

Full Length Research Paper

Integrated approach to solid waste management in Pune City

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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 (MC) 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.

Key words: Urbanization, management, lifestyle.

INTRODUCTION

The management of solid waste is one of the challenges facing any urban area in the World (Zerbock and Candidate, 2003). Human activities create waste and the ways that waste is handled, stored, collected and disposed off 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 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 et al., 1990).

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 complain 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 they do not get the adequate treatment. Usually, health staff of hospitals ignores rag pickers during treatment.

Abbreviations: **KPKP**, Kagad Kach Patra Kastakari Panchayat; **MC**, Municipal Corporation; **PMC**, Pune Municipal Corporation.

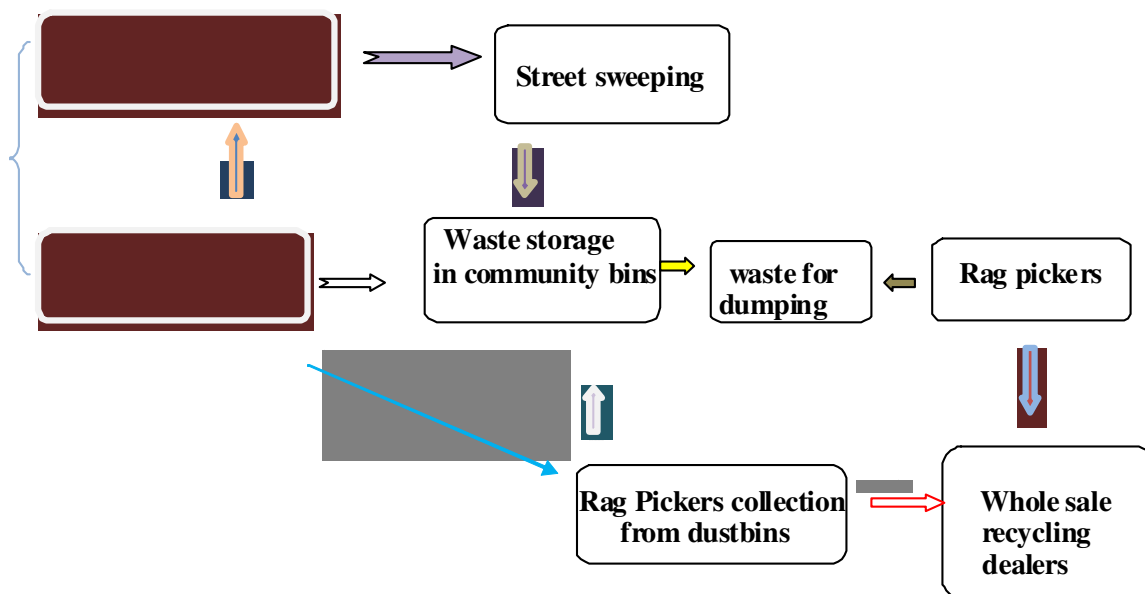


Figure 1. Solid waste management structure in Pune city. Source: By author.

Most of the rag pickers do not have health insurance. Any illness causes them a huge financial loss which affects 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 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 (MC) and government do not have the rules and regulation which will prohibit the solid waste thrown in the open surface, rivers or ponds.

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 MC 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 MC for issuing identity cards to rag pickers. In 2007, KKPKP is replaced by 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 MC has planned to manage solid waste through its system in the city. A solid waste management system in Pune city is presented in Figure 1.

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 and Narayan, 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 show that total 2602.17 tonnes of solid wastes that are generated each day in Pune city. Households generate 1985.02 tonnes of solid waste in the city which consists of kitchen wastes, vegetables, flowers, leaves, fruits, paper and bulbs etc. The litters are generating 17.87 tonnes of solid waste. It is generated during the various movie plays at interval time. People purchase readymade food, bottled drinks and packed water and get rid of them after they must have been through with them into the dust bins, which amount to only 0.69% of the total solid waste. Hospitals are also generating solid waste of about 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. The growing trend towards disposable, sterilized and reused material depends on the hospital preferences and it varies 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 which are 16.72% of the solid waste. Shops and commercial units are also generating wastes which are 91.11 tonnes and are 3.50% 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, and the next day waste is added to it before they are collected.

Constituents of solid waste

Total of 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. This helps in segregating and processing the waste.

Figure 2 show that, 65% of the solid waste comprises of the fermentable matter, followed by the inert materials and which is 10% of the total solid waste. The papers comprises of the 8% of the total solid waste in city. The paper, plastic, rubber, leather, metal and glass are 25% of the total solid waste.

Management of solid waste

Pune Municipal Corporation (PMC) collects solid waste and transports them up to the disposal site. Regularly funds are allotted for solid waste management in MC area. Therefore, MC clamors 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 MC 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. MC 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 MC for segregation. They are appointed for the five ghantagadis in city. But not all rag pickers are employee of the MC and no regular payment is given to them. They carry door to door collection in MC area. Most of the households pay them Rs.10 per month which is depending on their service and area. MC is extending their services such as waste storage and segregation to all 18 ghantagadis in city which 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 PMC has a decentralized pattern of solid waste segregation and disposal at its 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. PMC 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 recycling is encouraged. MC 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 ha. The second future land fill waste disposal site is located at Yewalewadi of 17.5 ha. The plan is to develop Urali Devachi 120 ha for waste processing and disposal facility. The funds are received from government of India under the scheme of Airfield town's project. The PMC 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 (Figure 3).

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

Table 1. Source: Compiled from data.

Type of unit	Solid waste (Tonne a day)	%
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

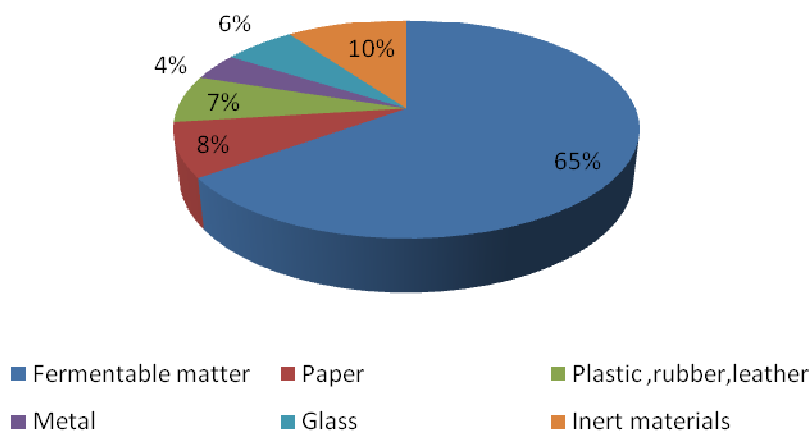


Figure 2. Constituents of solid waste.

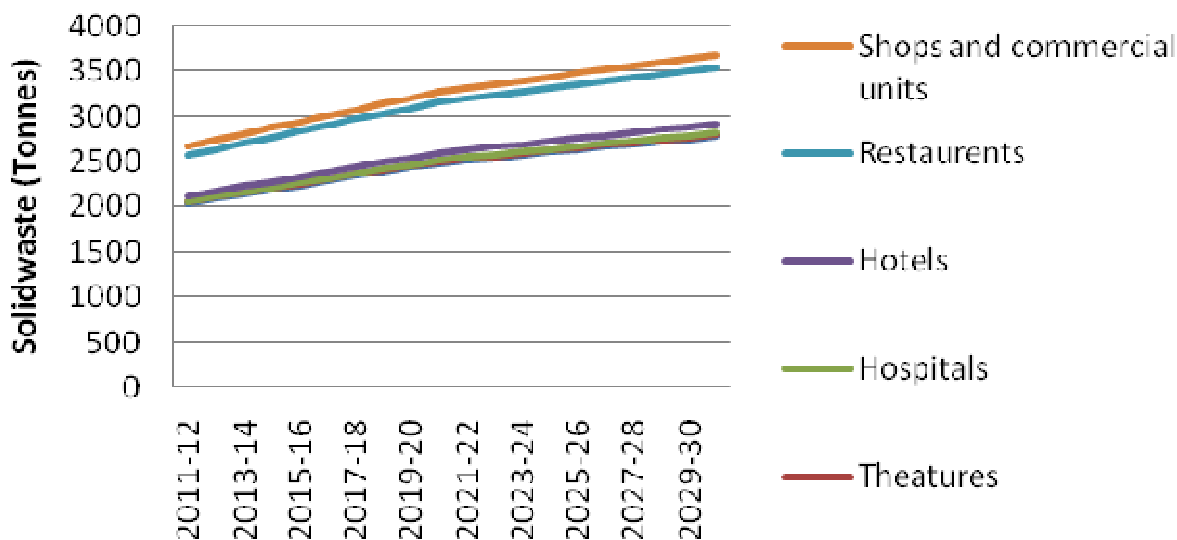


Figure 3. Solid waste in Pune City.

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, MC needs to do

quick, efficient transport arrangement and technological arrangements. Therefore after 2030, MC 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 MC to develop its capacity for solid waste management. We have not estimated the

Table 2. Tobit regression result.

Variable	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%.

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, 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:

$$Y^*i = \beta_1 + \beta_2 \text{pop} + \beta_3 \text{res} + \beta_4 \text{hos} + \epsilon_i$$

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

Pop: Population in ith year and t period

Res: restaurant in city in ith year and t period

Hos: hospitals in ith year and t period

ϵ_i : 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.

Table 2 shows 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 that sell food are the one that generate they 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 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 MC 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. MC can strengthen its capacity and institutional arrangement to handle all solid waste in city. To handle all the solid waste in city, MC 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). MC 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 (Ministry of Finance, 2009; Clairvair, 2006). MC must involve private sector in collection, transport and decompose of the solid waste in city. This will increase the coverage and collection capacity of the solid waste in city. Private sector has money to invest in machinery and transportation of solid waste etc. They can bring the modern machinery to collect solid waste in the city. The MC 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, 2006). MC 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 et al., 2007). Otherwise MC 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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