PUBLIC PRIVATE PARTNERSHIP IN SOLID WASTE MANAGEMENT IN MUNICIPAL CORPORATIONS OF MUMBAI METROPOLITAN REGION

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Abstract
The solid waste in all municipal corporations is rising in Mumbai Metropolitan Region. Such rise in solid waste generation is observed in Brihanmumbai, Thane, Mira-Bhayandar, Kalyan-Dombivali, Ulhasnagar, Navi-Mumbai and Bhiwand-Nizampur Municipal Corporation. An increase in solid waste is observed because of increase in urbanization, population density and income, changing food habits, taste and pattern. The growth of industry, commercial units such as hotels, theaters, restaurants, malls are rising fast. Such units are positively contributing to the solid waste generation. Solid waste collection, segregation and disposal capacity of Municipal Corporations is low and inadequate with rising solid waste. Therefore municipal corporations must adopt scientific methods for collection, segregation and disposal of solid waste. Municipal corporations must accommodate private sector for investment and management of solid waste. Urgent steps in this direction will reduce the water, air, soil pollutions and health hazards. It will improve the quality life of people in Mumbai Metropolitan Region.
Keywords: Population, Food habits, lifestyle

1. INTRODUCTION

Solid waste is an integral part of modern society. Human activities create solid waste and it required to store, collect and dispose. If it is not properly managed then it causes risk to environment and public health. Municipal solid waste management is a major responsibility of local government (Schubeler, 1996). In Mumbai Metropolitan Region, urbanization, population, industrial, commercial unit growth is higher. Mumbai is a financial capital of country. Therefore most of the financial institutions, corporate head quarters of number of Indian companies and MNC's are located in city. The growth of services sector such as finance, IT, telecom, tourism, entertainment, advertising, communication is higher in region. Services sector provides enormous employment opportunities to people. Therefore there is continuous migration from rural to Mumbai Metropolitan Region. Skilled and unskilled migrants do not find employment problem in region. They easily adopt with employment opportunities and housing. Metropolitan region has good connectivity of railway and roads. But rising population is putting pressure on existing amenities in Mumbai and municipal corporations of Thane district. Such inadequate civic amenities such as water supply, housing, transportation, health care, solid waste, sanitation is affecting on quality of life. It has resulted in to traffic, illegal slums, diseases and

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pollution etc. Similarly income of people, food habits, taste and pattern is changing fast. Solid waste management required unit and ward wise collection, segregation, storage, disposable system and scientific planning. For collection of solid waste, workers, rag pickers, ghanta gadies, vehicles are required. Municipal corporations are required budget to pay workers salaries, maintain vehicles and dumping grounds. But Municipal Corporations in Mumbai metropolitan region do not have resources for investment in various activities. It results in low manpower, less vehicles and irregular collection and transportation of solid waste. In low income or squatters settlements, waste collection is often non existent either because the settlements are informal, unplanned and possibly unauthorized or because the strategies and technologies adopted for service provision are inappropriate for operating in settlements with narrow and unplanned streets and lanes (Zhu, et.al., 2008). Municipal corporations do not have adequate dumping grounds for solid waste disposal. All these factors lead to lower coverage of solid waste in municipal corporations. The solid waste is thrown at roads, streets, common grounds etc. It leads to soil, water and air pollution and health hazards. During monsoon, it blocks the rain water flows and leads to water logging and floods. It also causes mosquitoes breeding and malaria in region. Health of the adults and children gets affect due to water borne and waste related diseases. The direct and indirect cost of visiting health care facilities is very high. Health facilities are overcrowded and visiting to doctor, standing in queue and repeated visits are very expensive for the poor households. Water and waste borne insects easily move from one corporation area to another area. Therefore each municipal corporation has the responsibility to manage the solid waste in their area. Solid waste management involves managing activities associated with generation , storage, collection, transfer and transport, processing an disposal of solid wastes in an environmentally compatible manner with due considerations of the principles of economy, aesthetics energy and conservation (Edelman, 1997). Clean environment increases the economic productivity of human beings and they remain healthy for long period of time. First section of this paper explains about the data and methodology. Second section deals with total solid waste generated with different type in each municipal corporation. Third section explains about the solid waste generated till 2031 in Mumbai, Thane, Kalyan-Dombivali, Bhiwandi-Nizampur, Mira-Bhayandar, Ulhasnagar and Navi-Mumbai Municipal Corporation. Second last section of the paper deals with ordinary least square regression results. Last section deals with policy implication and conclusion

2. DATA AND METHODOLOGY

Data for this study is collected from the census 2001 and 2011. These census figures are providing the population and number of habitations. Similarly, census also provides the number of units of hospitals, schools and colleges, commercial units of Greater Mumbai, Thane, Navi-Mumbai, Ulhasnagar, Mira-Bhayandar, Bhiwandi-Nizampur Municipal Corporation. We have referred the city development and current environment status reports of each municipal corporation. We have also refereed the solid waste

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management system of Pune, Delhi and Kolkata. We have used the ordinary least square regression model to examine the factors correlated to solid waste management. We used the simple forecasting method to estimate the solid waste generation till 2031 in Mumbai Metropolitan Region

2.1. Solid waste: An overview

Solid waste is broadly defined as including non-hazardous industrial, commercial unit and domestic refuse including household organic trash, street sweepings, hospitals and institutional garbage and construction waste (Zerbock and Candidate, 2003). In other words, "Waste is unwanted for the person who discards it". A product or material that does not have a value anymore for the user and therefore it is thrown away. But 'unwanted' is a subjective concept. The waste could have value for another person in different circumstances. Domestic waste generated during food preparation vacuum cleaning, gardening, old clothing, floor covering and old furniture, bottles, plastic bags etc. Commercial waste produced by shops, offices. The waste generated by hotels, restaurants, hospitals, also includes in this category. Hotels and restaurants generate waste during food preparation, bottles, plastic etc. Hospitals waste comprises as medicines, bottles, injections, papers etc. Street cleaning waste consist of paper, plastic bottles, bags, small stones, dust and debris fallen from passing trucks. Industrial waste includes construction waste and all unsalable factory waste. The material of metal plastic wood or cardboard, textile or other materials, some industrial waste is highly toxic. The major constituents of solid waste are domestic and commercial waste, paper and fermentable organic matter. Solid waste is visible and politically sensitive issue. Inadequacies in the service can have severe implications for the credibility of Municipal Corporation and council. Proper solid waste management is important for public health, environment, economic and political reasons. Improper waste management can have negative effects on public health, environment and natural services. Therefore integrated solid waste management is demanded across the world.

2.2. Solid waste in Mumbai Metropolitan Region:

Solid waste generated in different Municipal Corporation is different. In a municipal corporation, the solid waste generation depends on the population, industrial units, shops, commercial units etc. If the population is growing then these units are also growing. It leads to more solid waste generation in municipal corporation area. We have calculated the solid waste generated in current year.

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TABLE 1 - SOLID WASTE ACCORDING TO MUNICIPAL CORPORATIONS

Municipal Corporation	Solid waste (Metric Tones)	Percent
Mumbai	8837.01	65.15
Thane	1061.34	7.82
Kalyan–Dombivali	969.59	7.15
Ulhasnagar	546.54	4.03
Navi-Mumbai	955.62	7.04
Mira-Bhayandar	612.26	4.51
Bhiwandi-Nizampur	583.02	4.29
Total	**13565.38**	**100.00**

The solid waste in Mumbai Municipal Corporation is 8837 Metric Tones per day. Due to higher density of population, commercial units' shops, theaters and industrial units, the solid waste generated is higher. It is 65 percent of the total solid waste generated in Mumbai metropolitan region. In Thane Municipal Corporation, solid waste generation is only 1061.34 Metric Tones. It is 7.82 percent of total solid waste. But it is still higher as compare to Municipal Corporation in Thane district. In Thane city, population is rising fast. Services sector growth is higher; therefore the numbers of unit are rising. In Kalyan-Dombivali, the solid waste generation in each day is 969.59 Metric Tones. It is 7.15 percent of total solid waste in Mumbai Metropolitan Region. In Ulhasnagar Municipal Corporation, solid waste generation is 546.54 Metric Tones. It is 4.03 percent of total solid waste in Mumbai Metropolitan Region. It is the only Municipal Corporation where lowest solid waste is generated. The reason is that it is a small Municipal Corporation in terms of population and all other units. In Navi-Mumbai Municipal Corporation, solid waste generated is 955.62 Metric Tones. It is 7.07 percent of total solid waste. Navi-Mumbai is a modern and planned city. The solid waste generation is rising fast due to high income, population, and number of commercial units. Solid waste generation in Mira-Bhayandar is 612.26 Metric Tones. It is 4.51 percent of the total solid waste. In Bhiwandi-Nizampur Municipal Corporation, the solid waste generation is 583.02 Metric Tones. Total solid waste generated in Mumbai metropolitan region is 13565.38 Metric Tones.

2.3. Type of solid waste generated in Mumbai city:

Solid waste is not only generated by the households but it is generated by the commercial units, hotels and welfare and recreation units in city. Such units are regularly visited by the people of same and other municipal corporation area. Therefore solid waste is a combination of all the types of units in corporation area.

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TABLE 2 - SOLID WASTES IN MUMBAI CITY ACCORDING TO TYPE

Type	Solid waste (Metric Tones)	Percent
Households	5615.00	63.54
Slums	1423.00	16.10
Academic institutions	129.10	1.46
Industry	135.00	1.53
Theaters	37.00	0.42
shops and malls	1211.00	13.70
Hospitals	83.00	0.94
Hotels	53.00	0.60
welfare/recreation/fire stations	151.00	1.71
Total	**8837.10**	**100.00**

Solid waste generation by households in Mumbai city is 5615 Metric Tones. It is 63.54 percent of total solid waste in Mumbai city. It is only because of density of population which creates more solid waste in city. The slums are generating solid waste in city, it is 1423 Metric Tones. Large and small industries are also generating 135 Metric Tones solid waste but it is 1.53 percent of total solid waste. Shops and malls contribute 1211 Metric Tones. It is 13.70 percent of total solid waste. Many people visit every day to shops and malls in city. Hotels are contributing 53 Metric Tones wastes in city. People of city and outside of city regularly eat food in hotels. During food preparation and service, maximum solid waste is generated in city. Hospitals contribute 83 Metric Tones of solid waste. Few big hospitals are located in city. Patients from all states regularly visit to hospitals in city. Therefore everyday during treatment and prescriptions of medicines, maximum solid waste is generated in city. Welfare/recreation and fire stations create 1.71 percent of solid waste in city. Many people visit to welfare and recreation centers during festivals, holidays etc. Therefore the solid waste generation is higher. The solid waste generated is further classified according to various components.
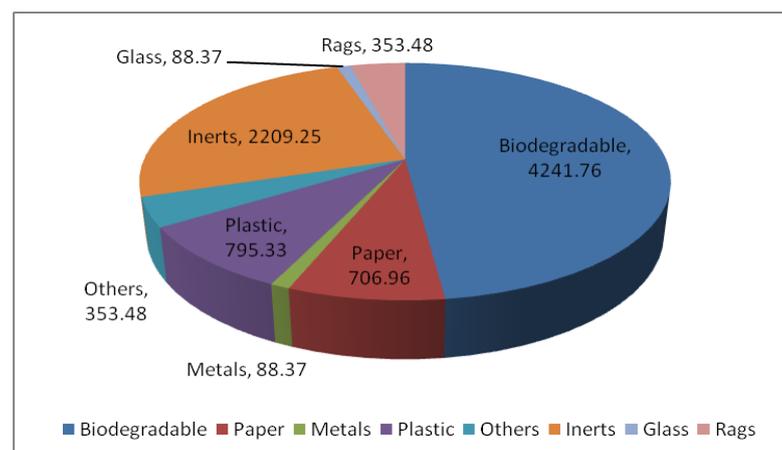

FIGURE 1 - SOLID WASTE COMPONENTS IN MUMBAI CITY (METRIC TONES)

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Graph shows that biodegradable solid waste in Mumbai city is 4241.76 Metric Tones. Paper consists of 706.96 Metric Tones solid waste. Rags and others are generated in same quantity (353.48 Metric Tones) in city in current year. In Mumbai city, glass and metals are generated as 88.37 Metric Tones. Inert is generated as 2209.25 Metric Tones. The use of plastic is more for shopping bags, bottles of water and cosmetic, medicines etc. Plastic generation is 759.33 Metric Tones in Mumbai city. Municipal Corporation has banned the use of plastic bags in city. But the use is continuously rising due to lifestyle and sell of commodities. Paper is generated as 706.96 Metric Tones in city. The use of paper is higher in city for different purposes. These are the broad components of solid waste in Mumbai city.

2.4. Solid waste in municipal corporations of Thane district:

Solid waste generated in all the Municipal Corporation of Thane district is not uniform types. The density of population, commercial units, shops, small and large industries, school and colleges and hotels and restaurants are different. Some municipal corporations are old but some are new and they are in developing phase. Therefore it is difficult to compare them with each other but it is important to estimate their solid waste by different types of units.

TABLE 3 - SOLID WASTE ACCORDING TO TYPE IN MUNICIPAL CORPORATIONS OF THANE DISTRICT

Types	Thane	Kalyan-Dombivali	Ulhasnagar	Navi-Mumbai	Mira-Bhayandar	Bhiwandi-Nizampur
Population	774.67 (72.99)	661.89 (68.26)	260.54 (47.67)	631.27 (66.06)	389.33 (63.59)	368.04 (63.13)
Industry	88.08 (8.30)	130.43 (13.45)	165.47 (30.28)	157.82 (16.51)	97.33 (15.90)	92.01 (15.78)
Shops	10.99 (1.04)	10.31 (1.06)	9.07 (1.66)	6.93 (0.73)	11.66 (1.90)	9.29 (1.59)
Hotels	39.9 (3.76)	33.89 (3.50)	29.79 (5.45)	26.46 (2.76)	26.28 (4.67)	24.25 (4.16)
Restaurants	21.83 (2.06)	23.83 (2.46)	25.32 (4.63)	25.24 (2.64)	28.58 (2.43)	21.37 (3.67)
Theaters	12.45 (1.17)	12.99 (1.34)	15.03 (2.75)	7.55 (0.79)	14.88 (2.43)	14.55 (2.50)
Primary schools	19.92 (1.88)	16.82 (1.73)	8.18 (1.50)	19.92 (2.08)	9.9 (1.62)	9.35 (1.60)
Secondary schools	18.01 (1.70)	15.91 (1.64)	7.73 (1.41)	18.84 (1.97)	9.35 (1.53)	8.85 (1.52)
Colleges	2.61 (0.25)	1.61 (0.17)	0.78 (0.14)	1.91 (0.20)	0.94 (0.15)	0.89 (0.15)
Post graduate institutions	2.38 (0.22)	1.68 (0.17)	0.82 (0.14)	1.99 (0.20)	0.98 (0.15)	0.93 (0.15)
Health	70.5 (6.64)	60.23 (6.21)	23.81 (4.36)	57.69 (6.04)	23.03 (3.76)	33.49 (5.74)
Total	**1061.34 (100)**	**969.59 (100)**	**546.54 (100)**	**955.62 (100)**	**612.26 (100)**	**583.02 (100)**

Figures shows the solid waste in Metric Tones / Figures in parenthesis shows the percentage of solid waste

In Thane Municipal Corporation, population contributes 774.67 Metric Tones of solid waste. It is 73 percent of the total solid waste. It is highest solid waste generation as compare to other municipal corporations of Thane

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district. In Ulhasnagar Municipal Corporation, solid waste generated by population is only 260.54 metric tones. Ulhasnagar city has many manufacturing units. Therefore the solid waste generated by population is low. The solid waste generated by the large and small industry is 165.47 metric tones; it is 30.28 percent and highest among all other municipal corporations in Thane district. The solid waste generated by industry in Thane municipal corporation area is only 88.08 metric tones. It is only 8.30 percent and lowest as compare to other municipal corporation. Total solid waste by industry in Thane is declining because industries are either shifting or they are getting close. Due to pressure of urbanization many industrial areas are converted into residential areas.

Solid waste by shops in Mira Bhayandar is 11.66 metric tones. It is highest as compare to all other municipal corporation in Thane district. In Navi Mumbai, it is only 6.39 Metric Tones. It is lower (0.73 percent) because of lower density of shops. Solid waste generated by the hotels in Ulhasnagar Municipal Corporation is 5.45 percent. It is highest because many big and small hotels exist and they are the need of manufacturing and industrial area. In Navi Mumbai, hotels are generating only 2.76 percent of total solid waste. The solid waste generated by the restaurant is higher in Ulhasnagar Municipal Corporation (4.63 percent). The lowest solid waste generated by the restaurant is found in the Thane municipal corporation area (2.06 percent). Restaurants are located in few pockets of city.
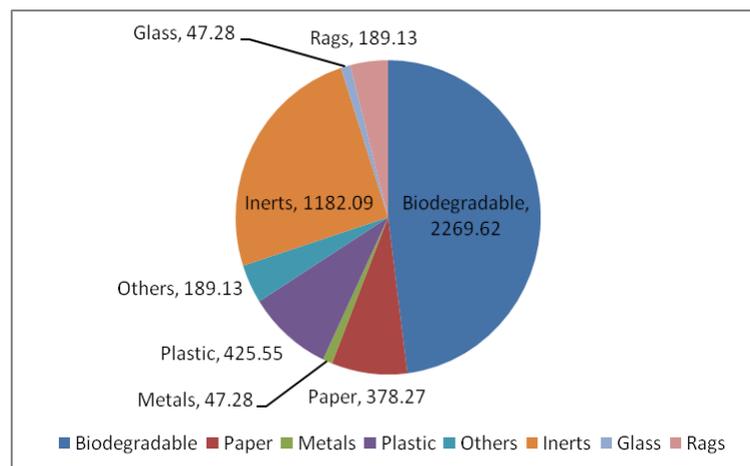

FIGURE 2 - SOLID WASTE COMPONENTS IN MUNICIPAL CORPORATIONS OF THANE DISTRICT (MT)

In Ulhasnagar city, there are many small mini theaters. Workers and other people regularly visit these theaters. During the intervals, food, other items are consumed by the people. Therefore solid waste generation is 2.75 metric tones. In Navi Mumbai region, solid waste generated by the theaters is only 0.79 percent. There are few theaters available in Navi Mumbai. Solid waste generated by the primary and secondary schools in Navi Mumbai is 2.08 and 1.97 Metric Tones. Colleges and post graduate institutions are contributing 0.25 and 0.22 Metric Tones solid waste in Thane city. Solid waste generation by the health institutions in Thane city is 6.64 percent that is 70.5 Metric Tones. In Mira Bhayandar Municipal Corporation

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only 23.03 Metric Tones of solid waste is generated. In this Municipal Corporation, there are less medical facilities exist. It is important to examine the component of solid waste generated by municipal corporations in Thane district.

Solid waste through biodegradable form is 2269.62 Metric Tones in all the municipal corporations in Thane district. Paper consists of 378.27 Metric Tones in all the municipal corporations. Metals and glass consist of same (47.28 Metric Tones) solid waste generation. Plastic use for different purposes is more in all the municipal corporations. Therefore plastic consists of 425.55 Metric Tones in all the municipal corporations of Thane district. Rags consist of small piece of paper or cloths. It is 189.13 Metric Tones of solid waste in all municipal corporation of Thane district.

3. COLLECTION AND DISPOSAL OF SOLID WASTE IN MUMBAI METROPOLITAN REGION

Solid waste collection, segregation and dumping grounds are different in Municipal Corporations. Each municipal corporation has its own workforce, vehicles and dumping grounds. In Mumbai city, solid waste is collected from few households. Road sweeping is also done in some part of city. Total road length in city is about 1950 kilometer. At present 67 percent of road length are swept in one or two shifts by municipal staff. But it is inadequate and irregular swept by municipal staff. The private contractors sweep 33 percent of roads in city (MCGM, 1995). Everyday many people visit beaches in city. They throw waste at such places. Garbage management in the four beaches that is Girgaon chowpaty, Shivaji Park, Mahim, Juhu and Versova outsourced to private sector. In Mumbai city, solid waste comprises as compostable matter that is paper and card board and other materials such as plastic, metals, glasses etc. Waste collection is done through community bins and house to house collection. There are few households covered under the waste collection system. Kutcha slums are ignored in solid waste management system. Some slums are illegal and they are located at hills or near railway line, pipeline etc. The solid waste collection from community bins is carried about in three shifts and transported either to the three transfer stations or directly to the disposed points. Solid waste is collected from the main roads and collection points, where as the inside area is completely avoided in solid waste collection system. The daily collection and transportation is done through an average number of about 1000 to 1354 trips. During the monsoon, number of trips becomes less due rain and unplanned dumping grounds. Solid waste is observed lying in various wards in city. It is a responsibility of the MCGM to provide municipal solid waste management services. However, the MCGM is not able to handle the increasing quantity of waste. As a result, waste litters all over the place giving rise to health and environmental problems. (Rath, 2007).

Thane Municipal Corporation (TMC) provides door to door collection in some parts of city. Waste is collected from common points and market. It uses collection vehicles like dumper placers, ghanta gadies and

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rickshaws. The solid waste from each collection point is brought to the dumper placers and other collection vehicles. From the total waste, vegetables, fruit market, hotels and segregated wet waste from municipal solid waste is treated by TMC. It is in collaboration with Enviro-vigil organization through bio-methanation process. TMC has provided bio-medial waste facilities through MS/Enviro-Vigil, Thane. The biomedical waste is treated and disposed through incinerator. Disposal site is located at Chatrapati Shivaji Maharaj hospital, Kalwa (TMC, 2006). Solid waste is not efficiently collected from different points in Thane city. Delay in waste collection is often viewed because lack of transportation, manpower and management etc. In Thane city, industries are getting closed. The old industrial area is getting converted in to residential area. Integrated solid waste collection and disposal is inadequate in Thane city. In Ulhasnagar city, solid waste generated as kitchen waste, papers, plastics, glass, metals, rubber etc. Commercial units and markets are also generating waste in city. The industrial waste from industries stainless steel industry mainly consists of nitric acid. It is sometimes inflammable. The industrial waste generation is increasing in Ulhasnagar city. Apart from the industrial waste, there is generation of inert waste from repairs of houses, construction activities, silt generated out of cleaning of gutters and drainage. The quality of inert waste varies and it is collected and transported to land fill sites. The collection and transportation of solid waste is done by private agencies. They charge on daily basis in Ulhasnagar city. The hired agencies task is to collect the waste from the collection bins kept at regular interval in city and carry it to the dumping site. UMC is responsible for collection of domestic waste from all household and other units. But most of the houses are neglected or remain uncovered due to density of population, uneven surface etc. Slums are completely ignored by the civic administration. People of slums throw waste either in drainage line, common grounds, streets and roads. Segregation of the waste is not done at any level. It is collected in mixed form. The solid waste collected from the residential areas, street sweeping markets, commercial establishment etc. in bins. Town garbage is collected and dumped at two sites which are privately owned. A landfill site at Shanti Nagar is closed. In Ulhasnagar area, 25 hector located near Manje Kamba village has been identified for future landfill (UMC, 2006). At present, there are many lacunas in solid waste management system in Ulhasnagar city. In Mira Bhayandar Municipal Corporation, the average domestic solid waste generation is rising because of population and commercial units. But the universal solid waste collection, segregation and dumping is not exist. The solid waste is collected partly and dumped in land fill sites and there is no treatment plant. An area of 32 hector has been located for a new land fill site and vermi composition has been proposed in the processing of waste (NIUB, 2008a).

Solid waste management in Bhiwandi-Nizampur Municipal Corporation is inadequate and it has poor coverage. Few households, industrial units, commercial units, hotels and restaurants are covered under waste management system. In the city, most of the manufacturing units are of textile and garment types but waste collection system has not covered these units. Everyday waste is not collected from these units and

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waste is lying on the road and common places. Waste collection and transportation is given to private contractor. Bhiwandi-Nizampur Municipal Corporation is not able to use the land allotted by state government at Dapode. It is because of opposition from local villages. Municipal corporation claims of 85 percent households are covered under solid waste collection. But hilly and highly dense areas are ignored. At present, few rag pickers are identified and provided identity cards. Rag pickers are segregating and recovering the recyclable and reusable solid waste. Industrialization and urbanization led to greater generation of waste. The advent of plastics and the use of sophisticated packaging materials provided a further boost to recyclining (Chikarmane and Narayan, 2000). The city environment of Bhiwandi-Nizampur is highly polluted due to solid waste. Solid waste collected regularly from Kalyan-Dombivali municipal area. But the total coverage is lower in the twin city. There is lower manpower, vehicles, instruments etc. The waste is dumped at Adharwadi dumping ground. It is 45 acres plot developed for dumping solid waste. But capacity of dumping ground is full and overused. But KDMC continued to dump solid waste at Adharwadi (NIUB, (2008b).

If we observed the solid waste management of all municipal corporations in Mumbai metropolitan region then each municipal corporation has deficiency in terms of workers, community bins, vehicles, dumping grounds etc. Solid waste management is an important facet of environment hygiene and need to be integrated with total environmental planning. Its purpose is to provide hygiene, efficient and economic service to collect and transport solid wastes innocuous without transferring pollution loads to the water system or the atmosphere (WHO, 1971). Such solid waste generation will increase with increase in various components in it.

4. ESTIMATION OF SOLID WASTE IN MUMBAI METROPOLITAN REGION

We have estimated the solid waste in all the municipal corporations in Mumbai Metropolitan Region. The solid waste for the Brihanmumbai municipal corporation is estimated separately. This is mainly because this municipal corporation is old and it has high solid waste generation capacity as compare to other municipal corporations in Mumbai Metropolitan Region. Municipal Corporation of Thane, Kalyan-Dombivali, Bhiwandi-Nizampur, Navi Mumbai, Ulhasnagar and Mira-Bhayandar are comparatively small. We have estimated the solid waste till 2031 for all municipal corporations.

At present, solid waste in Brihanmumbai Municipal Corporation is estimated as 8837 Metric Tones. The solid waste in Mumbai city is increasing because of growth of population, health facilities, commercial units, institutions, welfare centers etc. Municipal solid waste will be 10000 Metric Tones in 2020. After 2031, it will touch 12000 Metric Tones every day. It will be a moderate change in the solid waste generation in city. Therefore Municipal Corporation must develop capacity to handle such increasing solid waste with changing time. Such solid waste generation requires planning for collection from household level, streets, carrying

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capacity, segregation, dumping and process of solid waste. We have also estimated the solid waste of municipal corporations of Thane district.
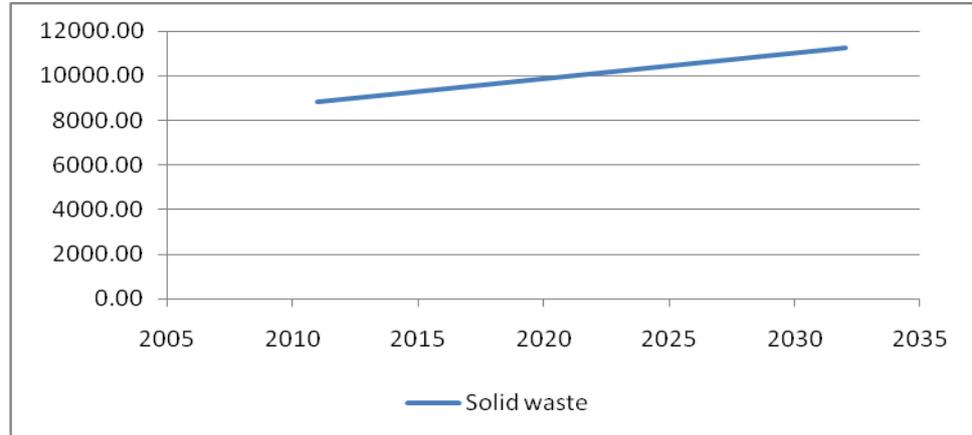

FIGURE 3 - GENERATION OF SOLID WASTE IN MUMBAI CITY (MT)

Population in the municipal corporations of Thane district is continuously rising. It further leads to the rise in the educational and health institutions, shops and commercial units etc. Due to continuous rise in the real estate prices in Mumbai city, population is also shifting in suburbs and in Thane district.

More transport facilities and developing infrastructure in the municipal corporations help people to move in suburbs and neighboring areas. Municipal corporations in Thane district are not growing equally in terms of population and institutions. It is depending on the transport facilities, real estate prices, available amenities and other facilities etc.
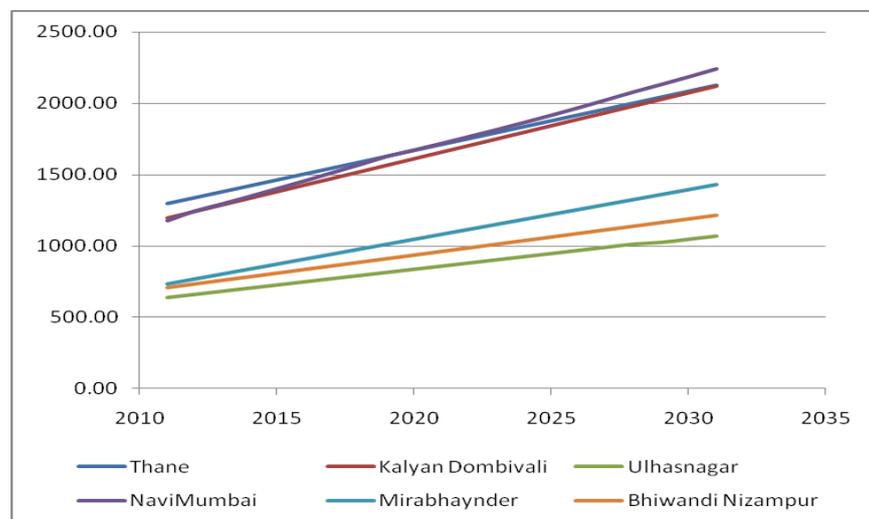

FIGURE 4 - GENERATION OF SOLID WASTE IN MUNICIPAL CORPORATIONS OF THANE DISTRICT (MT)

Solid waste in Navi Mumbai is rising fast. It is 955.66 Metric Tones (MT) in 2011 but it will be above 2000 Metric Tones after 2031. It is a planned and modern cyber city in Mumbai metropolitan region. Therefore population and commercial and others units will increase fast. The solid waste generation in Thane city in

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2011 is 1061 Metric Tones but in 2031 it will be more than 2000 Metric Tones. Population in Thane city is also growing fast. All other units will also rising with population. Thane is an immediate proximate city to Mumbai. Therefore more people afford and adjust to live in Thane city. The solid waste in Mira-Bhayandar, Bhiwandi-Nizampur and Ulhasnagar is not much different. But the solid waste in Mira-Bhayandar will rise very fast. Most of the people of western suburb will shift in Mira-Bhayandar area. Solid waste will be close to 1500 Metric tones in 2031. In all the municipal corporations, solid waste generation will rise with more or less number.

5. REGRESSION RESULTS

We have used Ordinary Least Square (OLS) regression to examine correlation of the solid waste generation in the municipal corporations in Mumbai metropolitan region with other factors. We have regressed total solid waste generated on waste generated by different types of units. The regression model is used separately for Brihanmumbai Municipal Corporation and Municipal Corporations of Thane district.

$Y_{it} = \alpha + \beta x_1 + \beta x_2 + \beta x_3 + \beta x_4 + \varepsilon$, where:

- Y_{it}: It is dependent variable. It is defined as the solid waste generated by the all units at time t in particular Municipal Corporation.
- α : It is intercept.
- β: It is co-efficient.
- x_1 ……..x_n : Independent variables
- ε: Error term

The results are presented in Table 4.

TABLE 4 - REGRESSION FOR BRIHANMUMBAI MUNICIPAL CORPORATION

Variables	Coefficient	Standard errors	T test
Population	-0.05	0.04	-1.21
Municipal dispensaries	217.84*	1.85	117.68
Private centerities	0.06	0.05	1.22
Private market	0.15**	0.05	2.96
Permitted factories	-0.29*	0.05	-5.11
Fire hydrants	-0.06	0.04	-1.44
Municipal industrial estate	-0.22*	0.05	-4.32
Municipal recreation centers	-0.09	0.05	-1.75
Government welfare centers	0.12***	0.04	2.6
Municipal welfare centers	217.91*	1.85	117.53
Constant	5238.74	229.88	22.79
R^2 square=1 Adjusted R^2=1 Root MSE= 0.0005			

*Significant at 1 percent, **Significant at 1 percent, ***Significant at 10 percent

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In Mumbai city, solid waste generation is positively co-related to municipal dispensaries, private markets, government and municipal welfare centers. Municipal dispensaries are providing various types of medicines to patients. Many patients are treated regularly in city. Therefore per capita solid waste generation is more in such dispensaries. Many people in city visit private commercial markets. In these visits, many people do shopping of different goods and commodities. In such process, various types of solid waste are generated. Now mall and super markets are developed in city. In government and municipal welfare centers, many food items are served and consumed by people therefore it leads to more solid waste generation. Solid waste management is negatively co-related to permit factories, municipal industrial estate. Permitted factories are lower in city and they are getting close due to various problems. In permitted factories production and employment is low, therefore less solid waste is generated in city. Municipal recreation centers have good plan for collection of solid waste. Few people visit such centers in city. Therefore solid waste generation is low. We have used ordinary least square regression to examine the possible co-related factors of solid waste in Municipal corporations of Thane district.

TABLE 5 - REGRESSION FOR MUNICIPAL CORPORATIONS OF THANE DISTRICT

Variables	Co-efficient	Standard error	T test
Population	1.12*	0.08	12.59
Industry	0.7**	0.18	3.74
Health Institutions	0.48	0.77	0.62
Shops	0.75	0.85	0.87
Hotels	2.02*	0.05	34.19
Theaters	1.74***	0.76	2.29
Primary schools	1.42**	0.53	2.64
Secondary schools	0.64	0.58	1.1
Colleges	-0.23	0.86	-0.27
Post graduation institutions	0.45	0.71	0.64
Constant	-0.94**	37.31	-2.52
	R^2=1.00 Adj R^2=1.00 Root MSE=0.008		

*Significant at 1 percent, **Significant at 1 percent, ***Significant at 10 percent

In Municipal corporations of Thane district, solid waste is positively co-related to the population, industry, hotels, theaters, primary school. Population is continuously rising in all Municipal Corporation of Thane district. It leads to more solid waste generation in each corporation area. Waste is created while preparing food, cleaning, paper, old cloth and furniture. Hotels, industry and theaters and primary schools are also rising in municipal corporations. Industries are either shift from Brihanmumbai municipal corporation area or new factories are established. Therefore solid waste generation is positively co-related.

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Hotels and theaters will rise in all the municipal corporations. They are the recreation activity and they are increasing with population growth. Primary schools are rising and they are generating solid waste in all the municipal corporations. The result is statistically significant and positive. This is mainly because population is increasing. Overall conclusion is that the solid waste generation is rising in all the municipal corporations of Thane district.

6. POLICY IMPLICATION

Solid waste management is neglected issue of urban development in the Mumbai Metropolitan Region. Due to economic growth, urbanization and population, the urban services and amenities has fallen short. Urban municipal corporations lacks of adequate capacity, institutional and financial capabilities and skilled manpower. Economic resources are inadequate for collection, transportation, processing and final disposal of solid waste. The present system is inefficient, unscientific, outdated.

Population coverage of solid waste collection is very low. There is irregular street sweeping and transportation and disposal of solid waste. The solid waste is not collected due to financial and infrastructural, technical constraints. The accumulation of wastes in the street increases contact of germs, insects, rats and other diseases vectors. Uncollected solid waste also causes the stagnation of water the breeding of mosquitoes. Children are especially vulnerable to the risks associated to solid wastes. The adverse effect of solid waste to soil, air, water and health of human being is much higher. During the rainy season, solid waste is not collected and transported efficiently. In recent years, solid waste management has attracted much greater attention all over the world. Solid waste management problems are basically urban problem (WHO, 1996). Municipal corporations are expected to collect the unit level solid waste.

At the community level, solid waste has to get segregated. Community bins must be provided for dry and wet solid waste. Dry solid waste must be composted at community level or in each ward. The wet waste must get processed at community level. Municipal corporations can generate electricity from wet solid waste. The Municipal Corporations must identify the new locations of dumping grounds. The waste collection, segregation and dumping must get modernize with new machines and equipments. Municipal corporations must involve the private sector in solid waste management and cleanliness in cities. The services and technological innovations have opened up new areas to the private sector. Global trends shows that the private sector has been able to mobilize funds necessary to finance infrastructure projects and that it is willing to accept risks provided the institutional environment meets certain minimum standards and the projects are properly structured (GOI, 2009). Private sector has economic resources and it can easily invest in the sweeping with modern machines, waste collection and transport vehicles. Private sector can develop scientifically managed dumping grounds in municipal corporation area. Solid waste management cannot be

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left to local level initiatives as community organizations lack sufficient resources or capacity to provide such a service in its entirety.

Policy makers need to give such areas more civic autonomy or provide via the state government, a modicum of basic environment services (Shaw, 2005). Recent years have been cash strapped municipal bodies gradually diverting themselves of their direct roles in provision of solid waste management, moving towards public private partnerships as a solution to their inability to handle conservancy operations efficiently. At the same time, there is rapidly growing awareness of the environmental and public health, consequences of the manner in which waste has been handled till now in India (Srinivasan, 2006). Municipal Corporations must have the broad objective of city cleanliness and health of the people. Clean city environment adds more investment and economic productivity of people. Immediate steps in this direction will reduce the incidence of illness and mortality. In order to increase the standard of living of population, such policies are required on immediate basis.

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