Integrated approach to solid waste management in Pune city

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Abstract

The solid waste is increasing in Pune city due to growth of population, urbanization, higher per capita income and standard of living, changing lifestyle and food habits. The solid waste created by the household units, shops, restaurant and commercial units are higher. Solid waste is inevitable task in urbanization process and it will increase in future. The collection, segregation, storage, transports and processing of solid waste needs planning and more investment. Clean city improves standard of living by reducing different diseases. Public private partnership is more useful in solid waste management. Government and Municipal Corporation must encourage local management through collection, transport and segregation and disposal of solid waste. Public awareness and segregation at source, rules and regulations related to solid waste will bring good change in solid waste management.

Keywords: Urbanization, management, lifestyle

Introduction

The management of solid waste is one of the challenges facing any urban area in the World (Zerbock Olar and M.S. Candidate 2003). Human activities create waste and the ways that waste is handled, stored, collected and disposed of can pose risks to the environment and public health. Solid waste can be defined as non liquid material that no longer has any value to the person who is responsible for it (Zhu Da et.al.2008). It is mainly generated from the houses, commercial, industrial and hospitals etc. It is an unwanted material left from the different process. Solid waste comprises of plastic, paper, glass, rags, food items and vegetables etc. It is continuously rising because of urbanization, income growth and changing lifestyle and food habits. Due to rising income and influence of western life style, the consumption of products that have shorter life spans and higher volumes of papers and plastic is increasing. These products as well as changes in food choices are adding to the volume of waste. Solid waste should get deposited by households and commercial units in community dust bins. Managing solid waste is a major challenge for cities in the developing world. Municipal solid waste management is a costly service that consumes between twenty to fifty percent available operational budgets for municipal services, yet services no more than seventy percent of the urban in habitants (Bartone C. et.al 1990).

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In Pune city, the rag pickers collect solid waste from homes and streets. Street sweepers also collect waste while sweeping various streets. Rag pickers visit every day to different households and collect waste and segregate it. These waste pickers consist of male, female and children of different age groups. The waste pickers are poor and they do not have access to the water supply, health care and sanitation. They carry big bags which have huge weight and consist of iron plates, plastic, politic bags and bottles on their heads or on their backs. The waste collection from the big bins in the street is hazardous task. Some of the women end up with factures from falling while entering in big bins or uneven surface. There is no transport facility for carrying the big bags of solid waste. Most of the waste picker women complaint of back bone pain. During monsoon, waste pickers come into electricity contact with bare electric wires. It causes causality to them. If rag pickers get injured by accidents and burns and admitted in any public health care hospital then they do not get the adequate health treatment. Usually, health staff of hospitals ignores rag pickers during treatment.

Most of the rag pickers do not have health insurance. Any illness causes them a huge financial loss. It affects on their future income, diet and drinking water. Some health inputs such as food and drinking water are directly purchased from market and they are based on daily earnings. The daily income from collecting and selling waste is very low. Therefore most of the women and men rag pickers are anemic and undernourished. Most of the time, during solid waste collection, police harass them and asking them for bribes or put them into jail. The universal coverage of solid waste by rag pickers is undoable. The households and commercial units throw their waste in open surface, rivers and small ponds. The solid waste creates smell and environmental pollution in the city and affects on the health of the population in city. In the city, the waste generated needs to be regularly collected, segregated, stored and transported and processed. The administrative system is required for collection of solid waste up to the processing of solid waste. Because of rising urbanization and inadequate manpower and investment, the solid waste is not collected regularly in entire municipal area. The municipal corporation and government do not have the rules and regulation which will prohibit the solid waste thrown in the open surface, rivers or ponds.

The first section of the paper explains about the structure of the solid waste in the city. The solid waste according to its constituents is presented in the second section. The third section of the paper explains about the regression result. The last section deals with the policy implication and conclusion.

Data and methodology

We have collected data from the census 2001 for city population. The census 2001 provides the ward wise population in Pune city. We have estimated the ward wise solid waste. City development report has provided insight to study solid waste management in Pune city. Environment report and transportation report has provided data input for the study. The solid waste management system of the metro cities such as Mumbai, Delhi, Kolkatta and Chennai is also studied. We have used Tobit regression to examine the correlation of total waste with other factors which creates solid waste in city. The data is analyzed in stata@10 software.

History of solid waste management in Pune city

The Kagad Kach Patra Kastakari Panchayat (KKPKP) is an association of waste collectors. It is established in 1993. Waste pickers are self employed workers but they are working for Municipal Corporation. They are not paid by Municipal Corporation of Pune. They pick up and sell recyclable scrap from municipal solid waste. It is the only means of their livelihood. The KKPKP successfully argued with Municipal Corporation for issuing identity cards to rag pickers. In 2007, KKPKP is replaced as Solid Waste Collection and Handling (SWACH) and became operational in 2008. It is improving the standard of living of the waste pickers and manages the solid waste in city. Over the period of time, the municipal corporation has planned to manage solid waste through its system in city. In Pune city, rag pickers are visiting houses and collect the solid waste. The waste pickers ranks lowest in the urban occupational hierarchy, even within the informal sector (Chikarmane P. and Narayan L. 2000) At the same time community solid waste storage system is practiced in city and it consists of different types of bins. Household deposit their solid waste in bins located at street corners and at specific intervals. The containers generally are constructed of metals, concrete or of both types in city. The containers used for the household storage of solid wastes are of many shapes and sizes. These community storage arrangements are conveniently located in corporation area. The PMC's ghanta trucks also collect garbage from households. Even though the storage arrangements are conveniently located in city, solid waste tends to be thrown around the storage area, roadside gutters etc. It happens partly because of indiscipline among people and partly by rag pickers and stray animals. The waste in community bins is carried by the containers up to the dumping ground.

Nature of solid waste in Pune city

In Pune city, solid waste is mainly generated from the households, theaters, hospitals, hotels and restaurants. The commercial units and shops are also generating maximum solid waste in city.

Table 1 Solid waste in Pune Municipal Corporation (2011)

Type of unit	Solid waste (Tonne a day)	Percent
Households	1985.02	76.28
Theaters	17.87	0.69
Hospitals	8.65	0.33
Hotel	64.32	2.47
Restaurants	435.20	16.72
Shops and Commercial units	91.11	3.50
Total	2602.17	100.00

Table one shows that total 2602.17 tonnes of solid waste are generated each day in Pune city. Households are generating 1985.02 tonnes of solid waste in city. It consists of kitchen waste, vegetables, flowers, leaves, fruits, paper and bulbs etc. The theaters are generating 17.87 tonnes of solid waste. It is generated during the various movie plays and it is especially at interval time. People purchase ready made food and throw the food and papers in dust bins. Packed water is purchase and bottles are thrown in dust bins. It is only 0.69 percent of the total solid waste. Hospitals are also generating solid waste and it is 8.65 tonnes in Pune city. Biomedical waste refers to any waste that includes anatomical, pathological, infectious, hazardous and other waste generated in health care facilities. It includes newspapers, magazines, paper bags, leaving of

foods packaging and discarded flowers. In addition, broken syringes, discarded splints, masks, disposable apron rubber gloves and broken glass ampoules etc. generated by other routine activities add to the daily waste stream. Now, trend is growing towards disposable, sterilized and reused material. But it depends on the hospital preferences and it is varying from hospital to hospital. Hotels are generating solid waste and it is 64.32 tonnes. Approximately 435.20 tonnes solid waste was generated by restaurants. It is 16.72 percent of the solid waste. Shops and commercial units are also generating waste. It is 91.11 tonnes. It is 3.50 percent of total waste. Commercial waste consists of wooden crates, carbon paper etc. Commercial sector like shops, offices, hotels etc. all use the community waste dust bins and their wastes are also collected along with the household wastes except in a rare number of commercial complexes where they pay a negotiated fee to the municipal authorities for collecting wastes from their premises. Most of the shops do not open before 9 am and so do not put out their waste out until that time. It is left mostly on the street until the next day's collection. It adds next day's solid waste collection.

Constituents of solid waste

Total 2602.17 tonnes of solid waste is generated every day in Pune city. It is important to understand the constituents of the solid waste in Pune city. It helps for segregation and process.

Table 2 Constituents of solid waste

Particulars	Total solid waste	Percent
Fermentable matter	1691.411	65
Paper	208.1736	8
Plastic , rubber, leather	182.1519	7
Metal	104.0868	4
Glass	156.1302	6
Inert materials	260.217	10
Total	2602.17	100

Table two shows that 65 percent of the solid waste comprises of the fermentable matter. It is followed by the inert materials and it is 10 percent of the total solid waste. The papers comprises of the 8 percent of the total solid waste in city. The paper, plastic, rubber, leather, metal and glass are 25 percent of the total solid waste.

Management of solid waste

Pune Municipal Corporation collects solid waste and transport up to the disposal site. Regularly funds are allotted for solid waste management in municipal corporation area. Therefore Municipal Corporation claims for necessary infrastructure for collection, storage, segregation, transportation, processing and disposal. In Pune Municipal Corporation, whole responsibility of solid waste management is given to health department. The medical officer of health department of the municipal corporation is responsible for solid waste management. Therefore health department is accountable for collection, storage, segregation, transportation, processing and disposal of solid waste. The solid waste collection and transport is managed

through a team of workers and a fleet of vehicles and dumper placers. Health department employ sanitary inspectors for solid waste management. Municipal Corporation is employing more than two thousand sweepers. The solid waste is also collected through rag pickers. There are more than four thousand rag pickers appointed by the municipal corporation for segregation. They are appointed for the five ghantagadis in city. But not all rag pickers are employee of the municipal corporation and no regular payment is given to them. They carry door to door collection in municipal corporation area. Most of the households pay them Rs.10 per month which is depending on their service and area. Municipal Corporation is extending their services such as waste storage and segregation to all 18 ghantagadies in city. But it will be additional economic burden on Municipal Corporation. At present in Pune Municipal Corporation, there is no specific organizational structure for solid waste storage, collection, segregation etc. The Pune Municipal Corporation has a decentralized pattern of solid waste segregation and disposal at it sources. Dry waste is collected by the rag pickers and other NGO's for recycling.

Primary and secondary collection

Primary collection means collection from source or roadside dustbins. The secondary waste collection means designated ramps at strategic locations. The primary and secondary arrangements overlap in Pune city. There is no clear distinction between primary and secondary collection points. There are few primary collection points in PMC. These primary points are in form of bins provided on the roadsides. Households and other waste generators put their solid waste at street corners and local open spaces where ever it is possible. In city, dust bins are over burdened of daily solid waste. These points are collection points depending on secondary and primary collection point. Pune Municipal Corporation has put five areas for door to door collection where rag pickers collect waste from individual households. The PMC has provided 84 dumper placer vehicles containers with about 1.0 to 1.5 tonnes of refuse–carrying capacity each. They are used for collection and transport of solid waste from the collection points to the disposal sites. There are two JCB loaders meant for loading waste from open secondary collection points. There are 2690 bins and they are insufficient therefore at source segregation and recyclining is encouraged. Municipal Corporation is employing NGO'S for solid waste segregation at source and at disposal sites by using the services of more than 4000 rag pickers (PMC 2006).

Process and disposal

PMC has shifted the dumping ground from Kothrud to Urali Devachi in 1999. It is located 25 kilometer away from city. The area of dumping ground is 43 acres. The second future land fill waste disposal site is located at Yewalewadi of 17.5 acres. The plan is to develop Urali Devachi 120 acres for waste processing and disposal facility. The funds are received from government of India under the scheme of Airfield town's project. The Pune Municipal Corporation has adopted the decentralized system of waste disposal at local level. The wet waste can be disposed by vermiculture.

Future forecast of solid waste in city

It is important to understand the solid waste generated by the various units in city over the period of time. We have assumed that the population in city will rise and the restaurants, hotels and theaters will rise in proportion of population in the city.

Table 3 Forecast of solid waste in Pune city (tonnes)

Type	2011-12	2021-22	2031-32
Population	2034.83	2513.14	2783.84
Theaters	18.31	22.62	25.05
Hospitals	8.87	10.96	12.14
Hotels	66.15	83.59	92.51
Restaurants	447.57	565.66	625.98
Shops and commercial units	93.69	118.4	131.05
Total	2669.42	3314.32	3670.58

The solid waste from all the components in current year is 2602 tonnes. We have estimated solid waste generated by various units up to 2030. The solid waste from household units will rise due to growth of population and number of units. In proportion to population, commercial units and shops will rise in all the wards of city. Restaurants and hotels are equally required for the growing population. If people are visiting these hotels and restaurants then solid waste will increase in the city. We have estimated that the solid waste in the city in the year 2025 will touch approximately to 3500 tonnes per day. For storage and carrying, Municipal Corporation needs to do quick, efficient transport arrangement and technological arrangements. Therefore after 2030, Municipal Corporation of Pune should prepare to collect storage and transport and decompose of more than 3500 tonnes of daily solid waste. It is a roadmap for the municipal corporation to develop its capacity for solid waste management. We have not estimated the solid waste generation by industrial units. The festivals celebration such as Depavali, Ganesh chturhi, New year etc. adds to the total solid waste in city.

Regression result

The tobit regression (Greene W.H. 2003) is used to examine the correlation between total solid waste and various selected factors. The dependent variable is used as the total solid waste generated by the different categories. We have regressed total solid waste on the type of waste generated by units.

The model is defined as follows

$$Y^*i=\beta_1+ \beta_2\ pop+ \beta_3 res + \beta_4 hos + \varepsilon i$$

Where

$Y^*i>0$, It is a dependent variable. The independent variables are explained as follows,

Pop: population in i^{th} year and t period

Res: Restaurant in city in i^{th} year and t period

Hos: Hospitals in i^{th} year and t period

εi : constant term

We have not used the ordinary least square method for regression analysis. The ordinary least squares estimates are smaller in absolute value than the maximum likelihood estimates. The results are presented in the following table.

Table 2 Tobit regression result

Variables	Coefficients	Standard error	T ratio
Population	1.01*	5.06	2.00
Hospital	-0.07*	0.00	-5808.98
Restaurants	1.36*	6.38	2.10
Constant	0.00*	0.00	0.36
LR Chi2(3)=2932.87, log likelihood =198.52,Prob>chi2=0.00, pseudo r2=1.16			

- *All variables are significant at 5 percent

Table two explains that the population growth is positively correlated with the solid waste generation in Pune Municipal Corporation. The population growth is creating more waste due to change in income, taste pattern and commodities type. Therefore, it is positively co-related to total solid waste. The hospital waste is also negatively co-related to total solid waste. Most of the hospitals are using the new instruments with reuse and disposable capacity. They usually generate less solid waste. The solid waste is positively co-related to the restaurants in the Pune city. Most of the restaurants are serving the food which creates the waste. Due to higher income most of the people eat food in the restaurants in city. Such food habits are creating more solid waste in city. Such results are statistically significant and positive.

Policy implication

In Indian cities solid waste generation rate is on the increase (Dhere A.M.et.al 2008) .Improper solid waste management causes all types of air, soil and water pollution. Indiscriminate dumping wastes contaminate surface and ground water supplies. Solid waste clogs drains; create stagnant water for insect breeding and floods during rainy seasons. Insect and rodent vectors are attracted to the waste and can spread diseases such as cholera and dengue fever. Financial health of the municipal corporation plays an important role in waste management. But institutional weaknesses and improper technology are the weak points. Proper infrastructure can help to tackle solid waste problem in city. For solid waste management comprehensive policies from household to the dumping ground are required. Municipal Corporation can strengthen its capacity and institutional arrangement to handle all solid waste in city. To handle all the solid waste in city, Municipal Corporation must take help of NGO's, researchers, universities and colleges. People's participation is essential to ensure a well managed system. There is also need to conduct an education campaign on waste management and health related issues in school (UNEP 2007). Municipal Corporation must spread messages

through radio, television, newspapers and hoarding about the advantages of clean city. Such efforts will reduce the open waste and waste at storage sites. There is need of scientific planning of the solid waste collection at each household, collection points and easiest way of transportation up to land fill sites. An increase in population has put tremendous pressure on budgetary resources. The unbundling of services and technological innovations have opened up these areas to private sector participation (MoF 2009, Clairvair O. S. 2006). Municipal Corporation must involve private sector in collection, transport and decompose of the solid waste management in city. It will increase the coverage and collection capacity of the solid waste in city. Private sector has money to invest in machinery, transportation of solid waste etc. They can bring the modern machinery to collect solid waste in the city. The municipal corporation has to keep information system about population, waste created, stored etc. The updated information helps for planning and action of solid waste in city. Waste collected needs to be segregated in to different types and decomposition of the dry waste require at the ward level. It will help to reduce the cost of collection and transport. Efficiency and efficacy of service provision have significant implication for public health and sustainability of operations (Srinivasan K. 2006). Municipal Corporation must pass the laws against the households and commercial units which are throwing the waste at open sites, ponds and rivers. Punishment should be given to all those involved in such activities. In municipal budget, city planning and solid waste management should be given more funds. People of the city must demand cleanliness in surrounding area for health and living standard. Development should bring about benefits to the whole community, must mitigate or reduce negative impacts that are caused by exploitation of resources and economically must increase the overall affluence of society (Mangkoedihardjo S. et.al 2007). Otherwise municipal corporation and government will continue its traditional activities without collecting solid waste in the city. For a growing metropolitan city, cleanliness should be given first priority.

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