Iran. J. Environ. Health. Sci. Eng., 2010, Vol. 7, No. 2, pp. 173-180

MUNICIPAL SOLID WASTE MANAGEMENT IN KOHIMA CITY-INDIA

R. Chatterjee

Birla Institute of Technology, Mesra, Ranchi, India

Received 30 june 2009; revised 10 December 2009; accepted 15 January 2010

ABSTRACT

This paper presents an overview of current solid waste management practices in Kohima, Nagaland, India and suggests solutions to some of the major problems. The levels of socio-economic development determine the quantity and composition of solid waste. Higher the level of economic development, greater the proportion of waste composition. The total population of the city is 1,32,836, among those, 90% population is predominantly tribal. Hence, solid waste is not that much problem in rural economy compared to urban areas. As a result of that, the problem of municipal solid waste management is not yet felt in the rural areas of Nagaland. Compared to that, the concentration of population with higher densities in Kohima towns as well as unmanaged growth of settlements are among major causes leading to the problem of municipal solid waste affecting public health and natural environmental systems. So the total elimination of the waste is an impractical suggestion, rather than it should be managed in an effective manner. The surveys have shown that the collection process is deficient in terms of manpower and vehicle availability. Bin capacity provided is adequate but locations were found to be inappropriate, thus contributing to the inefficiency of the system. At this time, no treatment is provided to the waste and waste is dumped on open land at Dhapa after collection. Lack of suitable facilities (equipment and infrastructure) and underestimates of waste generation rates, inadequate management and technical skills, improper bin collection, and route planning are responsible for poor collection and transportation of municipal solid wastes. This study was on field visit, secondary data collection, interviews with different individuals who were directly or indirectly involved with the project and also through the discussions with the relevant Kohima Town Committee officials to get a clear idea about the present situation of the town. The effective management of municipal solid waste has become a monumental challenge in the town with high population density and experiencing the problem of rapid urbanization. This study mainly focuses on the issue of management of municipal solid waste in Kohima town and also describes its existing systems, the way of dealing with the present upcoming problems and also suggests new innovative approach for effective management of municipal solid waste in Kohima town. The overall objective was to create an efficient, reliable and holistic system for management of municipal solid waste, so as to achieve a cleaner environment and improve the quality of life.

Key words: Municipal solid waste, Socio-economic developments, Urbanization, Economic development, Rural, environment

INTRODUCTION

Environmentally acceptable management of municipal solid waste (MSW) has become a global challenge due to limited resources, an exponentially increasing population, rapid urbanization and worldwide industrialization. In developing Asian countries, these factors are further exacerbated by inadequate financial resources, inadequate management and technical skills within municipalities and government authorities.

Waste generation is not rare in urban areas or any part of the world. The only aspect that may differ is the way of managing or handling the wastes. The explosion in world population is changing the nature of municipal solid waste management

*Corresponding author: E-mail: rajch_2001@yahoo.com
Tel: 033-233 46 128, 0943 04 64 865

mainly from a low priority, localized issue to an internationally social problem. The problem of managing municipal solid wastes is growing day by day, which results into a direct threat to the public health and to the environment.

Improper management of solid waste has been reported by several researchers in different cities of developing countries (Berkun *et al.,* 2005; Sharholy *et al.,* 2008; Imam *et al.,* 2008; Chung *et al*., 2008). Inadequate management of solid waste in most cities of developing countries leads to problems that impair human and animal health and ultimately result in economic, environmental and biological losses (Sharholy *et al*., 2008).

More than 90% of the MSW generated in India is directly disposed on land in an unsatisfactory manner (Das *et al.,* 1998). The problem is already acute in cities and towns as disposal facilities have not been able to keep pace with the quantum of wastes generated. It is common to find large heaps of garbage lying in a disorganized manner in every nook and corner in large cities.

An effective, efficient, suitable, systematic and sustainable waste management system is still non-existent in the Kohima city. The objective of this paper is to analyze some of the strengths and deficiencies in the current MSW management (MSWM) system in Kohima and propose feasible solutions like implementation of MSW Rules 2000 throughout the city, setting up of a system for waste collection, segregation of waste at source into biodegradable and non biodegradable and development of sanitary landfill as well as waste processing facility, capacity building for various stakeholders.

MATERIALS AND METHODS

The methodology adopted for management of MSW, included collection of information pertaining to solid waste management (SWM), from published documents, data available with the agencies and through consultations. It was done through primary surveys, especially on the assessment of the physical and chemical characteristics of wastes, socio-economic surveys, and consultations to understand the felt needs and priorities of the communities and the key stakeholders. In addition, secondary data was collected on the existing facilities available, such as sweeping staff, implements for primary collection, storage capacities, transportation facilities, existing institutional and organizational framework for SWM, operational and maintenance costs towards SWM, major wastes generating sources, existing collection routes and collection frequency, different maps on the existing and proposed disposal sites and cost estimation for SWM for certain years.

To maintain the proper management of MSW, a survey was carried out using a pre-designed questionnaire, which involved randomly selected households. The questionnaire was designed to assess the source, quantity, composition of waste generated per person per day. The sample collection procedure was based on the methodology of expert committee. Solid waste was collected from 10 different sampling points after proper selection so that the sampling points were distributed uniformly all over the study area. These points were selected based on the type of area, such as commercial, institutional, market and residential.

In the methodology of MSW management, it requires certain basic things, such as collection and storage, transportation, processing, treatment and disposal. To apply this in a proper and effective manner, different formats have been compiled for data collection through urban local bodies (ULB). These can be also used in different comprehensive training programmes conducted for the ULBs. Knowing the limitations of the urban local bodies, these formats are prepared with full efforts. Using these formats, the process of collection and storage, transportation, processing, treatment and disposal can be done in a systematic manner. It can be described as follows:

Collection

The process of collection can be done in the following way (Ref. MSWM in Virar Town):

Format 1 – Streetwise Data:

-Identification of the street/road/lane/small passages by name or number.

- Identification of junctions of roads/streets.
- Length, width and type of surface.
- Identification of the generators and quantity of waste on both sides of the streets.

- From residential layout of buildings, high rise buildings and bungalows.

Format 2 – Sector wise Data:
- It is done through compilation of the information collected in Format 1 and entering it it in this format.
- It is also available through lists on each side of the roads.
- Can be obtained from shopping centers, hospital buildings, hotels, resorts, markets, slums, etc.

Format 3 – Route Wise Collection:
- Separate routes should be planned for each category of wastes.
- In a shift of eight hours, number of trips should be assigned for each route.
- Vehicle/ Equipment name/ Number, type, capacity and trips assigned need to be specified for the route.
- At the end of each trip, the weight of the contents and time taken for collection should be recorded in the program sheet of each route.
- The backlog of collection points should be highlighted and reported for corrective action.
- The status should be reported at the end of each shift to the officer in charge.
- The corrective action should be so timed that there should not be any complaints from the users.
- A route plan was drawn out for collection of waste from door to door. In the residential area, the wastes are stored in a segregated manner within the complex and then carried up to the transport vehicle at a certain time or when the bell rings. Collection of waste can also be done from community bins, transfer points and transfer stations.

Transportation

In case of transportation of waste, the wastes are collected from doorstep to community bins and bulk transportation of waste is done from community collection units to centralized or decentralized processing sites. In the single stage system the wastes are collected from the households and are directly transported to the processing site or disposal sites. Transportation system involves minimum manual handling and exposure to the waste and processing of the waste. Two types of models are used for the transportation of wastes. Depending on the quantity of wastes generated per day, such as 5MT, 10MT, 15MT, 20MT, up to 50MT, and more than 50MT the transportation of wastes have been done. Waste generated more than 50MT per day and having disposal sites of more than 5km, is classified as "A" class council cities, where waste transportation is done accordingly to the city lay out. Different types of vehicles are used such as, truck, tipper truck, tractor-trailer and dumper placer for the transportation of wastes. Transportation of waste can also be done through manual loading or hydraulic loading systems.

Processing and disposal

According to the MSW rules 2000, the wastes must be stabilized or processed completely and only the residues are disposed in the sanitary landfill sites.

Through aerobic windrow composting the wastes are processed at the disposal site.

Waste to Energy (WTE) process, such as biogas plant or any appropriate technology is used. To process the biodegradable wastes locally at the point of generation, such as in societies or at homes, composting or vermicomposting may be used.

Compost processing is done with the help of manual screening.

For the graded product of compost, full infrastructure, full machinery and fine screening is required and only inert mass will go to the landfill.

At present, for the disposal of wastes, open dumping is also practiced. For the purpose of disposal of wastes to the dumpsites, the different upgradation of the dumpsites can be noticed. (open dumping to controlled dumping), which involves reduction of the working area of the site to a more manageable size. Engineered landfill and scientifically designed sanitary landfill sites are also used as dumping of wastes in the disposal site. The lifetime of the existing dumpsite should be assessed for the purpose of disposal of wastes.

The stabilization of waste can be done through windrow composting, spraying biocultures to

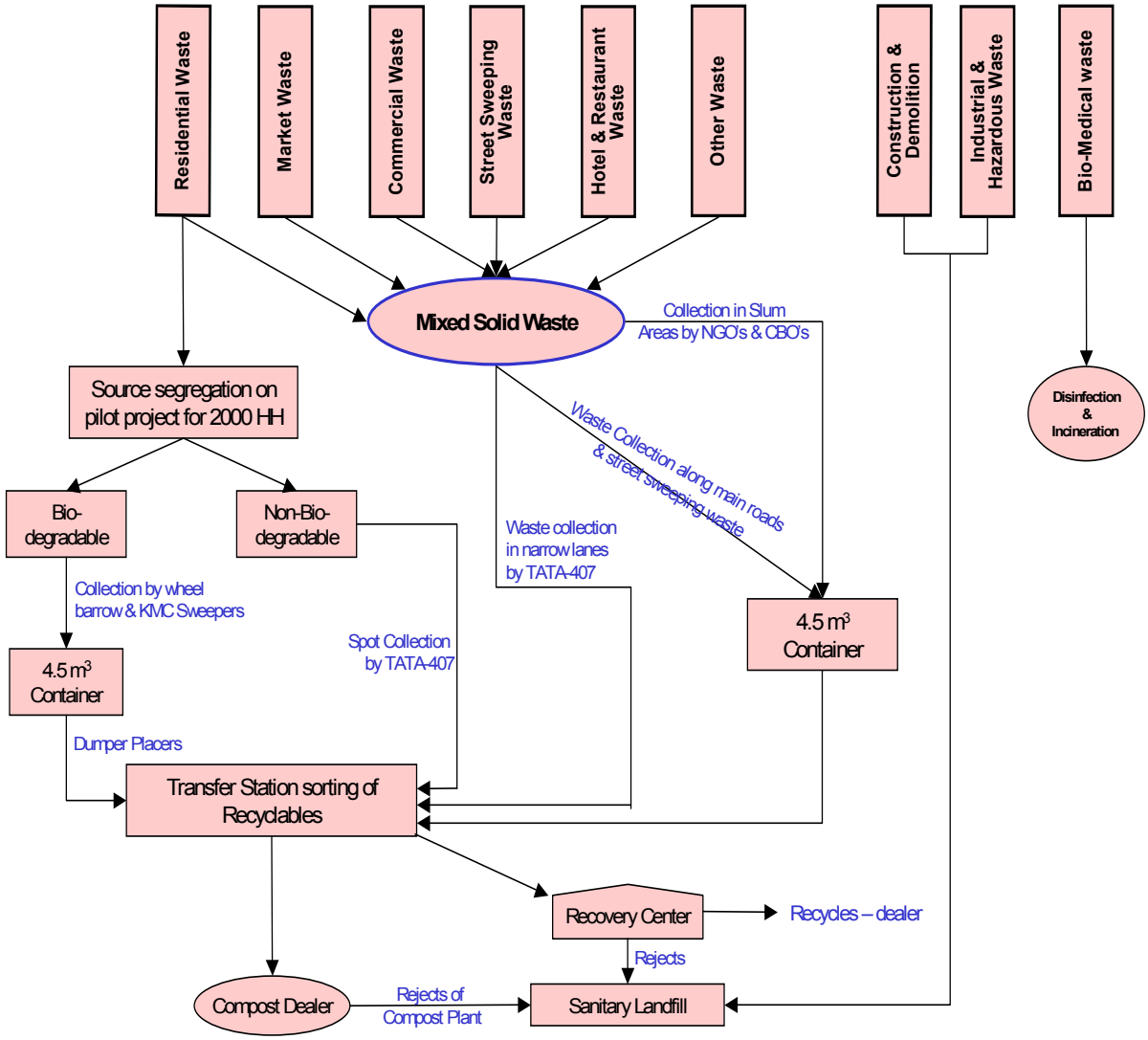

Fig. 1: Municipal solid waste management system in Kohima City

hasten the process of composting which results into less generation of leachates. Pushing the waste to one side of the dumpsite can also do the stabilization of waste. The inert materials should cover the waste, either by soil or construction debris.

Compressing the waste and covering the material, can improve the landfill operation and reduce the nuisance of flies, stray animals, birds etc.

Ultimately if the existing sites are inadequate for 25 years of use, then it is necessary to acquire new sites.

RESULTS

MSWM in Kohima city depicts certain crucial issues or major findings through the city. It involves managing activities associated with collection, generation, storage, transportation, processing and disposal of wastes in an environmentally compatible manner, along with adopting the principles of economy, energy, aesthetics and conservation.

In the year 2006, the projected waste generation was 0.40 kg of waste per capita per day. For the GKPA, the waste generation projection was made up to the year 2041. By 2041, the generation of waste should be increased in a large amount with respect to the growth of the population. The

projected waste generation is shown in Table 4.
In Kohima, the responsibility of the waste management lies with the Kohima Municipal Council (KMC). The present system of municipal solid waste management gives a broader view of the entire system.
At present, the amount of waste generated from the Kohima city is around 54 MT per day. Out of this, around 35-40% of wastes are collected from the entire city as per the present data available.

Table 1: Sources of solid wastes in Kohima city

Waste generating sources	Proportion of wastes (%)
Residential	57.00
Commercial (markets, shops, etc.)	19.00
Institutional (offices, banks, colleges, schools, etc.)	15.50
Industrial	3.00
Biomedical wastes in hospitals and nursing homes	0.50
Construction and demolition wastes	5.00

Source: Kohmia Municipal Corporation

Waste generation and quality

The daily generation of wastes (54 MT) are generated mainly from the major sources, such as residential (57%), commercial (19%), and institutional (15.50%), industrial (3%), biomedical wastes (0.50%) and construction and demolition (5%).
Physical and chemical analysis of municipal solid waste in Kohima was performed on samples collected from 5 locations, 3 from the city and 2 from disposal sites shown in Tables 2 and 3.
In the composition of MSW, large amounts of biodegradable wastes are present. Almost 64% is composed of biodegradable waste. The biomedical waste generated is 155Kg. In the chemical analysis of MSW in Kohima, it has been observed that the moisture content is very high compared to other materials. Municipal solid wastes are also composed of papers, plastics, glasses, metals, inorganic matters, etc. The composition of MSW varies from place to place, on the basis of factors such as population, source, average income, social behaviour, industrial production and market for waste materials.

Segregation, collection and transport

In Kohima, the responsibility of waste management lies with the Kohima Municipal Council. Different types of wastes such as plastics, scrap metal and bottles, i.e. all recyclable wastes, are generally segregated and either sold to rag pickers at household level or scavenged at community bins or disposal sites.
Waste storaging capacity is inadequate in the city. There are around 30 storage bins available. Few mechanized containers of 4.5 m^3 capacity are introduced in the areas for the proper enhancement of the waste storaging capacity.
In the collection of municipal waste in Kohima city, main sources are dustbins and community bins. Two types of community bins (large and small) are used for a total of approximately 1200 collection bins. Specified capacity colour bins are used to collect segregated biodegradable and non-biodegradable wastes at source.
Eight different types of vehicles are used for the transportation of wastes. The average waste-carrying capacity of vehicles is around 2.5-4.48 m^3. On an average, 20 MT per day of wastes are transported as compared to the average American cities of 95 kg/m^3, (Tchobanoglous *et al.,* 1993), which makes compaction largely unnecessary. Spillage occurs during the transportation of wastes, as vehicles are not covered or properly sealed. Manual or hydraulic loading and unloading may be performed. Wastes are cleared daily with the majority of vehicles carrying out 2 trips and a few carrying out only 1 trip.

Treatment and final disposal

The total area of the disposal site is about 56.53 acres located at the southeast of the city. All municipal wastes are dumped on a sloping site about 8 km from the city. Wastes are generally dumped in open streams or burnt in empty spaces. The Siste Ru river flows just below the disposal site and, as a result, the majority of dumped wastes accumulate in the river. Huge amounts of biomass, suited for use in soil nourishment to increase fertility, are lost through the burning of wastes. Frequency rates for irregular disposal are high. Almost 49% of the population is served by an unofficial service, whereas only 31% by the official service. Wastes are collected on a weekly/

biweekly basis and in regular/irregular manner.
The disposal of biomedical waste is usually carried out by open burning at the disposal site using old tyres. Processing or recycling procedures are not currently applied in Kohima. The only recycling performed is carried out to some extent by rag pickers exposed to harsh, unprotected conditions.

DISCUSSION

Solid waste is a serious environmental problem in both developed and developing countries. In recent years, most developing countries have improved their municipal solid waste management practices. The increasing amount of wastes generated by rapid urbanization in these countries is usually not properly managed. Solid waste management systems in developing countries must deal with many difficulties, including low technical experience and low financial resources which often cover only collection and transfer costs, leaving no resources for safe final disposal (Collivignarelli *et al*., 2004).

Table 2: Results of physical analysis of the solid wastes

Parameters	Different locations				
	Para medical Ward	Agri Colony	T-Khel market (Porter land)	Disposal site-I, NH-39	Disposal site-II, NH-39
Biodegradable organic fraction (%)	62.8	73.6	77.0	69.8	69.3
Paper and cardboard (%)	7.9	6.2	6.1	8.6	9.2
Plastics (%)	8.2	4.3	4.9	4.9	3.8
Metals (%)	3.8	2.6	2.1	2.3	4.9
Glass or ceramics (%)	4.1	1.8	3.9	2.9	3.2
Bio-resistant (cloths, leather, napkin), (%)	1.5	1.9	1.2	1.2	1.0
Inert (stone, brick, earthen wares), (%)	2.0	1.6	1.3	2.3	3.1
Fine earth (ash, dust, soil), (%)	3.9	3.9	1.6	2.8	2.2
Others (wooden substances, rubber, bone, coal), (%)	5.8	6.1	2.1	5.2	4.3

Source: Primary Data

As the present scenario of the entire city of Kohmia, and concerning problems associated with the municipal solid waste management, it is variable in terms of characteristics and quantity of the wastes from place to place. At present, no treatment is provided for collected solid waste. The same prevailing situation is also present in Kolkata, where more than 90% of the total collected waste is directly disposed in Dhapa in an unsatisfactory manner without providing earth cover. This method of dumping has led to heavy metal pollution in groundwater, since no leachate collection and treatment option is available (Goel and Hazra, 2009).

Sanitary landfilling with leachate and gas collection is the recommended method for disposal of MSW. So, the recommendations should not be taken up as a whole. These are the

Table 4: Projected waste generation in Kohima city

Year	2006	2011	2021	2031	2041
Population	132836	147382	176166	208512	246797
Waste generated (mtpd)	54	63	83	108	141

Source: Kohmia Municipal Corporation

Table 5: Estimated cost for MAWM in Kohmia city

Items	Units	Unit cost (INR)	Total (INR Million)
A. Primary collection			2.95
(i) Litter dustbins (Capacity 30L)	350	3000	1.05
(ii) Household bins (Pilot Project Basis)-capacity 20L	2000	300	0.6
(iii) H.D PVC bags (Pilot basis)	2000	50	0.1
(iv) Wheel barrow	200	6000	1.2
B. Secondary collection and transportation			15.9
(i) 4.5cu.m container	22	80000	1.76
(ii) Medium tipper trucks (3.5 m^3 capacity)	4	700000	2.8
(iii) Dumper placer trucks (4.5 m^3 capacity)	6	850000	5.1
(iii) Land cost for transfer station	LS	LS	0.5
(iii) Civil work for transfer stations (1 no.)	LS	LS	1.234
(iv) Large tipper trucks, from transfer station to disposal site (Two existing tipper truck of 5cu.m capacity also can be used and hence they can be considered as one 10cu.m tipper truck. These vehicles can run up to year 2012.)	3	1500000	4.5
C. Maintenance and garage facilities			1.78
Land cost	LS	LS	0.1
Equipment cost	LS	LS	0.5
Civil work for garage	LS	LS	1.182
D. disposal system			33.17
EIA study	1	1000000	1
Civil work for the electronic weigh bridge	1	122787	0.123
Cost of weigh bridge	1	1000000	1
Land cost for the new disposal site	LS	LS	6
Civil work for the new disposal site (including the approach road to the site as well as to the bottom of the site)	LS	LS	13.246
Bulldozer	1	6500000	6.5
Tipper truck	2	1500000	3
JCB	1	2300000	2.3
E. composting			11.24
Civil work for the compost plant	LS	LS	6.538
JCB	1	2300000	2.3
Loader bobcat JS75	2	1200000	2.4
F. miscellaneous			2.0
Market availability and investors study component for the compost plants and composts	L.S	L.S	1
Awareness campaign	L.S	LS	1
Project cost (A+B+C+D+E+F)			67.037
Detailed design (4%) of Project Cost	L.S	LS	2.681
Total (Cost)			69.72

several attempts to improve better management of municipal solid wastes in the city of Kohima. The following recommendations may serve as a policy tool for decision makers, planners and all those involved in the management of municipal solid wastes:

- Disposal of wastes in the streets, open spaces, in vacant areas or into drains should be banned.
- Levy of administrative charges for littering of streets.
- Source segregation of wastes.

Primary collection of wastes, i.e. door-to-door

collection of wastes should be implemented.
- Waste collection should be performed on a regular basis, i.e. daily collection.
- Street sweepers should be equipped with individual containerized wheelbarrows, metal plate and tray, long handled broom and protective gear.
- Mechanized containers should be used to enhance storage capacity.
- Litter bins should be provided at public places, such as—bus stands, taxi stands, market places.
- Abolition of open waste storage sites and manual collection.
- Upgrading of existing dumpsites or disposal sites.
- Open burning of biomedical wastes should be prohibited.
- Scientific incineration facility should be available inside or outside the premises.
- The safe and environmentally friendly process of aerobic composting requires less land space and should be applied in management of MSW.
- Sitting, construction and operation of sanitary landfills should be done systematically.
- Capacity building programme should be established.
- Public awareness strategies should be taken into consideration.

ACKNOWLEDGEMENTS

The author would like to thank the staff of Kohima Municipal Council for their immense corporation in this research.

REFERENCES

Berkun, M., Aras, E., Nemlioglu, S., (2005). Disposal of solid waste in Istanbul and along the Black Sea coast of Turkey. Waste Management, **25**: 847–855.

Chung, S.S., Carlos, W.H.L.o., (2008). Local waste management constraints and waste administrators in China. Waste Management, **28** (2): 272–281.

Collivignarelli, C., Sorlini, S., Vaccari, M., (2004). Solid Wastes Management in Developing Countries.CD-ROM of ISWA 2004 World Congress. 17–21.

Das, D., Srinivasu, M., Bandyopadhyay, M., 1998. Solid state acidification of vegetable waste. Ind. J. Environ. Health, **40** (4): 333–342.

Goel. S., Hazra.T .,(2009). Solid waste management in Kolkata, India: Practices and challenges. Waste Management, **29** (2009) :470–478.

Imam, A., Mohammed, B., Wilson, D.C., Cheeseman, C.R., (2008). Solid waste management in Abuja, Nigeria. Waste Management, **28** (2): 468–472.

LASA (LEA Associates South Asia Pvt Ltd), (2006). Solid Waste Management in Kohima Town, unpublished report of LASA.

Sharholy, M., Ahmad, K., Mahmood, G., Trivedi, R.C., (2008). Municipal solid waste management in Indian cities – A review. Waste Management **28** (2): 459– 467.

Tchobanoglous, G., Theisen, H., Vigil, S., (1993). Integrated Solid Waste Management, 'Engineering Principles and Management Issues'. McGraw-Hill Inc., NY. ISBN: 0- 07-06-3237-5.