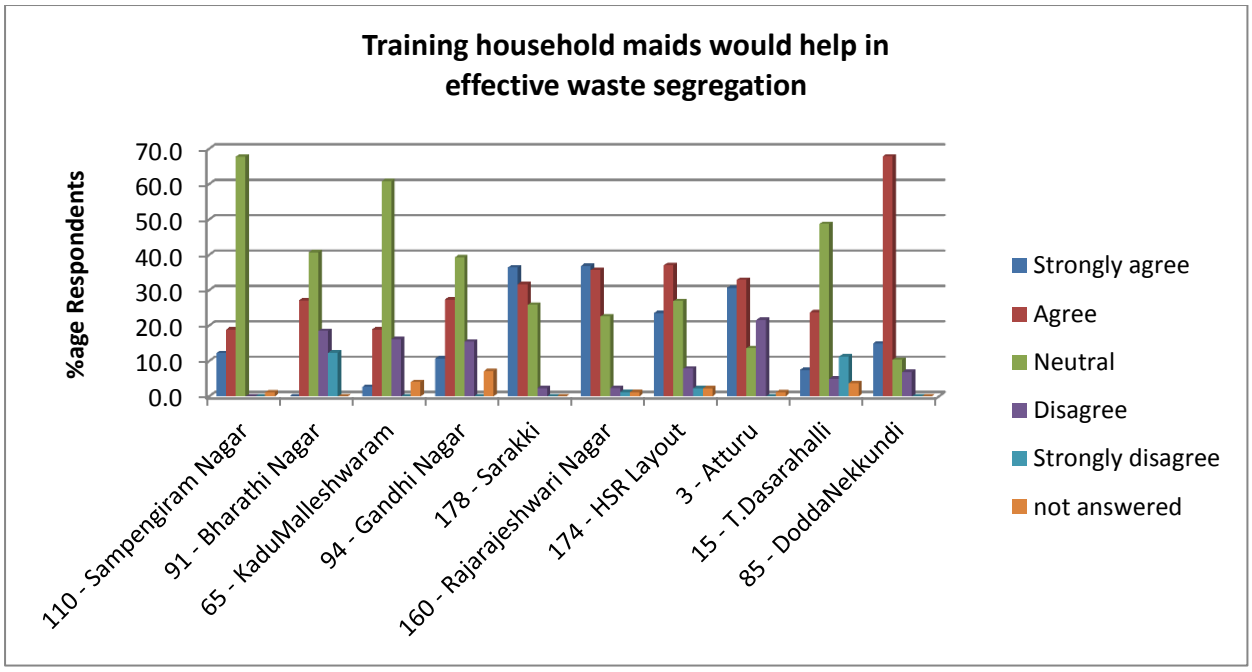


Table 48: Opinion on ways of ensuring effective waste segregation

Household maids should be trained about waste segregation	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	not answered
AVERAGE (%)	17.6	32.1	35.7	9.6	2.7	2.1

Figure 61: Opinion on ways of ensuring waste treatment for resource recovery

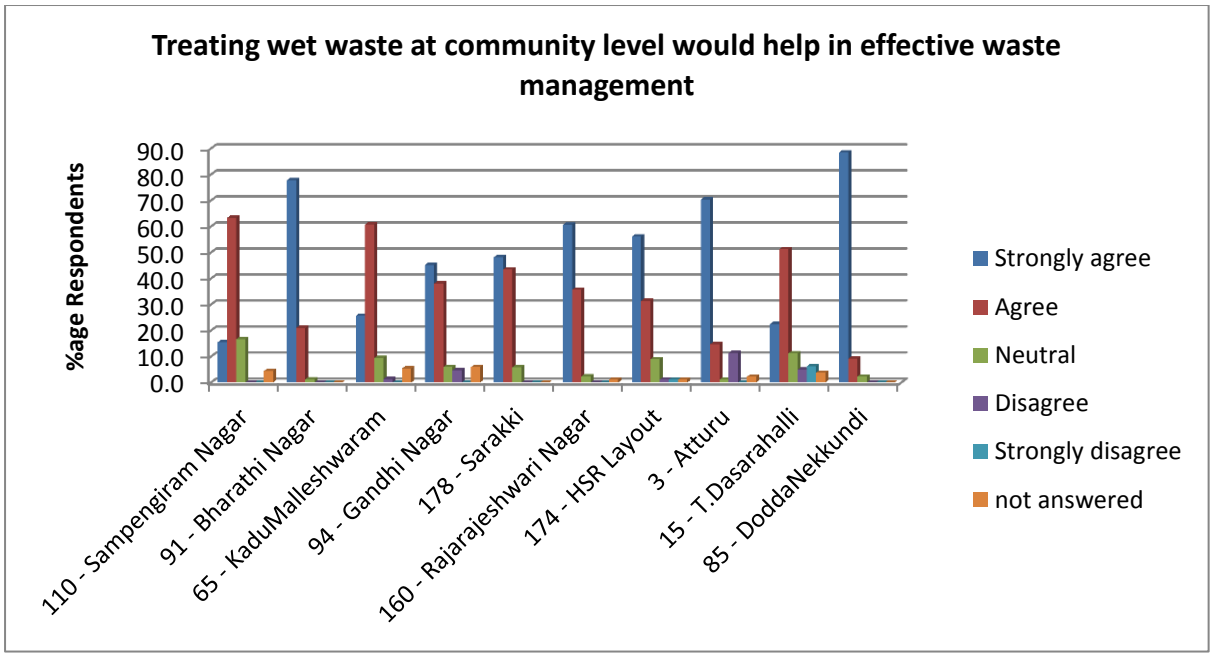


Table 49: Opinion of ways of ensuring effective waste treatment for resource recovery

Effective waste management can be achieved by treating wet waste at community level	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	not answered
AVERAGE (%)	51.1	36.9	6.5	2.4	0.7	2.4

5.2 STUDY OF EFFICIENCY OF WASTE MANAGEMENT IN CASE OF WASTE GENERATED FROM SHOPS

Out of the 10 wards surveyed, the total number of shops covered was 58. The details of the samples covered are given in Annexure 1. In order to find the efficiency of service delivery, questions similar to the households were asked to the shopkeepers of the selected shops. The charts in the following pages show the result of the survey conducted.

5.2.1 Indicators for examining the due diligence of the primary collection of waste in shops

Figure 62: Method of waste disposal

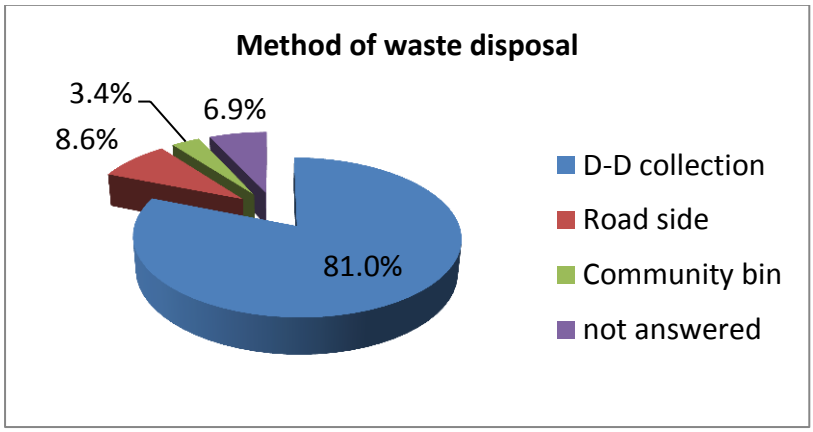


Figure 63: Frequency of door-to-door collection of waste

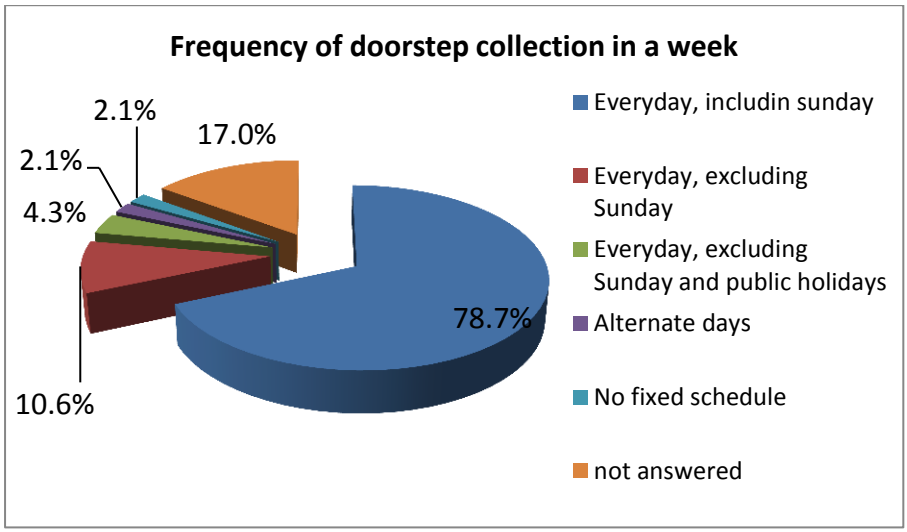


Figure 64: Time of collection of waste from doorstep

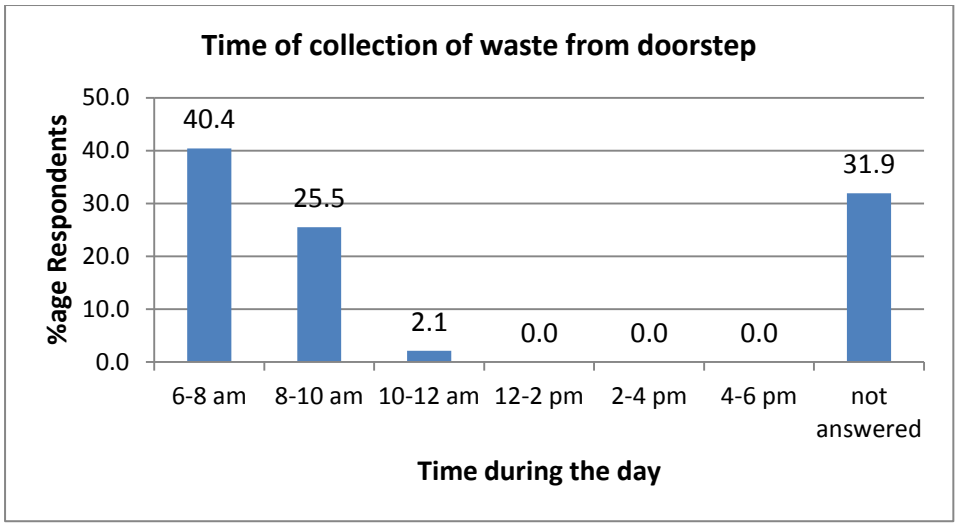


Figure 65: Efficiency in collecting waste at a fixed time

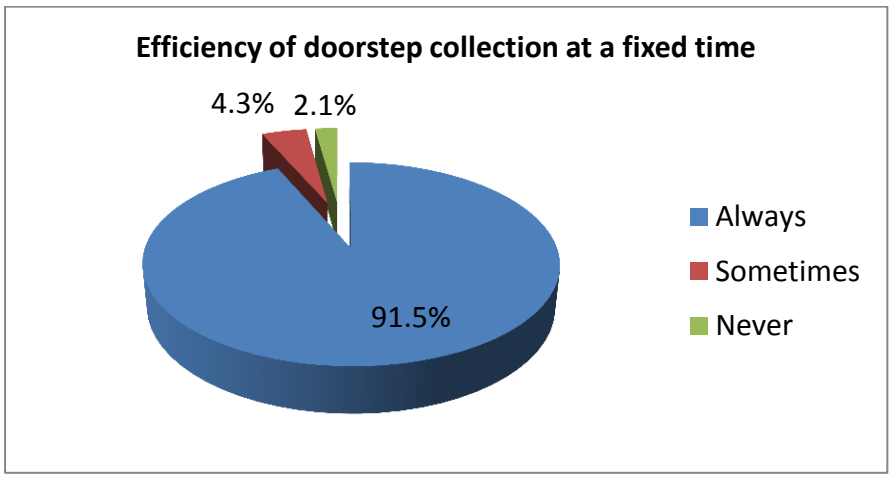


Figure 66: Frequency of street cleaning

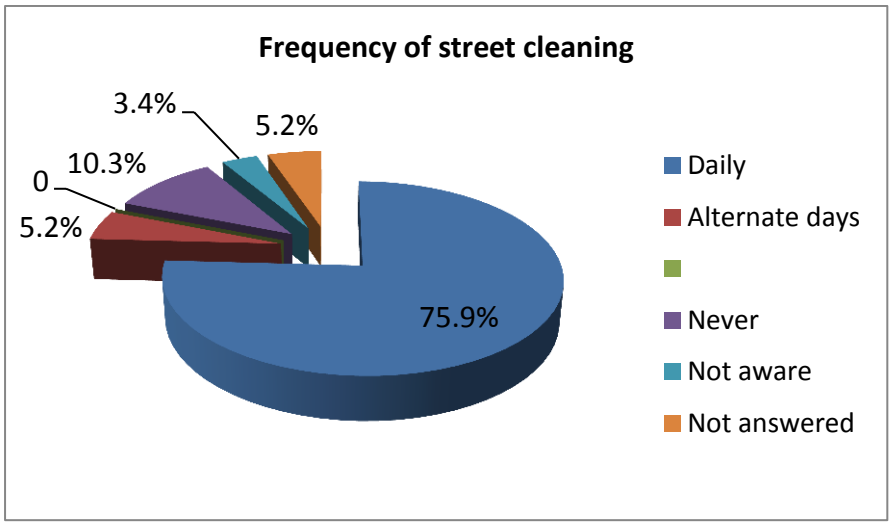


Figure 67: Time of collection of waste from the streets

5.2.2 Indicators for studying the behaviour of shopkeepers and their concerns and issues in storage, segregation and disposal of waste

Figure 68: Method of waste disposal when there is no doorstep waste collection

Figure 69: Extent of segregation of waste

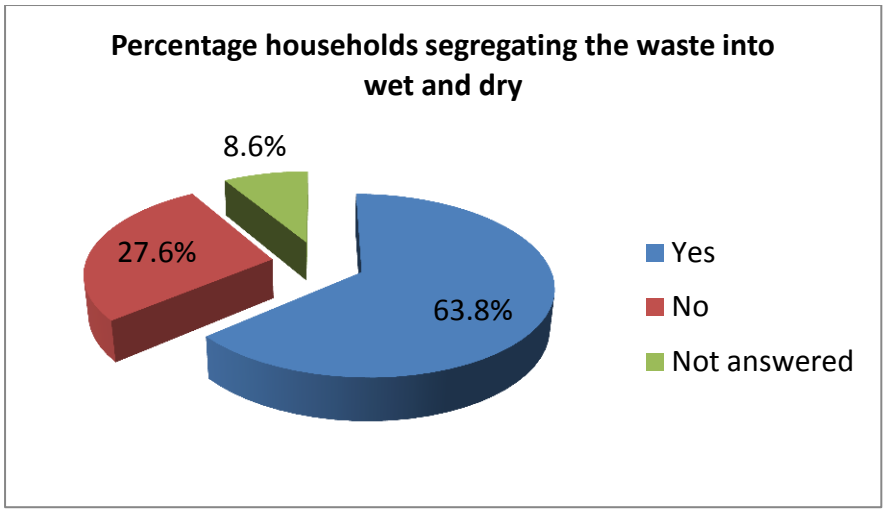


Figure 70: Percentage of segregated waste being collected in a segregated manner

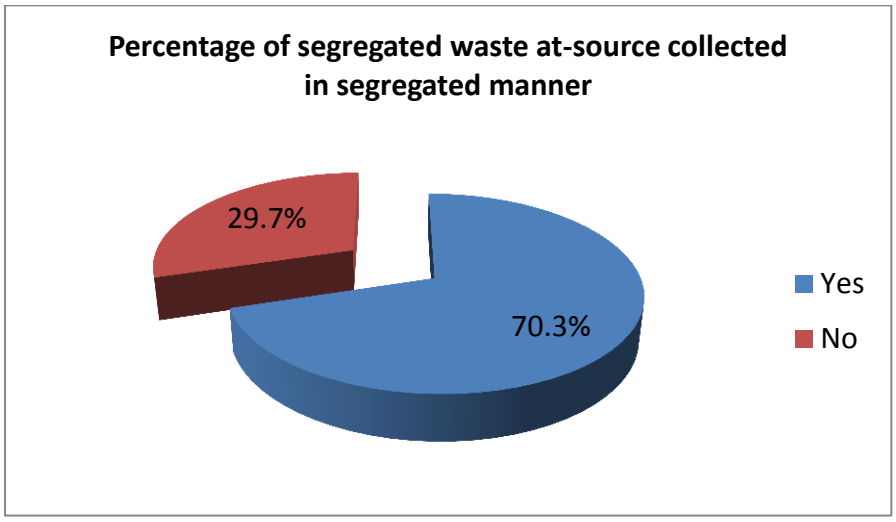


Figure 71: Reasons for not segregating the waste at-source

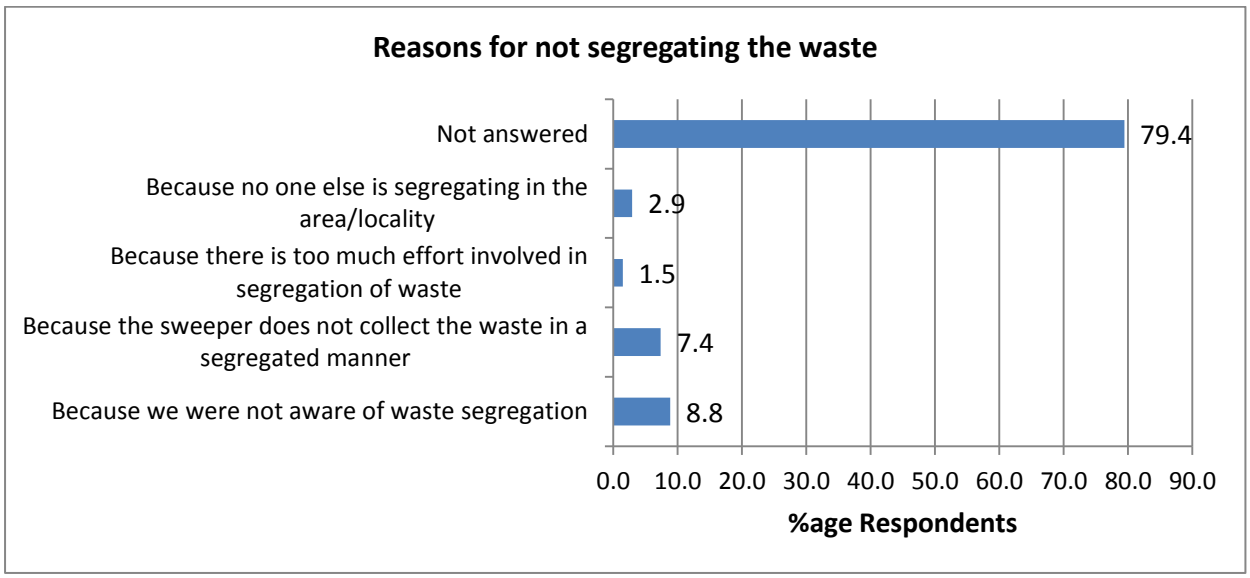


Figure 72: Satisfaction level w.r.t. doorstep waste collection

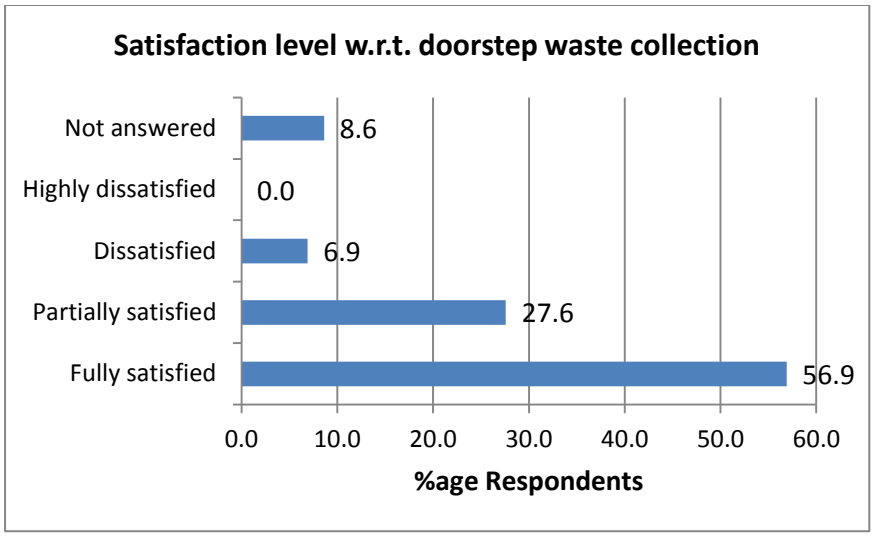


Figure 73: Satisfaction level w.r.t. collection of waste from the streets

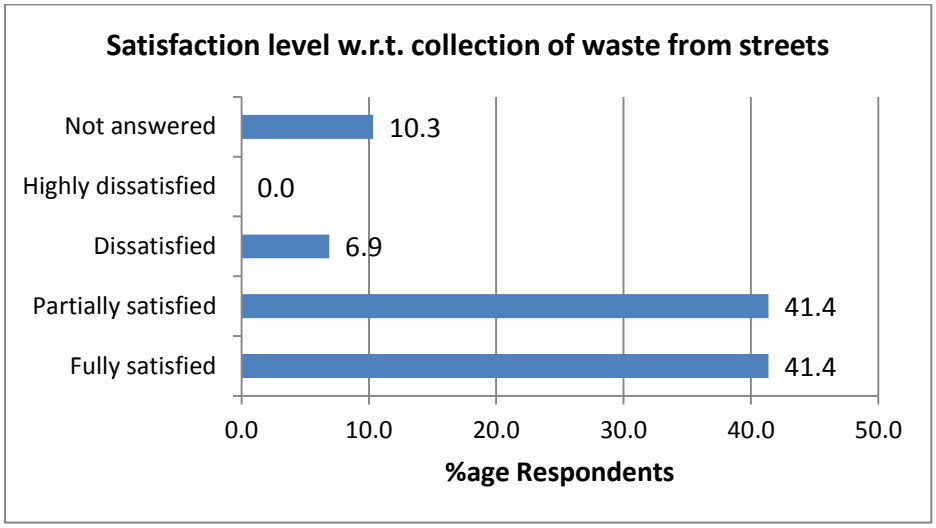


Figure 74: Satisfaction level w.r.t. street sweeping in their area

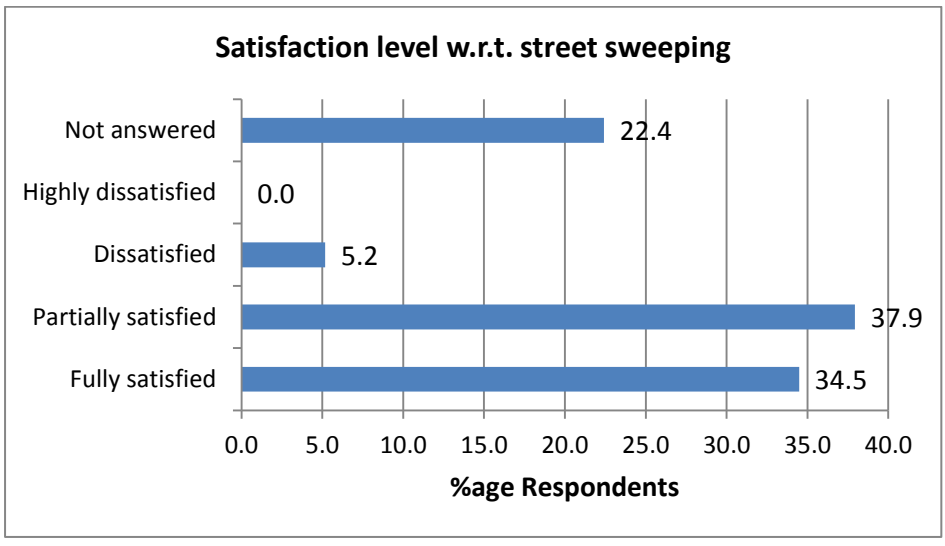


Figure 75: Percentage of establishments participating in any form of awareness program

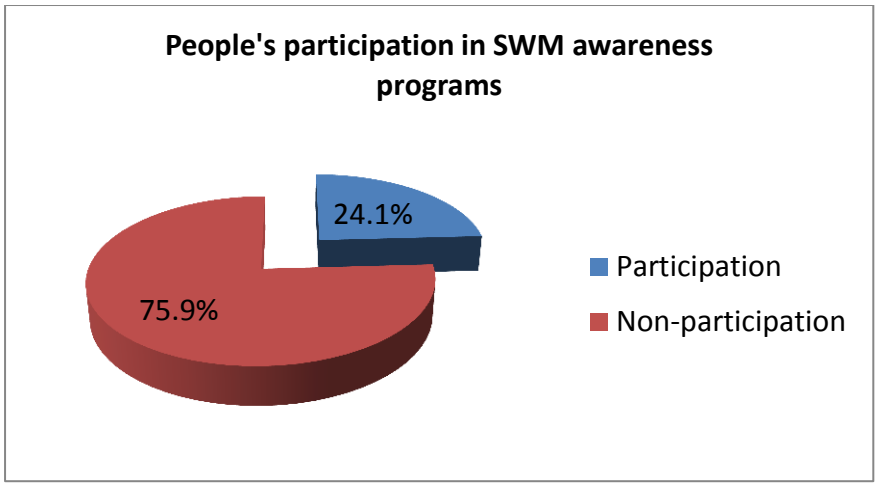
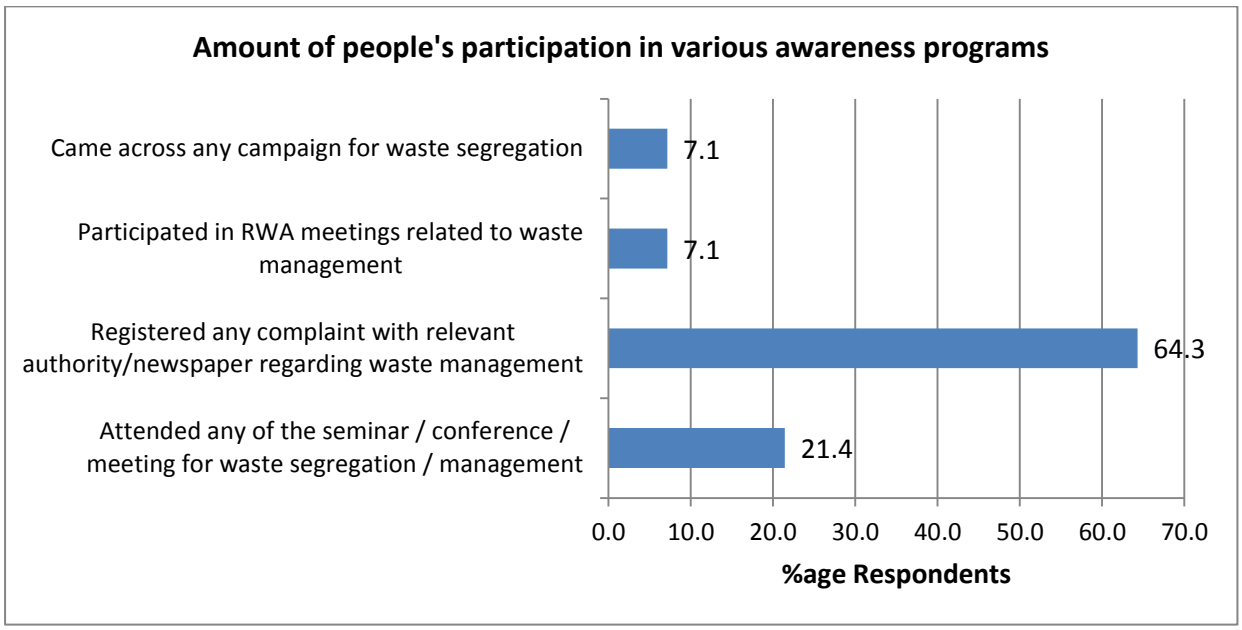


Figure 76: Different awareness programs in which establishments have participated



5.2.3 Level of awareness and interest in participation by shopkeepers in improving the solid waste management at Bangalore

Figure 77: Awareness about extent of solid waste management problem in Bangalore

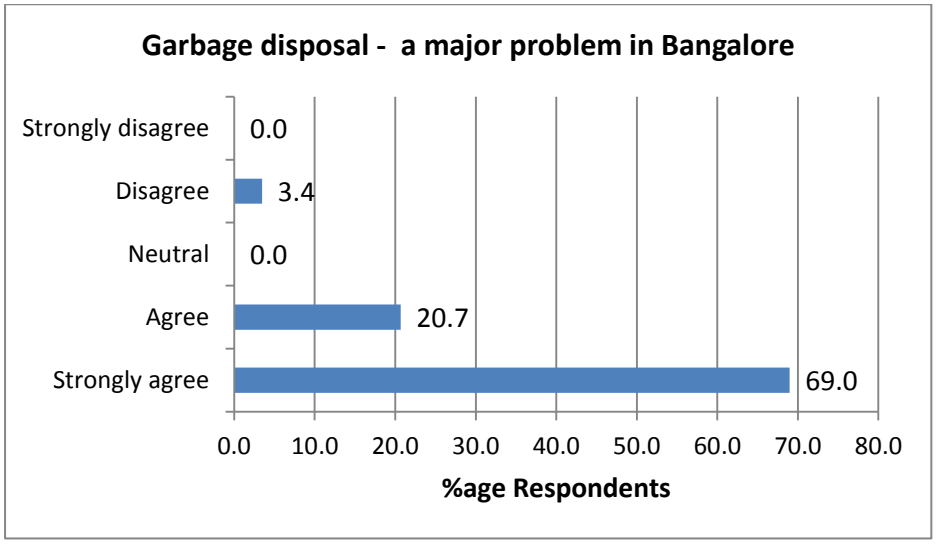


Figure 78: Awareness about change in way waste is managed

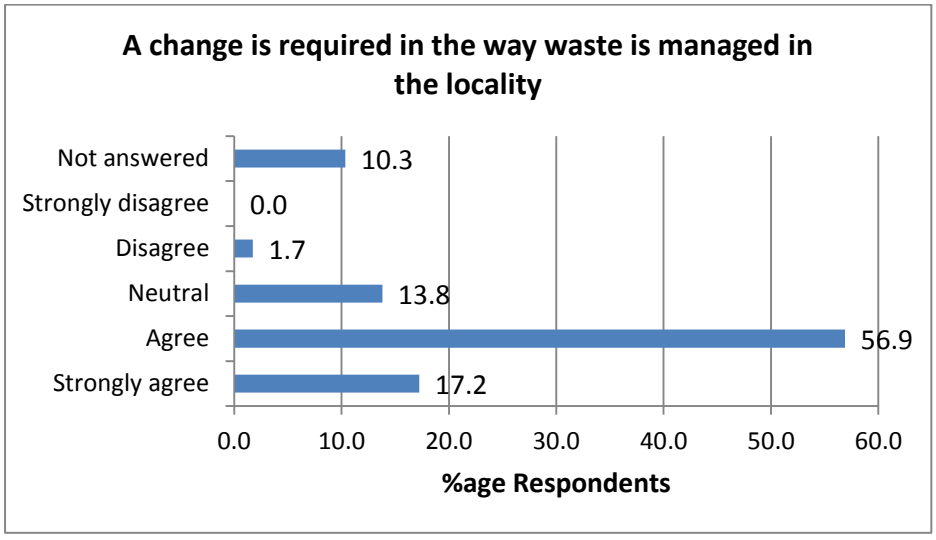


Figure 79: Awareness about importance of waste segregation at source

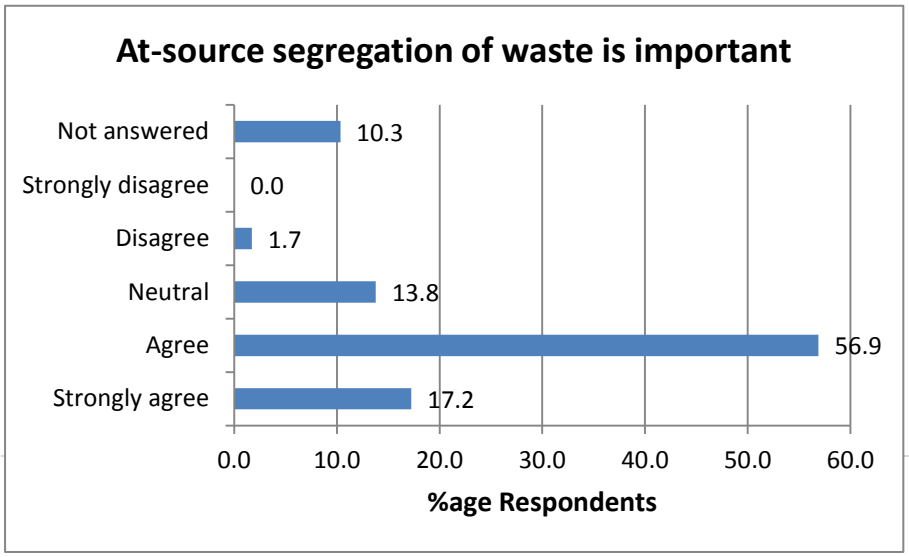


Figure 80: Willingness to pay for better waste management

Figure 81: Awareness about citizen's responsibility in keeping the city clean

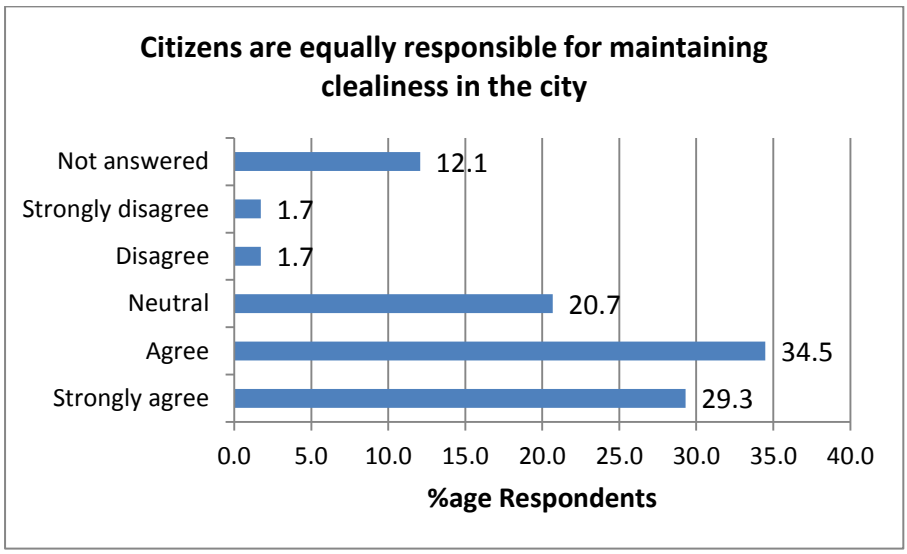


Figure 82: Opinion on ways of ensuring effective waste segregation

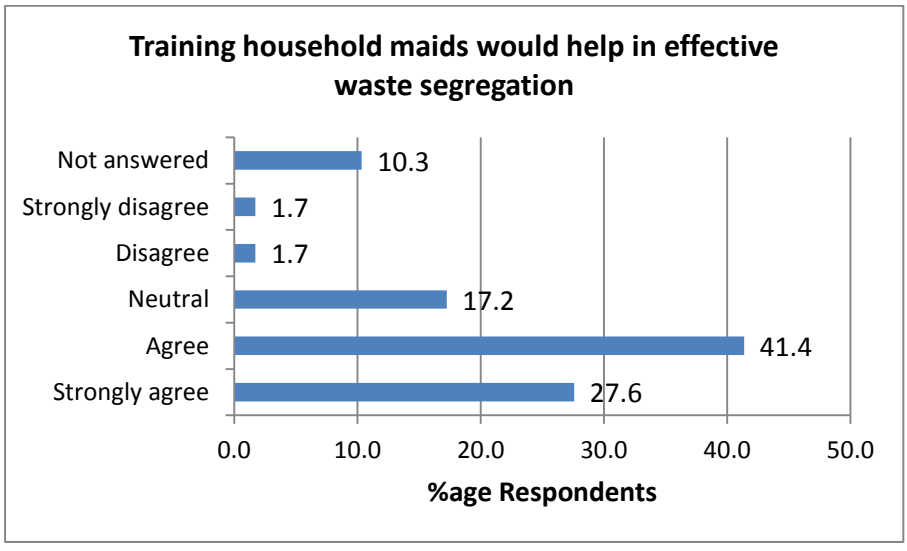
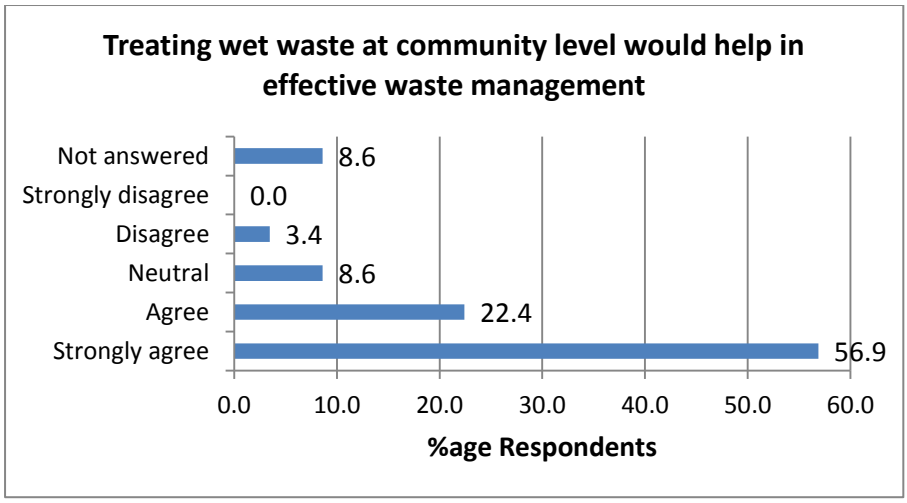


Figure 83: Opinion on ways of ensuring effective waste treatment for resource recovery



5.3 STUDY OF EFFICIENCY OF WASTE MANAGEMENT IN CASE OF BULK WASTE GENERATORS

The list of survey samples covered for the citizen's survey other than the households and shops is:

Table 50: Number of bulk waste generators surveyed

Total no. of wards	10
Apartment	27
Restaurant	26
Hospital	12
Nursing Home	3
School	14
Marriage Hall	7
Total no. of Samples	**147**

The charts below indicate the result of the survey conducted in the above mentioned categories.

5.3.1 Indicators for examining the due diligence of the primary collection of waste

Figure 84: Method of waste disposal

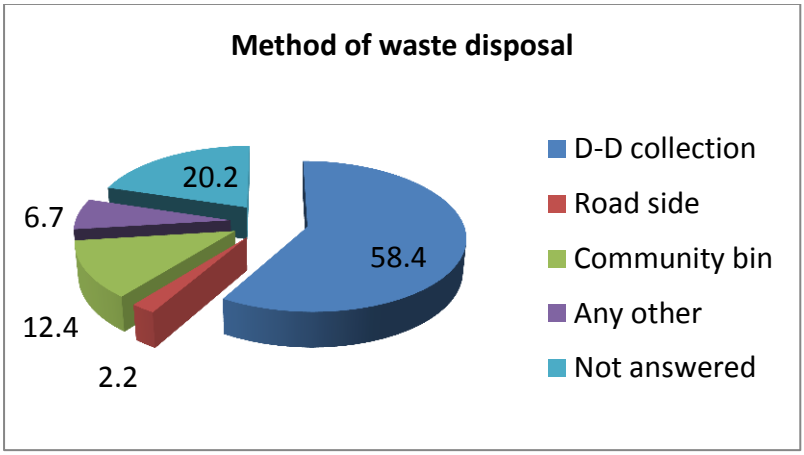


Figure 85: Frequency of doorstep waste collection

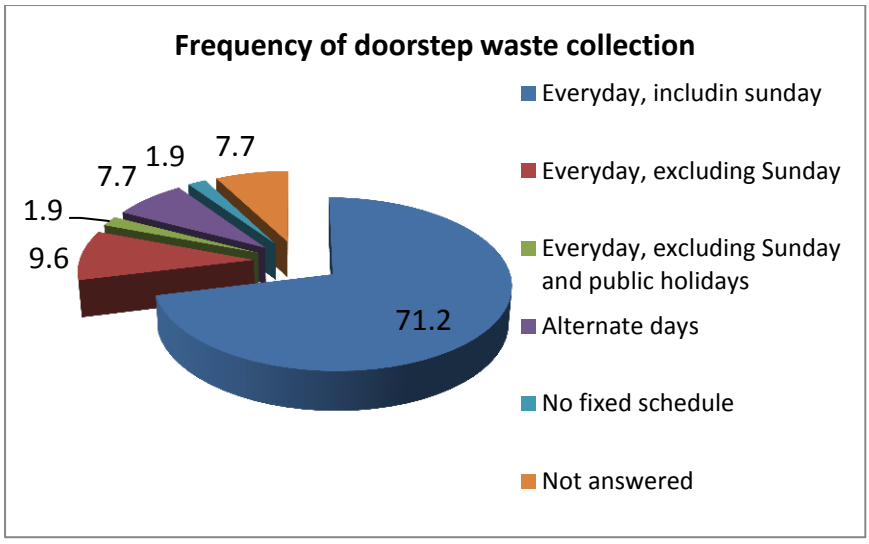


Figure 86: Time of collection of waste from doorstep

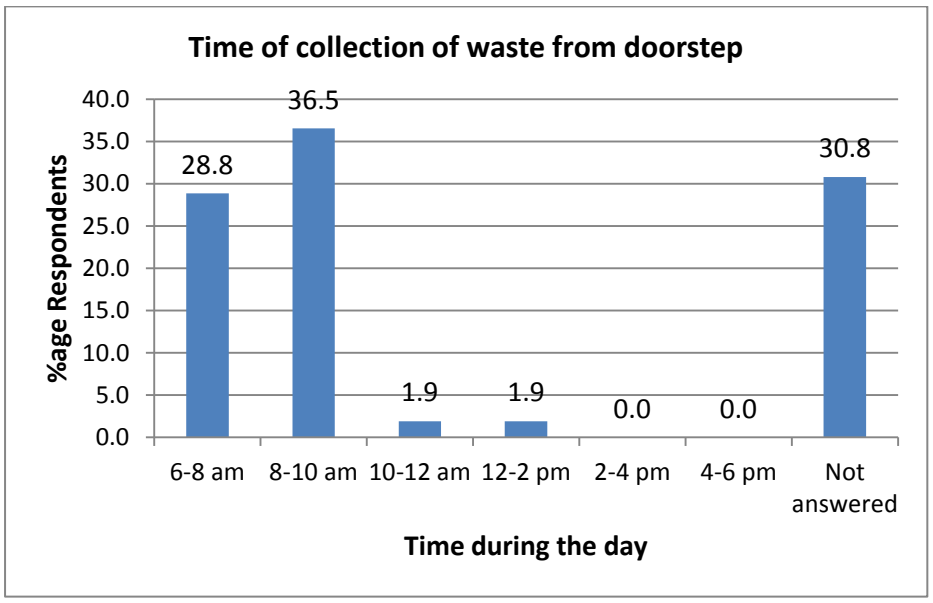


Figure 87: Efficiency of doorstep waste collection at a fixed time

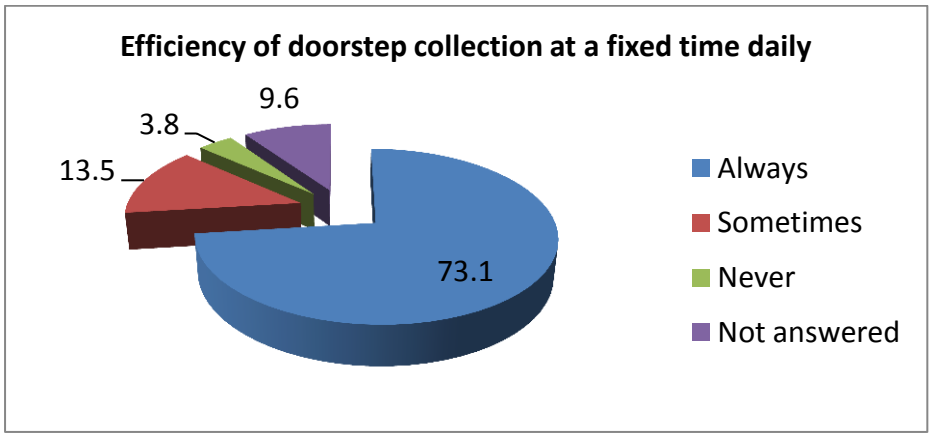


Figure 88: Frequency of street cleaning

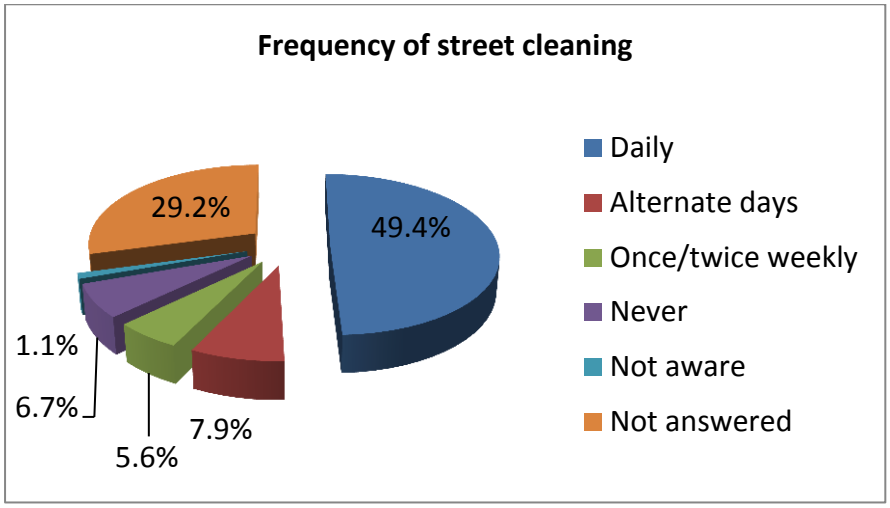
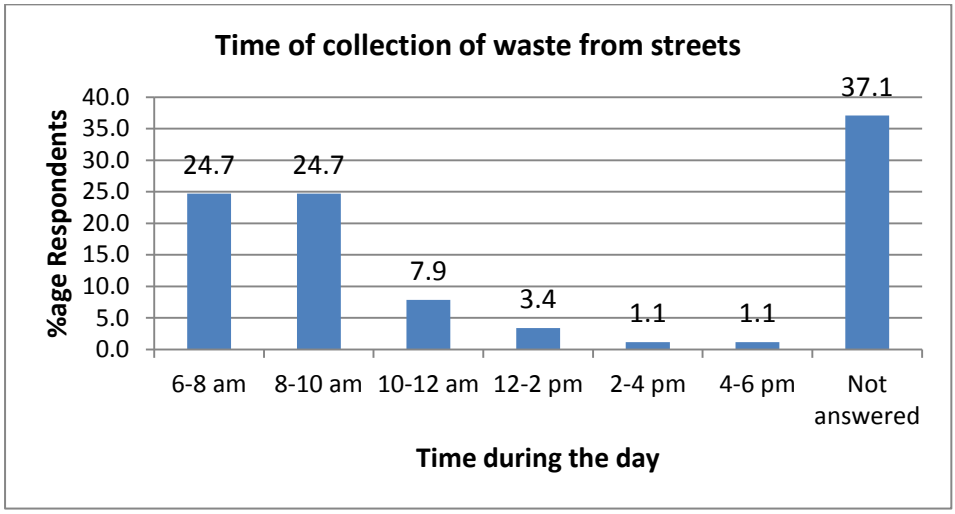


Figure 89: Time of collection of waste from the streets



5.3.2 Indicators for studying the behaviour of bulk waste generators and their concerns and issues in storage, segregation and disposal of waste

Figure 90: Method of waste disposal when there is no doorstep waste collection

Figure 91: Extent of segregation of waste

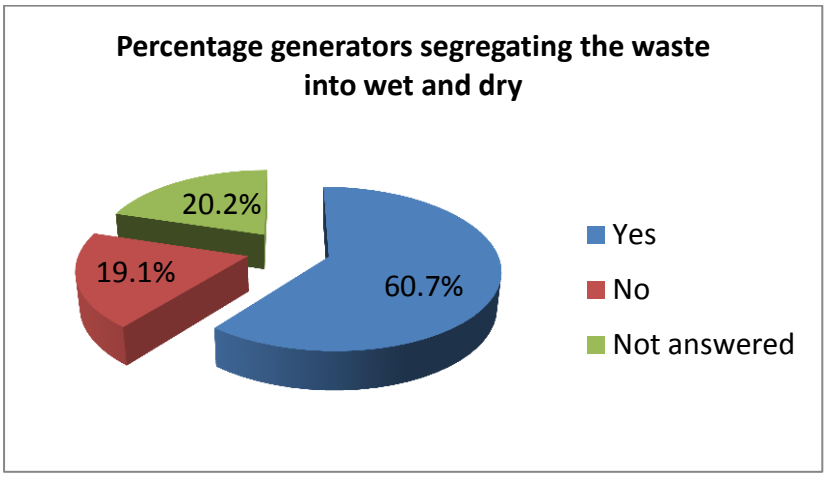


Figure 92: Percentage of segregated waste being collected in a segregated manner

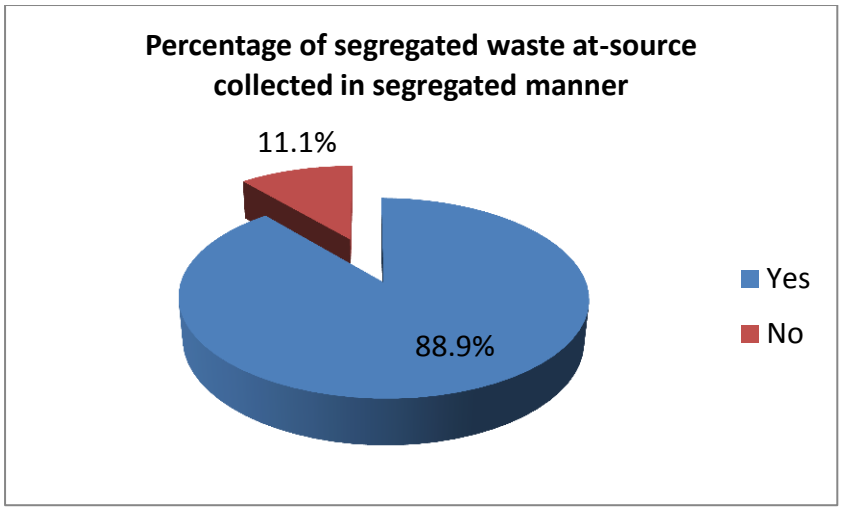


Figure 93: Various reasons for not segregating the waste at-source

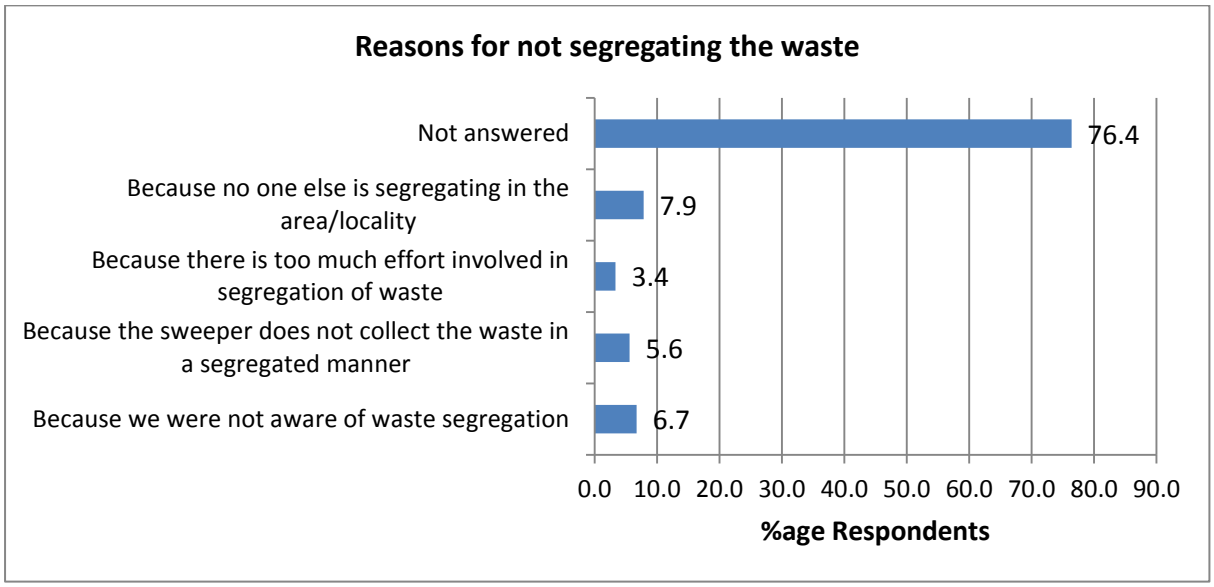


Figure 94: Satisfaction level w.r.t. doorstep collection of waste

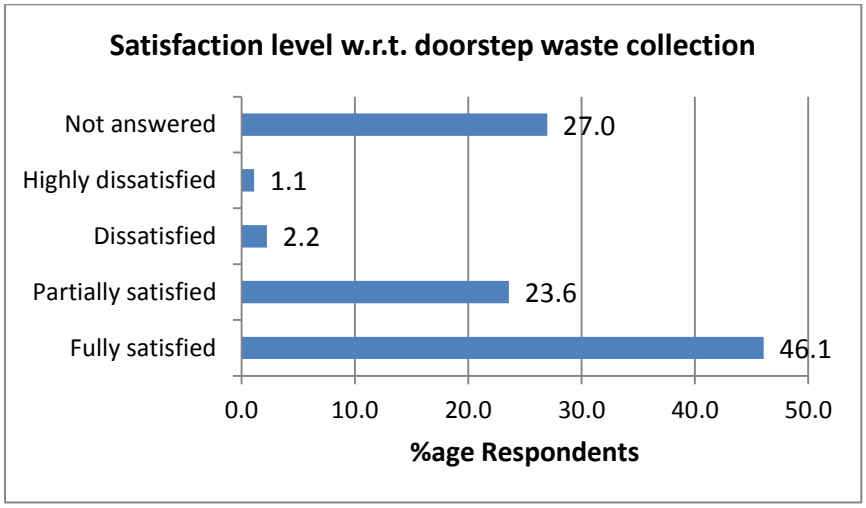


Figure 95: Satisfaction level w.r.t. collection of waste from the streets

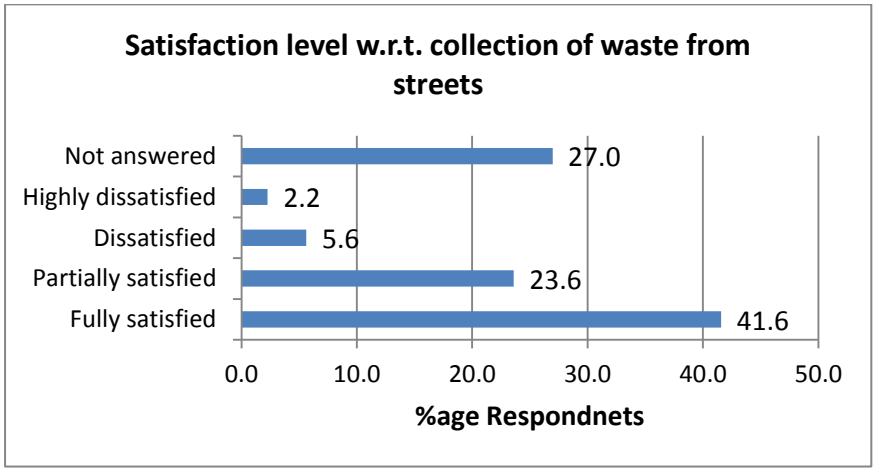
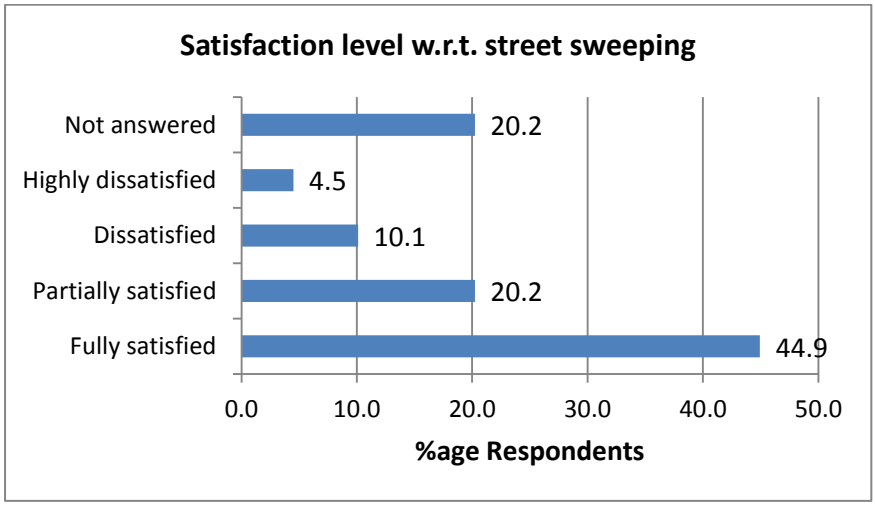


Figure 96: Satisfaction level w.r.t. street sweeping



5.3.3 Indicators for people's awareness and participation

Figure 97: Percentage bulk waste generators participating in any form of awareness program

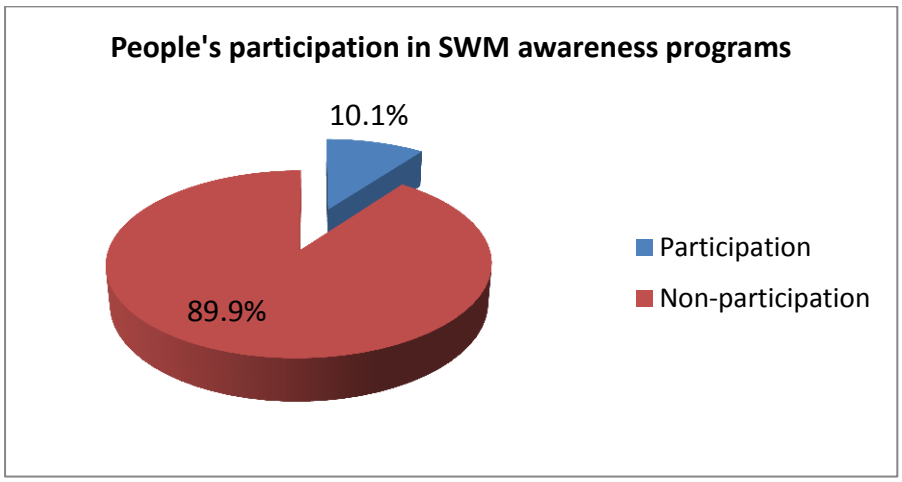


Figure 98: Various awareness programs where bulk waste generators have taken part

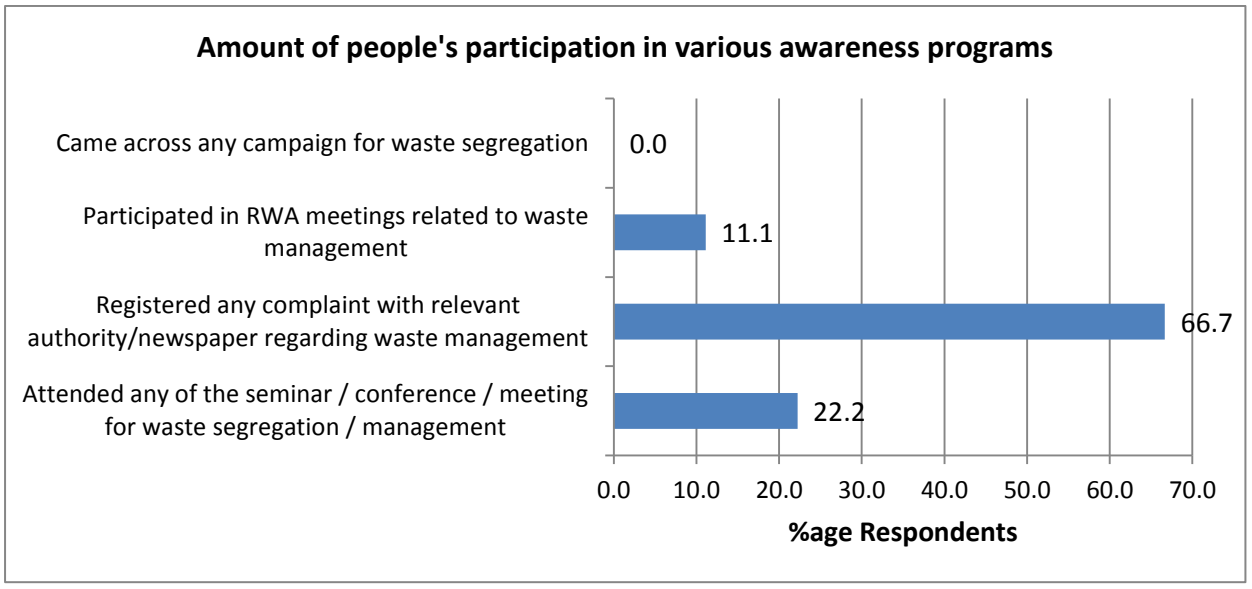


Figure 99: Awareness about extent of solid waste management problem in Bangalore

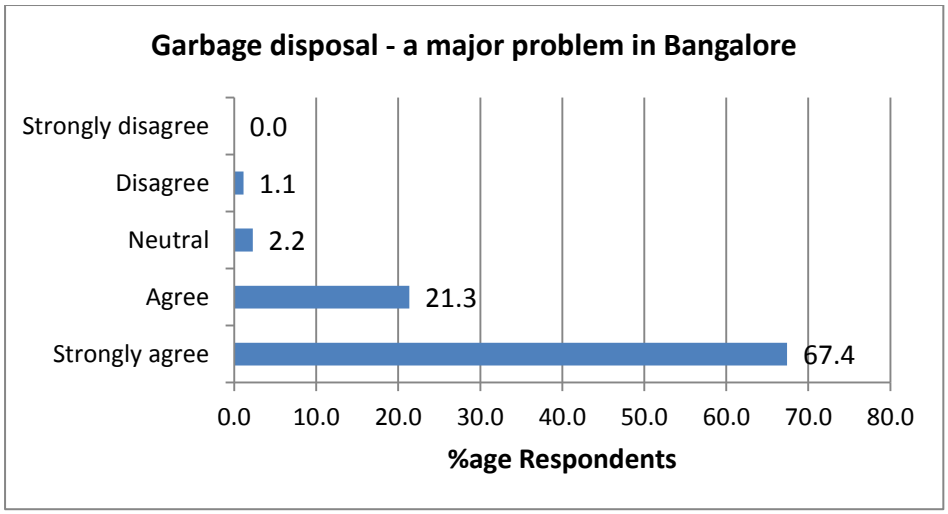


Figure 100: Awareness about the change required in the way waste is managed

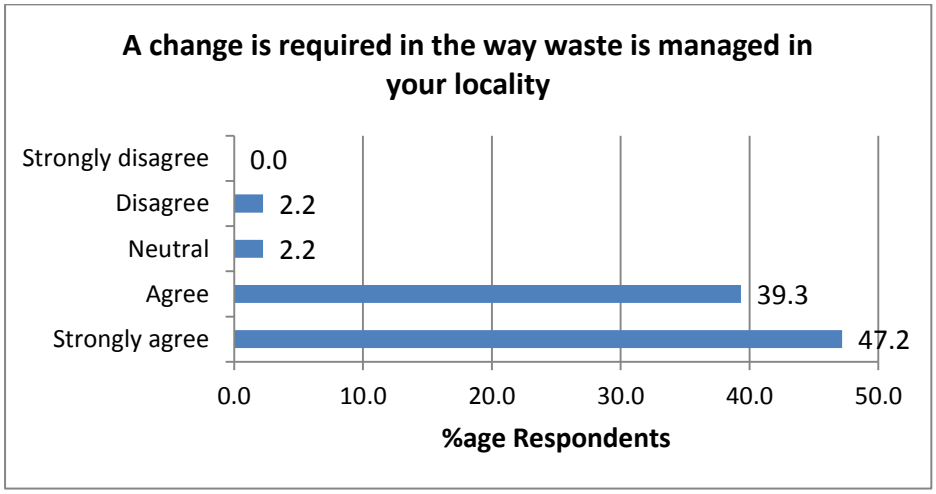


Figure 101: Awareness about the importance of waste segregation

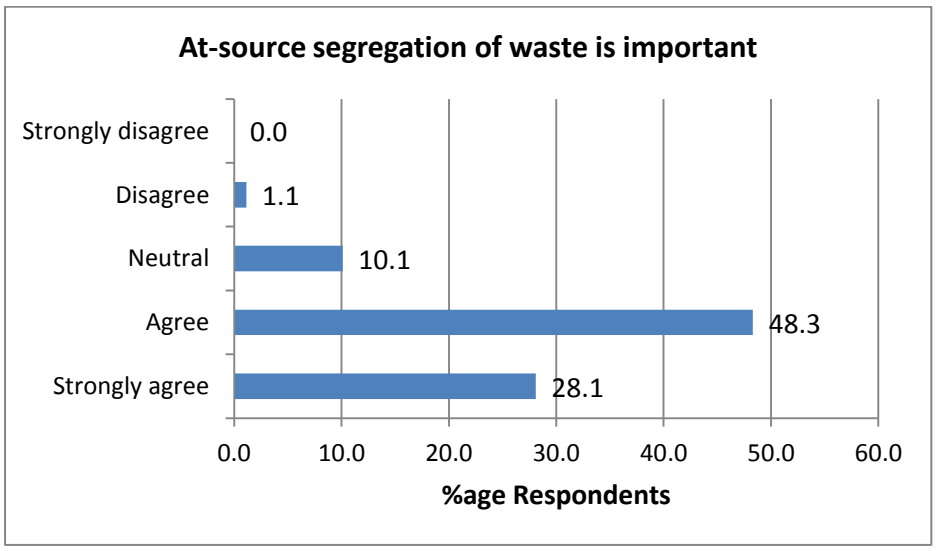


Figure 102: Willingness to pay for better waste management

Figure 103: Awareness about citizen's responsibility in keeping the city clean

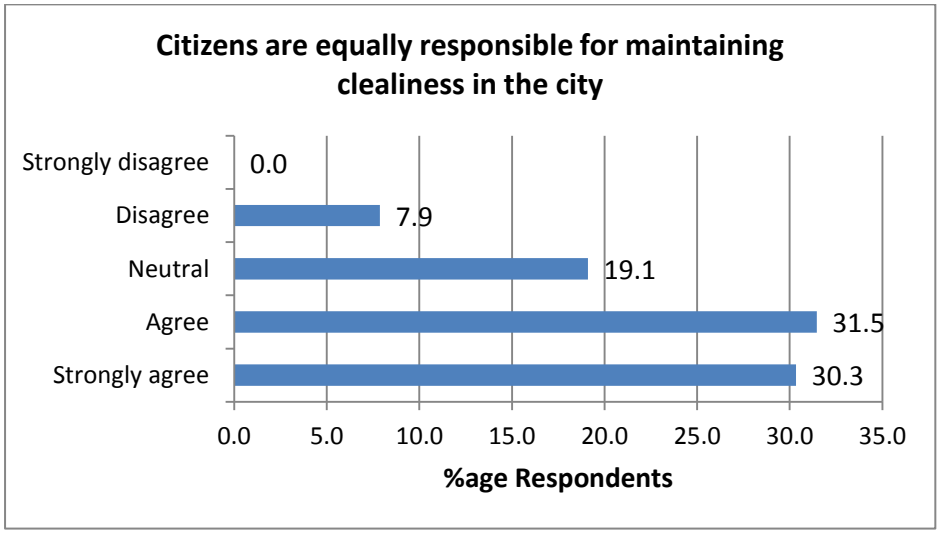


Figure 104: Opinion on ways of ensuring effective waste segregation

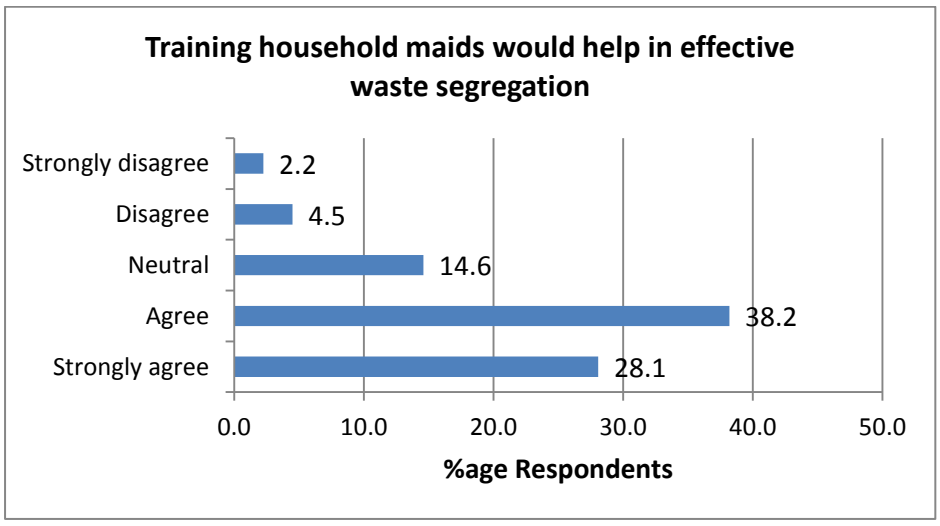
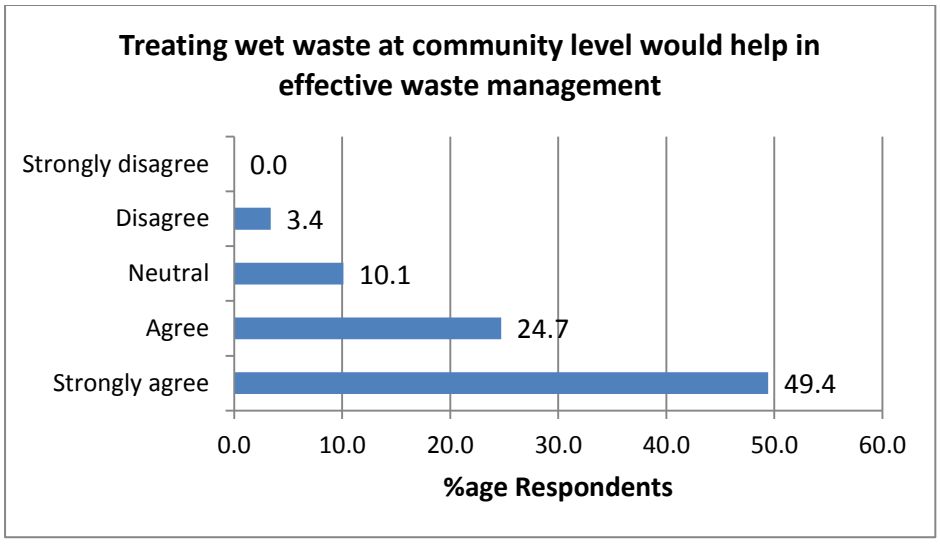


Figure 105: Opinion on ways of ensuring effective waste treatment for resource recovery



5.4 ISSUES AND PROBLEMS IN SELECTED WARDS BASED ON SURVEY RESULTS

5.4.1 Issues and Problems in managing solid waste from the households

The systems are not standardized across wards. Performances across the wards vary and mostly depend upon the officers, corporators and people than on resources. Average performance of the selected wards for doorstep collection of waste is much better than that of street cleaning. This may be the very reason for the waste management problems in Bangalore. Even though 75% of the waste is collected directly from the households, the remaining 25% of waste coming on the streets, vacant plots, etc. is not efficiently collected. Also most of the waste collection and street cleaning is over by noon and any waste that comes on the road after noon gets cleaned up only the next day.

Another serious issue is the lack of awareness and participation in segregation of the waste produced.

The results indicate that just 40% households segregate the waste out of which 70% say that the waste gets collected in a segregated manner by the worker. This indicates that only 28% of the waste enters the waste stream in a segregated manner. There is lack of awareness about waste segregation in the residents as well as the workers collecting the waste. A portion of the mixed waste is informally segregated by the workers. Most of the unusable dry waste gets mixed up in the waste stream and reaches the disposal site.

Limited people's participation is seen, by way of registering complaints to the authority. Timely response to the complaints may encourage citizens to participate in other awareness programs like RWA meetings, attending seminars/workshops, etc. Although respondents seem to be aware about the waste management issues in Bangalore and importance of at-source waste segregation, on ground implementation of the same is restricted in some localities only.

More than 60% respondents are ready to pay for solid waste management services and 28% are neutral about the payment for the services.

5.4.2 Issues and problems in managing solid waste from the shops & bulk waste generators

Overall service delivery and waste segregation in case of shops & bulk waste generators is better than that of households but has scope for improvement. Most of the doorstep waste collection and street cleaning is over by noon even in areas dominated by shops & restaurants. Hence the waste that comes to the streets after noon is mostly left there for a day before the workers clear it the next day. In commercial areas, collection of waste and street cleaning twice a day is preferred by the shop owners.

Segregation of waste is performed by more than 60% of respondents in both cases, however some of this segregated waste is mixed up by the workers and only 44%, in case of shops and 54%, in case of bulk generators, enters the waste stream in a segregated manner. Awareness about waste segregation for shopkeepers, bulk generators and workers collecting the waste is necessary.

Participation in solid waste management activities like registering complaints, attending seminars/workshops, RWA meetings is low (25%) in case of shops and minimal (10%) in case of bulk waste generators.

Most of the shopkeepers and bulk waste generators agreed to pay for the waste management services, provided it is effectively delivered.

6.FINDINGS OF THE STUDY AND RECOMMENDATIONS

6.1 FINDINGS OF THE STUDY – GAP ANALYSIS

The findings of the study after analysis of the information obtained from secondary sources, the survey result, the quantity and composition of waste generated and process mapping are as mentioned below:

6.1.1 Policy Level

- Policy of integrated Solid Waste Management 2012 for BBMP - prepared by the Department of Environmental Cell - includes ways of involvement of private sector for MSWM through appointment of independent private agency for bulk waste producers; house-to-house collection contracts to waste pickers/NGOs or SHGs; comprehensive contracts with contractors providing their own vehicles and responsible for Labour Laws; performance oriented contracts based on outputs and not inputs.
- A guideline for PPP in waste processing is also part of the SWM Policy for Bangalore.
- The policy, however, lacks the ways of incentivizing/dis-incentivizing the citizens and other stakeholders to segregate the waste. It lacks the means of effective mechanism and role of citizens in monitoring the service delivery on a daily basis.
- It does not contain the standards for evaluating and monitoring the performance of the service providers.

6.1.2 Organizational level

- No effective monitoring mechanism. Monitoring at each ward depends upon individual chief executive and the success in implementation of solid waste management rules also depend upon his/her extraordinary championship.
- Change in organizational structure to an approachable decentralized structure.
- Also post of environmental engineers have been created for better skill set to carry the municipal services of solid waste management.
- Adequate training of engineers and role clarity of individual officers and staff is needed to improve monitoring.
- Inadequacy in career growth avenues for qualified / specialized staff is demotivating.

6.1.3 System Efficiencies and Deficiencies

Efficiencies

- System of giving small and multiple contracts is easy and quick to implement. The private entrepreneurs are willing to invest in collection and transportation equipment, as well as providing labour, tools, equipment, etc.
- BBMP is able to cover the city even with in-house limited resources

Deficiencies

- The normative standards stated in the SWM Policy for Bangalore for segregated storage of waste on premises, door-to-door collection, street sweeping, secondary storage these have been rarely cross-checked with the on-ground performance of the contractors / workers.
- There is lack of proper data at ward level to measure the performance of the service provider using standard norms.
- The mode of payment is based on quantity of waste brought to the landfill. This acts as a disincentive towards waste segregation and waste reduction.
- No effective monitoring mechanism. Monitoring at each ward depends upon individual chief executive and the success in implementation of solid waste management rules also depend upon his extraordinary championship.
- Fragmenting the accountability - the tendency is to pass the blame between the contractors / multiple staff.
- Segregation is impossible with passing of blames between the generators and contractors/BBMP.
- A lot of monitoring is required. Lack of the same leads to payment without getting the desired results
- Role of NGOs /SHGs / RWAs is limited due to the current system of contracts
- The contract should include the service provider's responsibility of checking if the waste is dumped by service provider of any other area.

6.1.4 Process Efficiencies and Deficiencies

- Segregation of waste and awareness creation

  Though lots of initiatives have been taken in terms of creating awareness about waste segregation, none of them are carried on a regular basis. As a result the initiative of introducing segregation of waste dies before it picks up.
- Primary collection and storage – absence of standards

- Even though the contract suggests no Garbage on Ground (nGoG) method, the transfer of waste at each stage is done manually.
- The waste collected from door-to-door using pushcarts is unloaded and stored in temporary depots which are vacant plots or road sides which necessitates multiple handling of waste. Waste an often spill over which is unsightly and unhygienic.
- The workers collecting waste from door-to-door are either not given the required tools and equipment or they have not been educated enough to use them. As a result, they handle the waste without the use of safety gear like boots, uniform, gloves, etc.

- Dry waste collection centres
  - One of the unique initiatives, if properly administered can help in separating almost 30% of waste produced per day.
  - Due to lack of proper waste segregation it is not very effective.
- Secondary collection and transportation
  - Most of the autos are old, unkempt and open without hydraulic system.
  - Practice of manual loading of waste prevalent.
  - Inefficient workshop facilities.
  - Very few compactors and mostly the waste is transported in open lorries or trucks with bags of segregated waste hanging on the sides.
  - Lack of synchronization of primary and secondary collection of waste result in multiple waste handling.
  - In most of the places the secondary collection is over by afternoon. Any waste reaching these points (in areas where there is no door-to-door collection) after this time remains there for atleast a day before it is cleared the next day
  - Due to the protest of the villagers in the areas surrounding the dump sites, the waste collected in compactors/tipper lorries is taken only at night after 11.00 p.m. This results in decay of the wet waste thereby causing more problems at the sites.

6.1.5 **Monitoring and Supervision Deficiencies**

- The biometric system suggested in contract document to monitor the punctuality and regularity of the workers/staff is not yet implemented
- At the ward level, only the junior health inspector is fully responsible for regular monitoring work. The rest of the officers are mostly engaged in activities other than solid waste management.

- Implementation of penalty system is completely missing and even though the SWM policy for Bangalore 2012 clearly states the penalty charges, the primary survey does not reveal even a single case where they have been fined for illegal dumping of waste.
- The start-up programs / initiative taken up by the Corporation fail due to lack of strict monitoring and serious implementation of penalty system.

6.1.6 Observations from the survey results – from households

- The systems are not standardized across wards.
- Performances across the wards vary and mostly depend upon the officers, corporators and people than on resources.
- Average performance of street cleaning is poor.
- Though 75% of the waste is collected directly from the households, the remaining 25% of waste coming on the streets, vacant plots, etc. is not efficiently collected.
- Also most of the waste collection and street cleaning is over by noon and any waste that comes on the road after noon gets cleaned up only the next day. This may be the very reason for the waste management problems in Bangalore.
- There is considerable lack of awareness and participation in segregation of the waste produced.
- Just 40% households segregate the waste out of which 70% say that the waste gets collected in a segregated manner by the worker. This indicates that only 28% of the waste enters the waste stream in a segregated manner.
- Limited people's participation is seen by way of registering complaints to the authority.
- Although respondents seem to be aware about the waste management issues in Bangalore and importance of at-source waste segregation, on ground implementation of the same is restricted to some localities only.
- More than 60% respondents are ready to pay for solid waste management services and 28% are neutral about the payment for the services.
- The wards that are cleaner than the others are the ones where Citizen's groups are active in the field of SWM.

6.1.7 Observations from the survey results – from shops & bulk waste generators

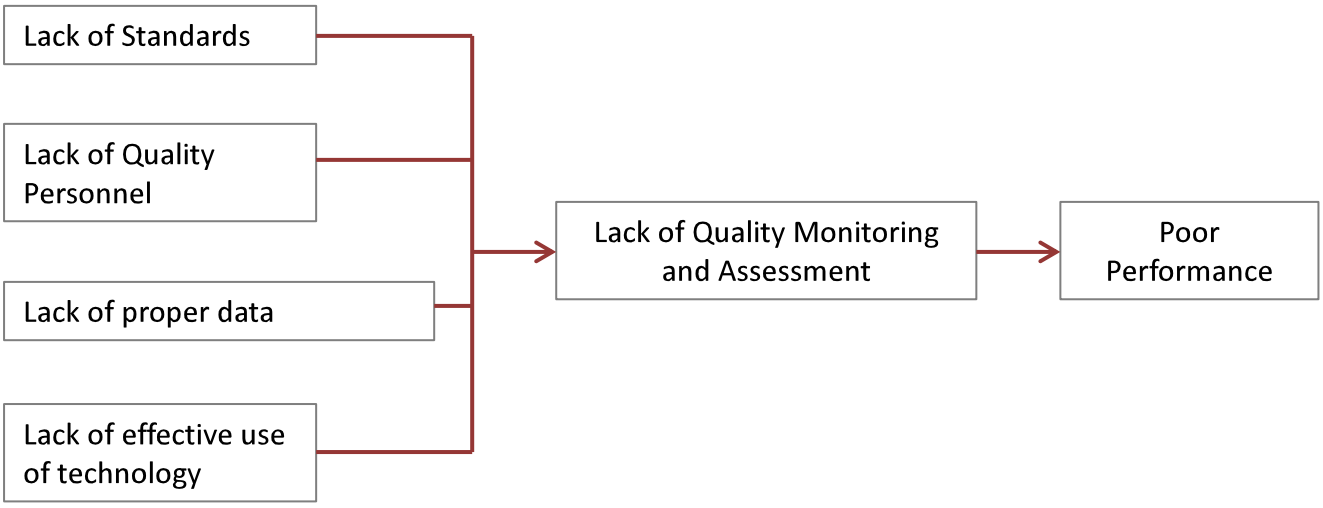
- Overall service delivery and waste segregation in case of shops & bulk waste generators is better than that of households but has scope for improvement.
- Even in areas dominated by shops & restaurants, most of the doorstep waste collection and street cleaning is over by noon
- In commercial areas, collection of waste and street cleaning twice a day is preferred

- Segregation of waste is performed by more than 60% of respondents in both cases, however some of this segregated waste is mixed up by the workers and only 44%, in case of shops and 54%, in case of bulk generators, enters the waste stream in a segregated manner
- Participation in solid waste management activities like registering complaints, attending seminars/workshops, RWA meetings is low (25%) in case of shops and minimal (10%) in case of bulk waste generators

Figure 106: Pictures showing current methods by which solid waste is handled in Bangalore

Service Quality Gap

Lack of standards, lack of quality personnel, lack of proper data and lack of effective use of technology leads to lack of quality monitoring and assessment. The poor performance, in current scenario, is the result of lack of quality monitoring and assessment.



6.2 RECOMMENDATIONS

The extent of segregation can be linked to the social value of segregation. The greater the extent of segregation, higher will be its positive impact on the society and lesser the extent of segregation, greater will be its negative impact on the society.

The social value curve can move from negative to positive if the extent of segregation increases (as shown in the graph below). Hence large proportion of segregation is important to improve the quality of society.

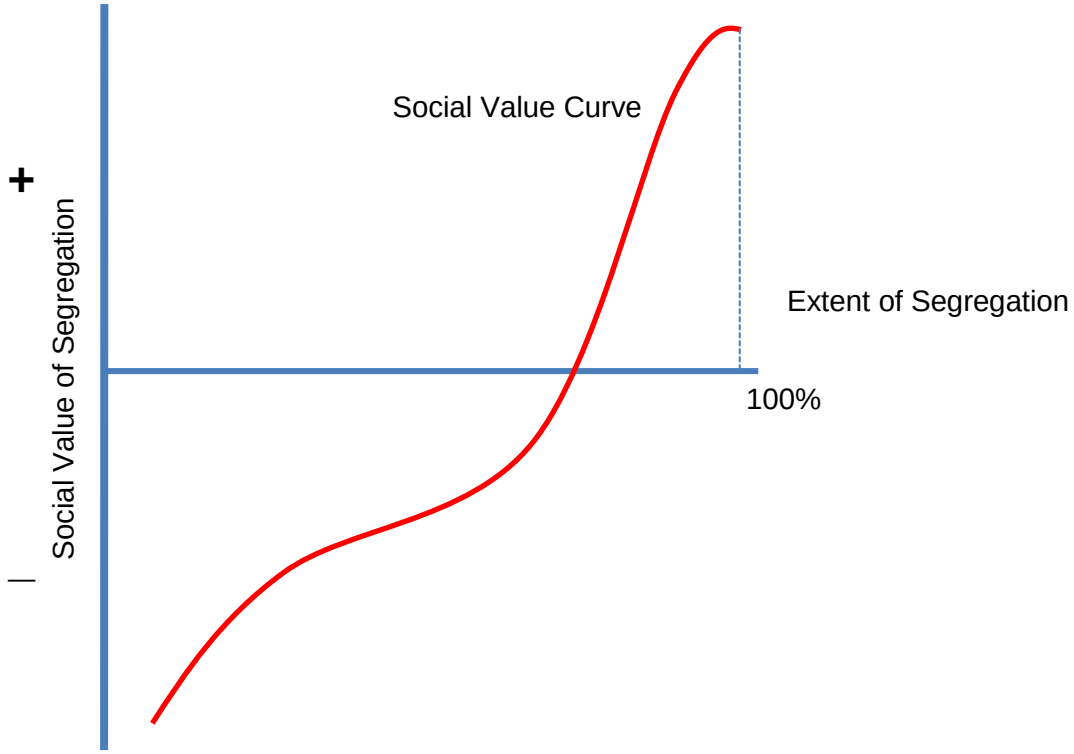


Figure 107: Social Value Curve

Economically it would be difficult to bring in the high-technology solutions of managing waste in Bangalore. The city is already moving towards the system of segregation for handling the large quantity of waste produced and the infrastructure for the same in already place or in the process. Hence, it would be wise to incorporate segregation of the waste as the solution to the waste management problems. By reducing the quantity of waste produced, one can economically handle the management of solid waste in Bangalore. To achieve this all the stakeholders i.e., the residents, the Corporation, the contractors, the pourakarmikas (workers), rag pickers and the NGOs/RWA's /CBOs/SHGs have to play an important role. The various ways by which it can be done are:

6.2.1 Policy level

- **Policy of Integrated Solid Waste Management 2012 for BBMP to be modified and followed**

Contract changes required to ensure that segregated wet waste is composted fully.

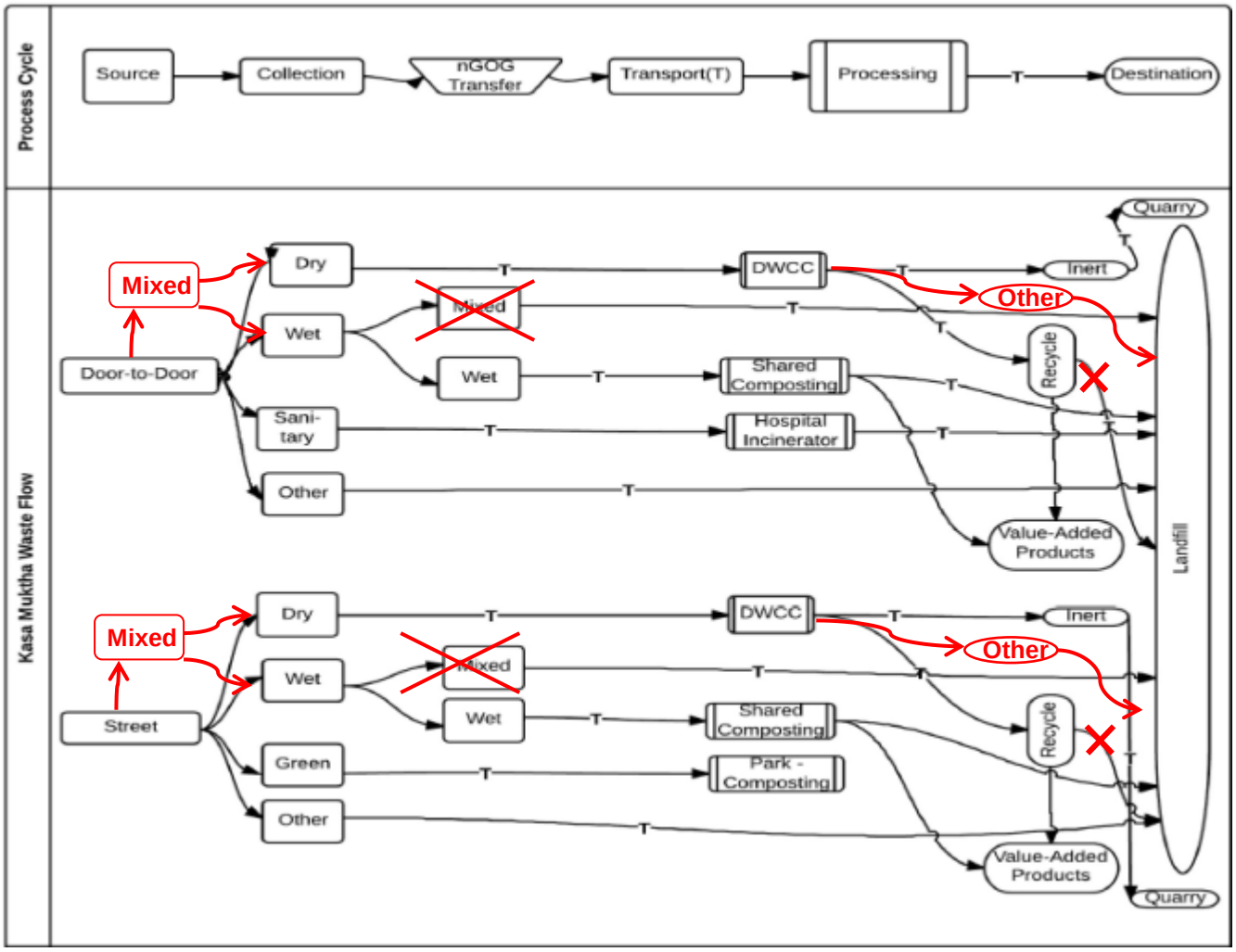


Figure 108: Recommended change in waste process flow

- **Laws for implementing Extended Producers Responsibilities**

- Strict laws should be framed to implement the Extended Producers Responsibility (EPR), which should take care of large amount of unmanageable waste from this stream.
- Producers should take back the packaging items at a certain rate of redemption (For e.g., thin plastic packets of chips, kurkure with metal lining; expired medicines; empty glass /pet bottles, empty cans, etc.)
- The companies should be made responsible for reducing the large quantity of packaging waste generated through the products they sell.

- **Segregation at-source to be mandatory responsibility of the generator**

- Strict implementation of segregation at-source
- Waste should not be accepted free of cost by those who give mixed waste to the pourakamikas.
- Mixed waste can be collected by the pourakamika by charging a fee for segregating the mixed waste. The pourakarmikas should have the right to reject the mixed waste if it is difficult to segregate the waste.
- Whenever someone misses giving waste to the PKs collecting waste from door-to-door, it shall be the responsibility of the generator to drop the waste (on-charge) at the Clean Bangalore Centre (CBC)

- **DWCC converted to Clean Bangalore Centres (CBCs)**

Dry Waste Collection Centres to be converted to SWM solution centre for activities related to solid waste management at a community level. They can be called as Clean Bangalore Centres (CBC) that shall run in collaboration with BBMP to provide the land & building and supervision; NGOs/SHGs for day-to-day functioning and; Industry (private players) to bring-in the managerial skills of running the centres and to make them economically sustainable. The following activities can be part of the CBCs:

1. Dry Waste collection centre & further segregation (dry waste can be brought to the centre by PKs collecting from door-to-door or by residents themselves)
2. Collection bins for mixed waste to be collected on-charge by those who missed door-to-door collection PK
3. Collection bins for other inorganic waste (sanitary / hazardous / inert waste) to be collected on-charge by those who missed door-to-door collection PK
4. Help/guidance for those who are composting the wet waste at household / community level
5. A store for selling standardized materials related to SWM (bins, hand gloves, waste paper bags for collecting wet waste, covers for collecting dry waste, material for composting wet waste, compost produced from wet waste, etc.)
6. Information on proper segregation of waste
7. Awareness campaigns to be conducted on a regular basis in the CBCs

The Clean Bangalore Centres should be a role model for maintaining cleanliness in the locality.

6.2.2 Organizational / Institutional

- BBMP to have a separate MSWM department with staff dedicated solely for SWM related work.
- Appointment of Environmental Engineers / Public Health Engineers / Sanitation experts with effective training related to Municipal Solid Waste Management

- Define clear roles and responsibilities of all working in SWM Department

6.2.3 Due diligence of System

- ***Three bins system of waste segregation (wet, dry and other inorganic waste)***
- ***Tackling wet waste at household / community level / city level***
- ***Dry Waste Collection Centres to be run by SHGs/NGOs/private bodies on self-sustainable basis***
- ***Collection and transportation of other inorganic waste***
- ***Standardization of segregation, collection and transportation system***
- ***Synchronizing primary and secondary collection***
- ***Limit Contractual services, enhanced role of BBMP, citizens and NGOs/SHGs***

Three bin system of waste segregation

- Introduction of segregation of waste into 3 broad categories need to be brought about.
- The 3 categories are:

- wet waste (organic waste) approx. 60%,
- dry waste (recyclable waste) approx. 30%and
- other inorganic waste (sanitary / hazardous / inert waste) approx. 10%

- This is necessary to remove the menace of segregating the third category mainly the sanitary/biomedical/hazardous waste from the wet and dry waste streams and thereby make it easier to process the usable substances from the waste

Tackling wet waste (60%) at household / community / city level

- Encourage composting of waste at household / community level
- Service can be provided by BBMP pourakamikas / NGOs for those who are willing to treat the wet waste at household / small scale level using various technologies to convert it into compost
- The pourakarmikas collecting the waste from the doorstep can be equipped for hand-holding such an activity and also supply the material for the same. This service is to be charged to the household and done without affecting primary collection.
- NGOs or other private agencies can also be allowed to provide such a service. They can also have a buy-back system of the compost generated.
- Areas where household / community level composting is not prevalent, the current system of door-to-door collection and transportation to KCDC / private composting units to be adopted. Waste to reach at these units before it decays.

Tackling dry waste (30%) at self-sustainable Dry Waste Collection Centres/ Clean Bangalore Centres (CBCs)

- DWCCs / CBCs that are established or under construction in each ward to be run by SHGs / NGOs/ private bodies.
- Other than the land & building, the vehicle/s, workers and other O & M cost to be borne by the service provider
- The service provider to collect/buy the dry waste once a week from various generators within the ward using their own vehicle/s. The dry waste can also be collected by the door to door Pourakarmikas and sold at DWCCs. Or citizen's can also come and sell it at the centre at their convenient time.
- The service provider earns by selling the segregated dry waste at the wholesale market
- BBMP to ensure that these service providers collect all the waste (including low value dry waste) from the generators
- Domlur DWCC model can be looked into for self- sustainability

Collection and Transportation of other inorganic waste (10%)

- Current system of collecting waste using push carts or autos, with an additional system of collecting the waste in a segregated manner to be deployed by BBMP
- Inorganic waste (sanitary / hazardous / inert) from all the generators and organic waste from those who are not processing the wet waste to be collected in separate containers.
- Hazardous waste to be addressed through EPR
- Wet waste to be taken to composting units (within 24 hours) only
- Inorganic waste (approximately 10%) to be sent to landfill sites and therefore only about 200 tpd of solid waste can dumped in landfill sites. Any amount in excess contractors will have to pay penalty. A target time needs to be set to achieve this.

6.2.4 Monitoring and Supervision

- ***Citizen's monitoring system***
- ***Strict monitoring and penalty system by BBMP***
- **Citizen's connect / disconnect**

Introduce Citizen's Monitoring System

- Modern concepts of social volunteers can be introduced to harness citizen's voice as a resource to solve real life problems such civic issues
- Preparing citizen's report cards would involve them to bring about a positive change in each ward. (Best practice case of ward no. 103, Punjabi Bagh, New Delhi).

- Modern day technologies like smart phones, social networking sites, etc. should be used for quick reporting and generation of MIS report.
- Involvement of citizen's through regular report card system & its effectiveness will keep the interest of the citizen's alive and also keep the authorities on its toes for performing.

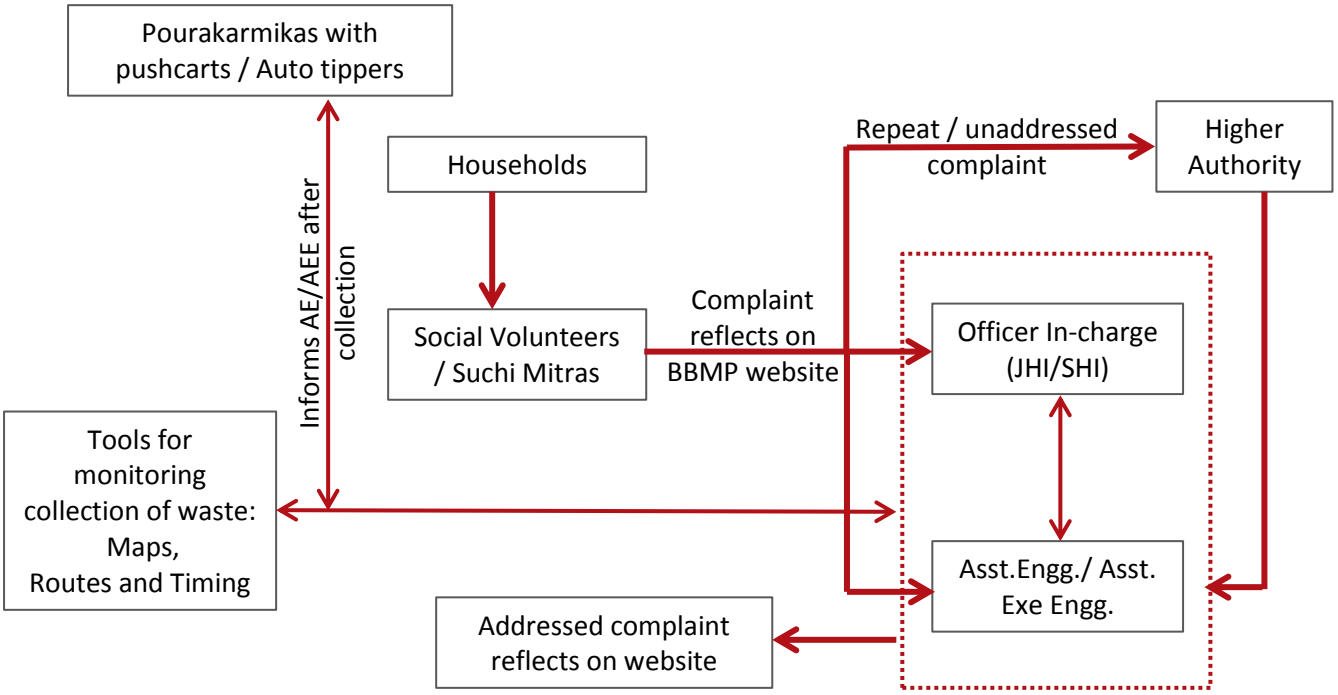


Figure 109: Suggested monitoring and redressal mechanism

Strict Monitoring and Penalty System by BBMP

- Monitoring Information System (MIS) for Solid Waste Management in each ward should include ward maps, route maps, and timing of services.
- Use of technology (smartphones, internet, etc.), media (television, newspaper), signage, websites to be done for awareness creation, achieving standardization and monitoring.
- Services provided by the contractors / SHGs / NGOs to be monitored by the Citizen volunteers and SWM department officials.
- Penalty system as suggested in the Policy for Integrated Solid Waste Management 2012 for BBMP to be followed and implemented
- Pourkarmikas should be allowed to reject mixed waste at the household level or accept it with a penalty. The composting units should stop accepting the waste if the contractor continues to send mixed waste.
- Professional Management of the whole system is needed
- For preparing the ward level data base, a paper on 'Integrated Sustainable Waste Management (ISWM) Action Plan for BBMP wards' prepared by Civic Bangalore can be referred.

Citizen's connect / disconnect

- The key to this proposal is regular awareness and strict implementation drive till the habit of segregation is inculcated in the current and new generation.
- 'Kasa Mukta Week' may be celebrated to make people aware of their roles and deliver their responsibility. Involve Schools in the programmes.
- Doubt clarification for waste segregation using BBMP's hotline (recorded message) or suitable apps.
- Regular training programs to pourkarmikas and demonstration to households.
- Regular awareness programs for educating the citizens about the importance of segregation should be carried out
- Help from schools to mobilize the students by explaining about household waste segregation and inculcating such habits in the young ones for easy implementation at household level

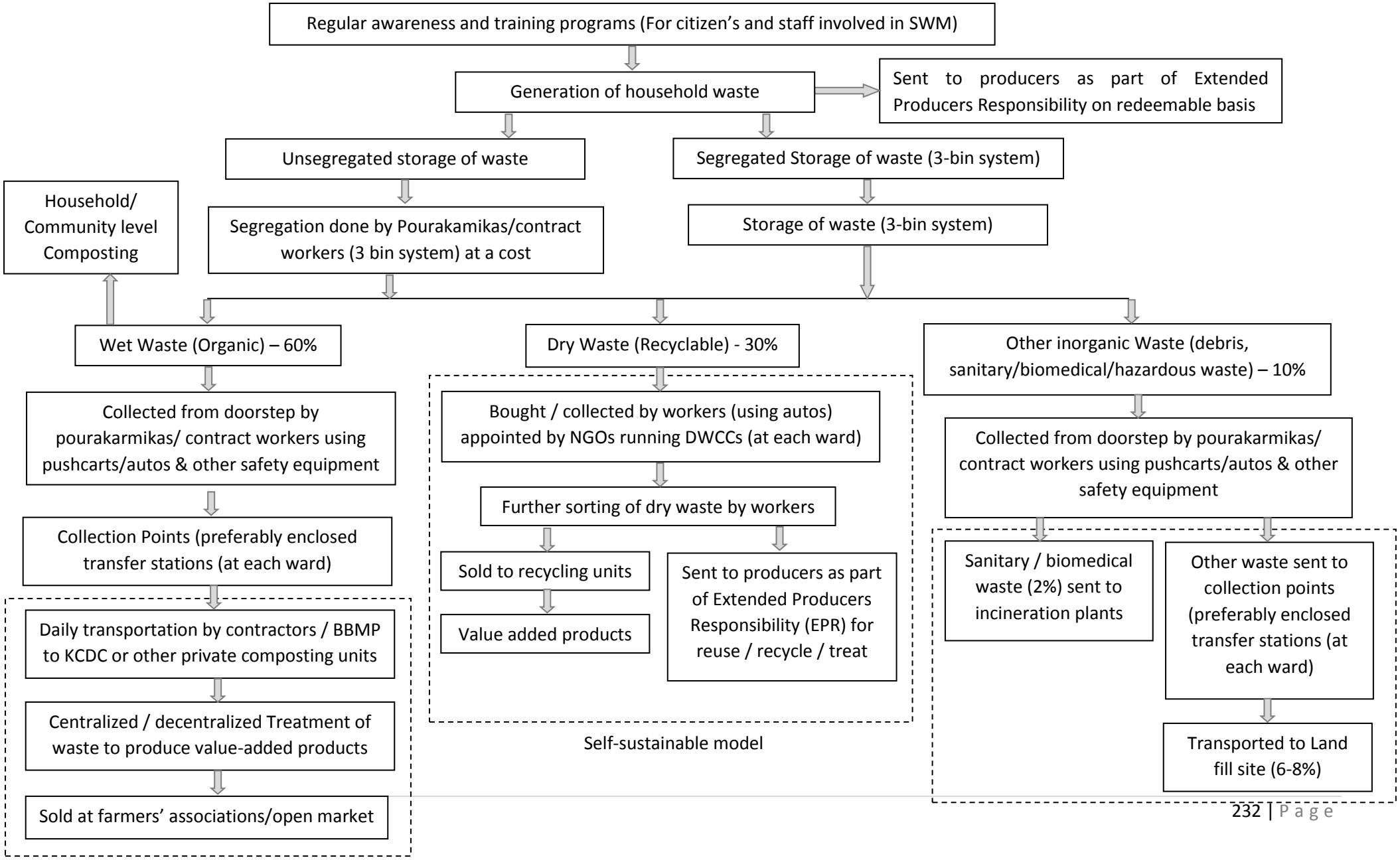
Implementation and benefits

Most of the infrastructure is already in place for this model. Implementation and enforcement of the rules needs to be achieved for its success.

This model would help in tackling the growing amount of waste generated due to changing lifestyles and would help in resource recovery at minimal cost just by segregating the waste at-source. The key to the success of this model will be daily collection of wet waste and transportation of the same to the resource recovery plants or decentralized treatment units. This would help in engagement of existing pourakarmikas and contract workers but reduce the burden of high contractual cost to the BBMP. It would also curtail the extent of mal-practices in engagement of contractors. Involvement of citizen's through regular report card system and its effectiveness will keep the interest of the citizen's alive and also keep the authorities on its toes for performing.

A flow chart to explain the proposed flow of household waste using the above recommended method of waste management is indicated below.

Figure 110: Flow chart for proposed household waste management (Segregation as the Key)



6.3 WAY FORWARD

A model packet (2-3 wards) can be selected for implementation of the above suggestions. This packet can act like a lab for experimentation of suggested model. The selection can be done after discussions with various stakeholders like the authorities, local NGOs/RWAs, citizens, MLA and ward councilor.

If successful, the model can be replicated in 50% of the packets in the second phase (6 months) and then in other parts of the city.

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