

## Solid Waste Management in Mangaluru City - A Case Study

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**ABSTRACT:** Mangaluru being a fast developing city faces the challenges of dealing with the solid waste generated. The calculation of the quantity of waste generated especially in the households and the manner in which the residents and the local government respond to it becomes crucial in facing this challenge effectively. Present study shows the average solid waste generated by Mangaluru is 226 tons per day with the per capita waste generation equaling to 0.4524 Kg per day. The household per capita waste generation equals to 0.2095 Kg per day. Though the total per capita waste generated in the city is not alarming, it is almost equal to the total per capita waste generated by the State of Karnataka and India in general. As we move from the outskirts of the city to the central part of the city there is an increase in the production of the solid waste. It is observed that in the outskirts of Mangaluru, the waste is mostly fed to the animals and used as manure, and thus less waste finds its way to the community dumpsites. Since the major part of the household waste generated in the city is biodegradable, by using eco-friendly technologies like vermicomposting in Mangaluru 50-60 tons per day of compost could be prepared from household waste alone. The goodwill of the people to cooperate in the proper management and disposal of the household waste needs to be utilized and at the same time strengthened by adequate awareness programs and facilities. Survey shows that the combined action of the municipal authorities and the residents of the wards is necessary in the entire process of management of solid waste.

**KEYWORDS:** per capita, household waste, bio-degradable, storage, collection, dumpsite, attitude, awareness.

### 1 INTRODUCTION

Mangaluru, which was earlier known as Mangalore is situated in the west coast of Southern India and is the fourth largest city in Karnataka State. Being the headquarters for the District of Dakshina Kannada, it is the largest urban coastal city in the State. It is located at 12°-52`N latitude and 74°-49`E longitude. The city is located in the confluence of Nethravathi and Gurupura rivers and is bound in the east by the Western Ghats and in the west by the Arabian Sea. Three National Highways, namely, NH-17 linking Panvel and Kanyakumari, NH-48 linking Mangaluru and Bengaluru, NH-13 linking Mangaluru and Sholapur pass through the city. The city has an international airport at Bajpe. It is the fast growing city in education, commerce and industry. The city with more than 5 lakh population faces the challenges of dealing with its solid waste too. This study in the first part includes deals with the calculation of the quantity of waste generated in the four wards of Mangaluru as a case study. In the second part the total production of solid waste in Mangaluru is dealt with. Finally the various steps involved in the management of the solid waste and responses of the residents concerning the same, are treated by giving special attention to the four wards of the city corporation.

### 2 MATERIALS AND METHODS

Out of the sixty wards of Mangaluru City Corporation, four wards were selected for the present study. They are, Ward 34 –Shivabagh, Ward 35- Padavu-2 (Central), Ward 39-Falnir and Ward 51-Alape-2 (North). For two weeks, in the twenty houses of each ward, on alternative days the household waste was weighed by separating it as bio-degradable, non-bio-degradable,

wet and dry for two weeks and per capita household waste generation was calculated. The present scenario of management of household solid waste and the awareness and attitude of the residents concerning the management of solid waste was also studied with the help of a questionnaire.

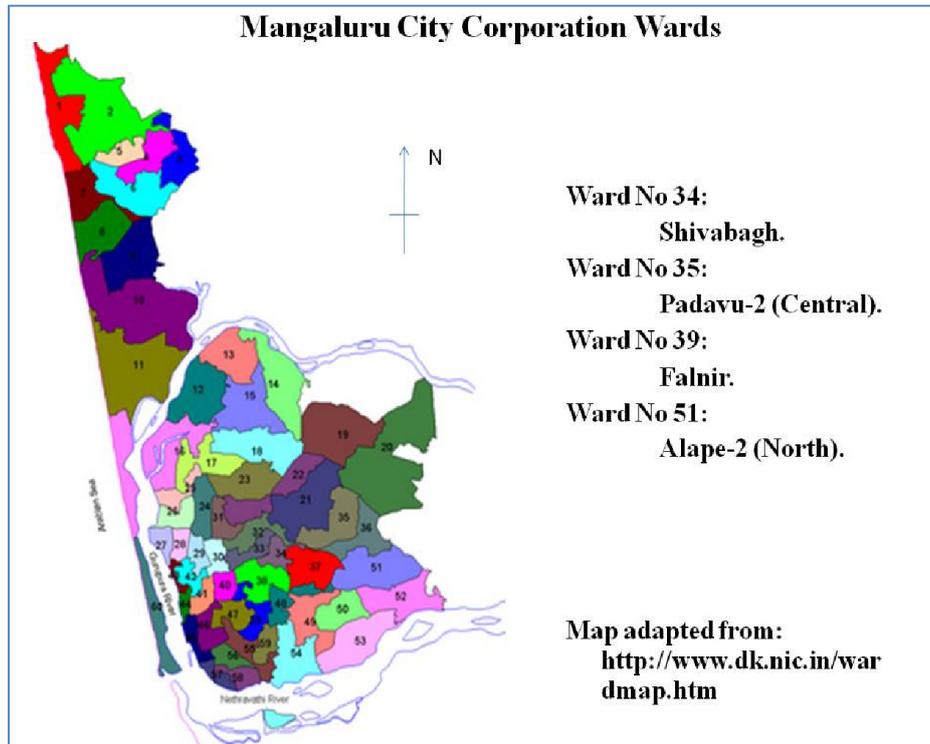


Fig.1 Mangalore City Corporation Wards

### 3 RESULTS AND DISCUSSION

The details of the total waste generated in 20 each household of four wards of Mangaluru city for two weeks on alternate days is summarized in table 1.

Table 1: Total and Per capita waste generation

	P	WET	DRY	TOTAL	NBD	BD	TOTAL
<b>FALNIR</b>	1666	182.992	41.227	224.219	16.903	207.316	224.219
<b>SHIVBHAG</b>	588	235.869	19.859	255.728	9.708	244.02	255.728
<b>PADAVU-C</b>	574	93.888	25.922	119.81	4.511	115.299	119.81
<b>ALAPE-2</b>	560	84.528	25.458	109.986	13.307	96.679	109.986
<b>TOTAL</b>	<b>3388</b>	<b>597.277</b>	<b>112.466</b>	<b>709.743</b>	<b>44.429</b>	<b>663.314</b>	<b>709.743</b>
<b>PER CAPITA</b>	<b>1</b>	<b>0.1762</b>	<b>0.0331</b>	<b>0.2095</b>	<b>0.0131</b>	<b>0.1957</b>	<b>0.2095</b>

In the above table: P-Persons (aggregate of members of the household); NBD-Non Bio degradable; BD-Biodegradable.

The table 1 gives the per capita waste generation and also the per capita wet, dry, bio-degradable and non biodegradable waste generated. The ward wise waste generation is enumerated in the figures 1, 2, and 3.

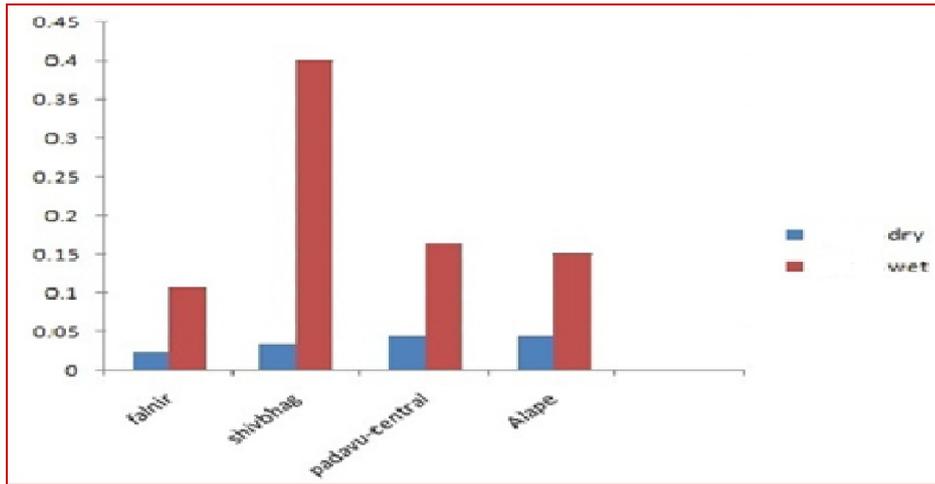


Fig.2 Ward wise Dry and Wet waste generation

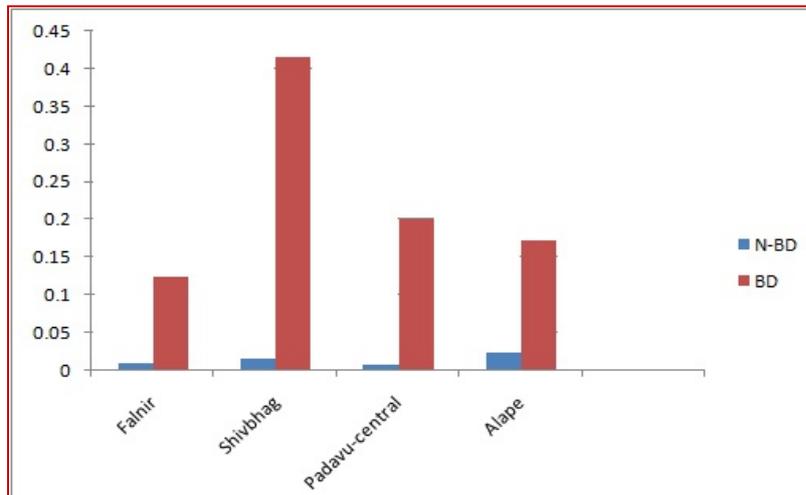


Fig. 3 Ward wise bio-degradable and non-biodegradable waste generation

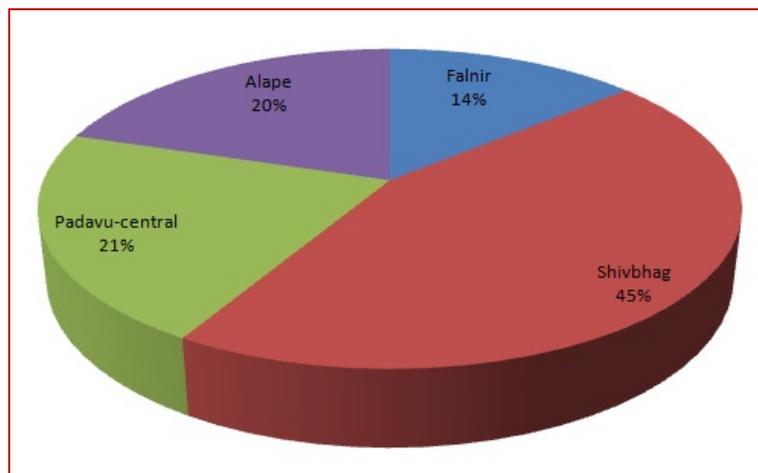


Fig. 4 Ward wise per capita solid waste generation comparison

As per the above calculation the per capita household waste generation for the city is 0.2095 Kg. At this rate the total Municipal Solid Waste production from the households alone would equal to 104.6 tons per day or TPD as the city population is 4,99,487 as on 2011 census [1].

Among the four wards, Shivbhag had highest household waste generation (0.4349 Kg per capita per day or pcpd) followed by Padavu-central (0.2087 Kg pcpd), Alape (0.1964 Kg pcpd) and Falnir (0.1346 Kg pcpd). It can be noted that where urbanization rate is high, waste generation rate is also high and there is a direct link of urbanization with waste production [2]. This is clear as the waste production in the Shivbhag Ward area is drastically higher than other areas under study. Shivbhag Ward is in the heart of the city and more waste is generated here.

**Table -2 Municipal Solid Waste Generation in Mangaluru city (as per Mangaluru city corporation data)**

Month	Waste generated (in Kg)	Per capita (in Kg)
January	6324720	0.4085
February	5768630	0.4125
March	6362210	0.4109
April	6338000	0.4229
May	7943950	0.5130
June	8164240	0.5448
Average	6816958.33	0.4524173

From the above table it could be noted that the waste collected at or transported to the dump site at Vamanjoor, Mangaluru is 226 TPD. The per capita waste generation per day is 0.4524 kg. Mangaluru city comes under the cities which have less than 500 TPD Municipal Solid Waste generation, along with Agartala, Asansol, Chandigarh, Faridabad, Guwahati, Jamshedpur, Kochi, Kozikode, Mysore and Shimla [2]. Overall view of the Solid Waste generation in various cities of India could be noted as follows. The national urban Solid Waste generated is 1,88,500 TPD and per capita production of waste is 0.5 Kg per day and per capita generation of Solid Waste of Karnataka's urban area too equals to 0.5 Kg per day with 11,788 TPD [3]. In Delhi the waste generation is 9000TPD with per capita 0.65 Kg per day and with 50% is fit for composting [4]. In Chennai city which tops in per capita solid waste generation in India with 0.7 Kg per day the compostable waste generated is 68% with total generation of solid waste estimated being 4500MTPD [5]. Bengaluru city produces 4000T of Solid waste per day and 55% is domestic waste with 72% of organic content [6]. The city of Pune generates 1600TPD with 0.4 Kg PCPD with 40% of the waste coming from households out of which 70% is organic waste [6]. The city of Guwahati which is the main urban centre of the entire North East India produces 425 MT of Solid waste per day with 0.155 Kg PCPD with 53.56% compostable waste and major part coming from households [7]. Kakinada city generates 260 TPD of solid waste, with 0.424 Kg PCPD out of which 140 TPD or 53.84% is domestic waste with a major part with organic waste [8]. Kolkata city generates 5114.76 TPD out of which household waste is 34.20% total 66.17% biodegradable [9].

As we can observe from the above data related to various cities of India, 60-75% of the waste generated from the households is biodegradable. In Mangalore the biodegradable waste in the areas of study was found to be very high, equaling almost 90%. As we have noted above, household waste generation for the city of Mangalore is 0.2095 kg pcpd. At this rate the total household waste generated would equal to 104.643 TPD. That is not less than 46.30% of the total waste generated. It is observed that when an eco-friendly technology like vermicomposting when applied to household wastes will yield 60-70% of vermicompost per each ton of substrate used. Thus we can conclude that in Mangaluru city, 65 TPD vermicompost could be generated from household waste alone.

### **3.1 THE MANAGEMENT OF DOMESTIC SOLID WASTE**

#### **3.1.1 STORING OF THE WASTE**

The statistics of the manner in which the household waste is stored in the houses under study are given in the table 2.

Table-2: Storing of waste in the households

	SHIVBAG	ALAPE	FALNIR	PADAVU	TOTAL	%
Closed Container	10	7	6	6	29	36.25%
Open Container	1	4	2	1	8	10%
Plastic bags	9	6	12	13	40	50%
Pile in the Yard		2			2	2.50%
Don't know		1			1	1.25%

It is observed that 50% of the households stored their waste in plastic bags because it is easy to throw it to the communal containers or hand over to the collector. 36.25% households stored the waste in the closed, usually plastic containers.

**3.1.2 SEPARATION OF WASTE**

While 50% of the households separated the recyclable items like metals and hardboards and plastics, 40% did not separate even the recyclables. 46.25% separated the compostable waste and used it as manure for the garden. About the separation of other waste like food, plastic, paper, glass etc they are of the opinion that since all the waste is dumped together there is no value in keeping it separate. However, if they are asked to do so by the MCC for its separate collection, 76.25% were willing to separate the recyclable waste and 81.25% were willing to separate the compostable waste.

The separation of waste, especially of the biodegradable waste is very important for their treatment since the different materials have different biochemical composition [10]. This will help in choosing proper treatment method such as vermicomposting.

**3.1.3 COLLECTION OF WASTE**

As per the collection of waste is concerned though in Shivbhag and Falnir wards there is door to door collection, only 32.5% participate in it. The collection here is done by private parties against certain fixed amount. Rest all manage their waste by themselves by dumping it at the nearby communal disposal sites. 42.5% of the households get rid of their waste daily, where as others get rid of it twice a week, now and then or on weekly basis. As far as handling of the waste is concerned 81.25% percent of the families parents or relatives handled the waste and only 18.75% children were involved in handling the waste. More than 90% of the people said that they are not given any coloured containers for the separation of wastes by the MCC though they are aware through the media that such a practice exist.

**3.1.4 GETTING RID OF WASTE OR ITS MANAGEMENT**

People get rid of their waste in various ways. Some of them burn or bury their waste. Some dump it in the yard and there are a few who dump it on the road too. They may take their waste to the common dump site or give to the garbage truck. Other may reuse, recycle or feed it to the animals. All this depends on the type of waste. The table 3 summarizes how they get rid of their waste.

Table 3: The manner in which people get rid of the Household waste

T	B %	B* %	Y %	R %	S %	T %	C %	U %	C %	A %
a. Food		1.25	7.5	2.5	25	31.25			11.25	21.25
b. Garden trimmings	6.25	2.5	17.5	3.75	23.75	25			17.25	
c. Paper/card board	33.75				17.5	21.25	15		12.5	
d. Metal			2.5		37.5	26.25	33.75			
e. Glass			1.25		72.5	21.25	5			
f. Plastic			1.25		47.5	30	17.5	3.75		

In the above table: T=Type of waste; B=Burn; B\*=Bury; Y=Dump in the yard; R=Dump on the road; S=Dump at the common dump site; T= Dump to Garbage truck; C=Recycle; U=Reuse; C=Compost; A=Feed to animals.

Majority of the waste is disposed either to garbage truck or at the communal disposal site. 21.25% of the households feed the animals with the food waste. This is seen in many houses where there are cats and dogs. People those who have a few cents of land at their backyard make use of the food waste, garden trimmings and paper for composting and burning. Those who say that they recycle the metallic waste, glass and plastic mean that they keep that waste separate to be sold to the scrap dealer or to the raddiwala. Though a small percentage, those who find the communal waste bins far from their house are comfortable to dump it somewhere on the road side too. Around 34% households use the paper waste and 6.25% households use the garden trimmings to burn it as fuel. More than 55% discard the recyclables with other waste and 65.25% make use of the compostable waste to do compost or to feed the animals. However, burning the garden trimmings, paper wastes, feeding the animals with food waste, and composting takes place in the households away from the city thus bringing down the waste generation considerably as seen in figures 1, 2 and 3.

### 3.1.5 PROBLEMS CONNECTED WITH COLLECTION AND DUMPING OF WASTE AND DUMPSITES

In general, the opinion of the 40% of the household health is the major problem caused by the improper disposal of the waste and 33.75% see some sort of problem and 18.75% don't see any problem. About 16.25% feel that the littering of waste in the neighbourhood causes them problems. Around 75% are not satisfied with the communal containers placed at the common site. The people felt that the containers are too far (18.75%), they are too small to contain all the waste of the locality (25%) or they produce unpleasant odours (25%). The rest either refused to comment on this or they had no opinion. When asked about the waste disposal site in their neighbourhood, 46.25% felt the site produced severe foul odours. 53.25% foresee a public health risk at the site, 15% see an uncontrolled dumping at the site, 3.75% felt it will cause ground water contamination whereas 6.25% found nothing wrong with the site while the rest restrained from making any observations. 42.5% of the people are willing to pay the common amount fixed for the door to door collector whereas the others were comfortable taking their garbage by themselves to the sight or they felt that the MCC has to manage it as they pay tax.

## 3.2 AWARENESS PROGRAMS

### 3.2.1 CONCERN, KNOWLEDGE

More than 3/4<sup>th</sup> of the households are concerned about the service provided by the garbage truck in the area (80%), litter in the area (81.25%), illegal dumping in the area (81.25%) and the management of garbage by MCC as local government (73.75%). It is encouraging that 90% have heard about composting and 91.25% have heard about recycling. Only 32.50% households know about what happens to the waste that goes out of their house and the 60% do not know about it while the others didn't respond. When asked about the place where the waste generated at their house and dumped at the communal site or garbage truck goes, 53.75% were able to say the name of the site and the rest answered negatively. Just 13.75% are satisfied with the way waste is collected, transported and disposed whereas 65% are not.

Though 5% disagree, it is encouraging that 80% know that they play an important role in managing the waste as a whole. Almost 90% agree that environmental education and proper management of waste should be taught in school. The purchase decisions that one make can increase or decrease the amount of garbage of one's household must get rid of is agreed by 70%. Burning garbage can be bad for one's health and the health of others is known to people and 82.5% care for it. Though 26.25% agree upon the statement that people throw garbage on the streets and in the drains and gullies because they have no other means of getting rid of (disposing of) their garbage, 67.25% disapprove of it.

Awareness, knowledge and equipment are the important components in relation to the efficient separation and management of waste. At the same time the municipality alone is not the stakeholder in this process but each and every citizen of the society are the co-stakeholders [11]. The understanding of this responsibility is the need of the hour. The NIMBY (Not In My Back Yard) attitude too is prevailing in Mangalore which is also very much connected to the lack of the above mentioned public involvement as stakeholders, which would be set right with increased awareness of this responsibility [12]. The concern of the people for better management of waste should be utilized at the earliest for building up awareness in the areas they are not concerned.

### 3.2.2 AWARENESS ACTIVITIES

Among the households under study only 22.50% said that they attended some sort of programme concerning the management of SW and 72.50% replied in negative. Only 28.75% people were aware of such awareness programs conducted in their neighbourhood but 66.25% answered negatively. About their awareness concerning whether the children are given

training in the school about SW management or whether the children have spoken about it at home 28.75% answered positively and 58.75% answered negatively.

If a recycling program was set up, 83.75% are willing to separate materials like plastic, paper, metals, etc and put them into separate bags for collection purposes. When explained about this unlike above 83.75% are willing to contribute financially for the pickup of recyclable materials from their houses. As far as their willingness to participate in awareness activities is concerned 67.50% answered affirmatively. 75% are willing to purchase less throwaway products (such as, plastic bottles) to help reduce the amount of garbage they get rid of, if an alternative product of the same cost was provided. 81.25% would like more information about how and what types of garbage you can compost, reuse, and recycle in order to reduce the amount of garbage that they need to get rid of.

The Local Government is not doing enough to fix the garbage problem is agreed by 86.25% of the respondents. Public education about proper garbage management is one way to fix the garbage crisis is agreed by 87.25%. Other personal issues (like crime, unemployment, and cost of living) are more important to them than a garbage-free community was agreed upon by 17.5% but 71.25% disapprove of it.

72.5% agree that regular collection of garbage is the only solution to the garbage problem and 5% disagree. Whereas 56.25% alone agree that picking up garbage around their community is their responsibility as a resident of the ward to which 27.5% disagree. Public education about proper garbage management is one way to fix the garbage crisis is agreed upon by 87.5% and it is very important that the Local Government put recycling laws and programs in place is accepted by 86.25%, while others had no opinion.

#### **4 CONCLUSION**

The average calculation of the per-capita solid waste generation per-day in Mangaluru city shows that it is in no way less compared to the other major cities of India. The solid waste generation of the city increases with urbanization is obvious from the study as it is noted that the area away from the centre of the city contributes less waste to the main Municipal Solid Waste generation. It is evident and true that all want to get rid of their waste. But the survey shows that getting rid of waste and its management in a scientific and effective way is more often lacking. The goodwill of the people to cooperate in the proper management and disposal of the household waste needs to be utilized and at the same time strengthened by adequate awareness programs and facilities. Study shows that the active participation of the municipal authorities and the residents of the wards is necessary in the entire process of management of solid waste.

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