DOI 10.15415/jce.2016.31002

Challenges and Responsibilities in Successful Management of Municipal Solid Wastes in India

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Received: October 08, 2016 | Revised: October 10, 2016 | Accepted: October 17, 2016

Published Online: September 05, 2016

Abstract Management of Municipal Solid wastes (MSW) is a genuine problem to all Municipal Corporations irrespective to their size, population or financial condition in India. Scientific technologies are available for pollution free hygienic disposal of all biodegradable solid wastes by converting them to good quality compost and also for systematic recycling of non-biodegradable wastes for their beneficial utilization. Machineries are also available for converting Municipal solid wastes to energy for partial fulfillment of highly demanded electricity. But still all Municipal Corporation in India mainly depend on old open dumping of solid wastes in some low lying dump-yards creating known environmental pollution hazards. The Municipal authority, the district administration and the common citizens have to play a constructive role for overcoming this problem. Important challenges faced by Municipal authorities all over India are non-preparedness to handle huge quantity of MSW generated daily, lacking of awareness by common people on benefits of segregation of MSW at source, non-availability of infrastructure as well as expert / skilled manpower for scientific disposal of MSW, accurate forecasting about city wise MSW generation and proper encouragement to Public – private partnership (PPP) model for efficient management of MSW. Everyone is essential part of this management system. Citizens have to take the responsibility for segregating solid wastes at home before handing over to Municipal workers and for refraining themselves from throwing out any solid wastes. Municipal corporations have to consider MSW as important resource material, use it for beneficial purposes through vermicomposting and recycling, and to stop dumping of MSW at outskirt by unnecessary spending money on its transportation. It is mainly found that installation of costly machinery for mechanical composting and electricity generation have sometimes become not

Journal of Chemistry, Environmental Sciences and its Applications
Vol. 3, No. 1
September 2016
pp. 19–34

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much fruitful to Municipal authorities due to lack of their expertise as well as maintenance and repairing problem of machineries. Scientific disposal with the help of NGOs and Entrepreneurs are found more effective, employment generative and cheaper than adopting costly mechanical system. Paradigm shift in thought process of every citizen can change the situation of management of municipal solid waste successfully.

Keywords : Mechanical Composting, Municipal solid wastes, Solid waste management rules, Vermicomposting, Waste to energy.

1. INTRODUCTION

The new Solid Waste Management Rules 2016 has been announced by the Ministry of Environment, Government of India which is applicable in Municipal areas, urban agglomerations, census towns, notified industrial townships and even different areas under the control of Indian Railways, Airports, Defence establishments, various state and central government organizations, sea ports, special economic zones, place of pilgrims and of historical importance, etc. During announcement of this rule, the revised version of Solid Waste Management rules 2000 at a press conference, the then Minister of State (Independent Charge) of Environment, Sri Prakash Javadekar mentioned, "about 62 million tons of solid wastes are generated annually at present in India, out of which 5.6 million tons is plastic waste, 0.17 million tons biomedical waste, 7.9 million tons hazardous waste and 15 lakh tons is e-waste. The per capita waste generation in Indian cities ranges from 200 grams to 600 grams per day". He also pointed out that only about 75 – 80 % of the Municipal solid wastes i.e. 43 million tons get collected, out of which 11.9 million tons (22 – 28 %) is treated while 31 million tons solid waste is dumped in landfill sites (PIB release, 2016). The major concern is the continual increase of waste generation from 62 million tons in 2016 to about 165 million tons in 2030 and 436 million tons in 2050. If dumping of solid waste continues at present rate without treatment, the additional requirement of land for dump yard will be about 1240 hectares per year and by 2031 the requirement of land will be 66000 hectares.

2. MUNICIPAL SOLID WASTES OF INDIA

Central Pollution Control Board Report of the year 2013 illustrated that there was sharp increase in Municipal solid waste generation in 59 cities of India (35 Metro cities and 24 State capitals) from 39031 tons per day in 2004-2005 [as surveyed by National Environmental Engineering Research Institute (NEERI),

Nagpur] to 5,592 tons per day in 2009-2010 [as surveyed by Central Institute of Plastics Engineering and Technology (CIPET), Chennai]. The report also mentioned that total about 127486 tons per day solid wastes was generated in 34 states of India during 2011-2012, out of which 89334 tons per day (i.e. 70%) was collected and 15881 tons per day (i.e. 12.4%) was processed or treated (CPCB, 2013). Major input of wastes in Municipal solid wastes (MSW) come from three important sources i.e. from individual houses as Residential wastes, from hotels, office buildings, educational institutes, etc. as Commercial & Institutional wastes and from streets, parks, recreational areas, etc. as Municipal services wastes (Table 1).

The MSW usually contain about 35 – 65% carbonaceous materials, 1 – 6% plastic; 2 – 6% broken glassware; 1 – 3% ferrous materials and 12 – 49% miscellaneous materials (tire, tube, cloths, rubbish, ash, etc.). Composition of solid wastes of six Indian cities is given below in Table 2 (Sannigrahi, 2011). It is interesting to note that about 60 percent of MSW in India is compostable and about 15% is recyclable in nature. The average moisture content is 47% and the average calorific value is 1500 Kcal/kg. The density of MSW varies from 150 kg/m^3 to 800 kg/m^3. The change in composition of MSW during 1996 to 2011 as mentioned in Planning Commission Report (2014) is shown in Table 3. Considerable change has been noticed in case of recyclables like plastic and paper wastes while biodegradables and inert materials remained almost same or slightly decreased. As countries develop economically and become more urbanized, the waste composition undergoes a change as the increase in the paper, paper packaging, plastics, multi material packing items and consumer products but decrease in the organic share (Kaushal et al., 2012).
Source : Sannigrahi (2015).

Table 1: Sources and Types of Municipal Solid Wastes.

Sources	Wastes generated by	Components of solid wastes
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, glass, metals, e-wastes, vehicular wastes, ashes and house hold hazardous wastes (pins, blades, medicines, etc.)
Commercial	Hotels, Restaurants, Markets, Stores, Office buildings	Paper, cardboard, plastics, Thermocole packing materials, Straw, woods, canteen wastes, glass, metals, e-wastes, vehicular wastes and hazardous wastes
Institutional	Government and Private Offices, Schools and Colleges	
Municipal services	Street sweeping, parks, recreational areas, beaches, landscaping	Paper, cardboard, plastics, dirt, dust, leaves, food wastes, vegetable matters, Lawn and tree trimmings, etc

Source : Sannigrahi (2015).

Table 2: Composition of MSW (%) in different cities of India.

Constituents	Kolkata	Bhubaneswar	Bangalore	Panaji	Ajmer	Delhi
Paper	6	4.1	8	5.8	4.9	5.9
Plastic	4	5.3	6	1.2	6.1	4.6
Glass	6	1.7	6	3.5	2.6	3.1
Metals	3	1.1	3	1.2	1.6	1.2
Vegetable matter	55	56.1	65	60.8	35.5	57.7
Miscellaneous	26	31.7	12	27.5	49.3	27.5

Source : Sannigrahi (2011).

Table 3: Change in composition of MSW (%) with time.

Year	Biodegradables	Paper	Plastic/ rubber	Metal	Glass	Rags	Others	Inert
1996	42.21	3.63	0.60	0.49	0.60	–	–	45.13
2005	47.43	8.13	9.22	0.50	1.01	4.49	4.02	25.16
2011	42.51	9.63	10.11	0.63	0.96	–	–	17.00

Source : Planning Commission Report (2014).

3. CHALLENGES FOR SOLID WASTE MANAGEMENT IN INDIA

Solid waste generation depends on the economy of the people and per capita generation increases with the level of income of the family or individual. Most solid wastes that are generated find their way into land and also in water bodies without proper treatment and causing severe water pollution. Uncontrolled open dumping is a common feature in almost all cities in India (Kumar et al., 2009). Unscientific dumping is prone to flooding and major source of surface water contamination during monsoon and ground water contamination due to percolation of leachate (Mor et al., 2006). Wastes dumped in landfill emit greenhouse gases like methane and carbon dioxide which add to air pollution. In India, estimated methane emission is about 16 million tons per annum in terms of CO_2 equivalent through landfills (International Energy Agency, 2008). Siddiqui and Khan (2011) estimated the annual energy potential from landfill gas available at selected sites in Delhi (Balswa, Gazipur and Okhla) as 8.4 MW, Mumbai (Deonar and Gorai) as 5.6 MW, Ahmedabad (Pirana) as 1.3 MW and Pune (Urli) as 0.7 MW, respectively. Almost all cities in India are facing the problem of limited availability of land for waste disposal. The earlier acquired land for land filling are now either over used or have come in the inside of residential area due to expansion of the cities (Sannigrahi, 2011).

Scientific disposal of solid waste through segregation, collection, treatment/processing and disposal in an environmentally sound manner minimises the adverse impact on the environment. Following challenges have to be overcome for successful management of solid waste.

(a). Non-preparedness of Municipal authorities to handle MSW

Waste quantities are increasing and municipal authorities are not able to upgrade or scale up the facilities required for proper management of such wastes. In many cities and towns, garbage is littered on roads and foot-paths. Lack of organized system of house-to-house collection of waste has created the littering habits. Majority of the municipal authorities do not have preparedness to set up waste processing and disposal facilities (CPCB, 2013). Sharholy et al. (2008) also reported earlier about haphazard dumping of MSW in low lying areas in the out skirt of the city by Municipal bodies of low-income group of cities mainly due to limited knowledge and awareness regarding contamination, waste reduction techniques and other aspects of MSW management.

(b). Lack of proper waste collection procedure

Efforts are being made by many local bodies for creating mass awareness among the citizens for ensuring proper management of MSW including collection, segregation, transportation and storage. Such efforts are confined to a few wards / localities within the city or town. Attempts have also been taken to achieve success by placing separate bins for each category of wastes. But in many cases, the segregated wastes are mixed up again by the municipal workers at the time of transportation and disposal, defeating the purpose of segregation. Lack of segregation derive proper scientific disposal of waste (Singhal and Pandey, 2000). Municipalities well equipped with waste transporting vehicles like trucks, tractors with trailers, dumpers, mobile compactors, etc., are many times not following the waste transportation norms, resulting transporting waste under uncovered conditions and unwanted littering on the way exposing the waste to the public (CPCB, 2013). It is often seen that a substantial amount of waste is left to rot on the streets and / or is dumped into low lying areas, canals, rivers, etc. Several factors like lack of appropriate collection systems, lack of and / or inadequate waste disposal bins and collection vehicles, lack of funds, lack of enforcement of appropriate regulations, etc are responsible for low collection efficiency (Kaushal et al., 2012).

(c). Non-following of proper waste processing techniques by Municipal authorities

As mentioned earlier, house-to-house collection and segregation not fully covered in any city. There is a large gap in between waste collection and

processing. Most of the municipalities have no sanitary landfill facility and follow dumping for disposal of MSW (CPCB, 2013). Since the MSW generated in India has high (more than 50%) organic constituents, high moisture content (dampness) and considerable quantity of inert content, the calorific value of waste is low (800 to 1100 kcal/kg) and incineration is not successful (Kansal, 2002). However, high organic content is advantageous to convert MSW to good quality compost by adopting aerobic / heap composting, or anaerobic / pit composting or vermicomposting techniques. India has an estimated potential of producing about 4.3 million tons of quality compost each year containing about 45 thousand tons of nitrogen, 11 thousand tons of phosphorus and 23 thousand tons of potassium (Saha et al. 2010). Refuse-derived fuel (RDF) technology can also be effectively used in large municipalities for producing power / thermal energy from MSW

As per Central Pollution Control Board compilation report for the year 2013-14, municipal authorities have so far only set up 553 compost & vermicompost plants, 56 bio-methanation plants, 22 Refused Derived Fuel (RDF) plants and 13 Waste to Energy (WtoE) plants in India. The untapped waste has a potential of generating 439 MW of power from 32890 tons per day of combustible wastes, 1.3 million cubic meter of biogas per day or 72 MW of electricity from biogas and 5.4 million metric tons of compost annually to support organic agriculture (Planning Commission Report, 2014).

(d). Forecasting the quantities of MSW

Kaushal et al., (2012) has mentioned that a successful long term planning on MSW management depends on the characteristics of the solid waste and estimation of future quantities. Both planning and design systems require accurate prediction of solid waste generation, but achieving the anticipated prediction accuracy in fast growing regions is quite challenging. Decisions related to treatment choices and disposal options for solid waste management will also get affected by the composition of the solid waste in the future. Srivastava et al., (2008) used Fuzzy regression based approach for forecasting the composition of Delhi MSW while Kumar et al., (2011) attempted to estimate the quantity of MSW of Eluru city in Andhra Pradesh considering four input variables such as population, MSW generated, percentage of urban population of the nation and GDP per capita of the nation in the artificial neural network model.

(e). Implementation of Public – Private Partnership (PPP) in MSW management

PPP mode implementation usually happens at ground level when individually neither public services nor private sector can achieve their respective goals and

aspirations of stakeholders. MSW management appears to be fit case for PPP mode for Indian scenario as it is very costly affair and Municipal authorities alone are unable to accomplice the task assigned as per municipal solid waste management rules (Joshi and Ahmed, 2016). The effectiveness of partnership, well defined relationship, and clear demarcation of role, accountability, and adoptability due to dynamics among the various stakeholders are elementary necessities to make PPP work for MSW management (Ahmed and Ali, 2004). Some Indian companies like Zen Global Finance Ltd (RDF), Enkem Engineers Ltd (Biomethanation in collaboration with Entec, Astria), Global Environmental Engineers Ltd (Biodigestion in collaboration with Paques Pvt, Netherland), Excel Industries (Composting), etc. have started their work in MSW management (Joshi and Ahmed, 2016).

Cleanliness is an essential prerequisite for societal survival. The present citizens of India are living at a time of unprecedented economic growth and changing lifestyles. Unhygienic conditions on the streets and polluted environments in the cities will widen the gap between their expectations and prevailing conditions which will deteriorate the belongingness of citizens with the society. Proper solid waste management is essential for maintaining the quality of life. Improper solid waste management deteriorates public health, causes environmental pollution, accelerates natural resources degradation, causes climate change and greatly impacts the quality of life of citizens (Sannigrahi, 2015). Prime minister Sri Narendra Modiji has started 'Swachha Bharat' program for increasing awareness among locals on proper solid waste management and for keeping surrounding areas as clean.

4. RESPONSIBILITY OF STAKEHOLDERS

The quantity of solid waste generation depends upon standard of living, food habits and degree of commercial activities. Higher living standards generate more wastes (mainly non-biodegradable) than lower living standards. Similarly high income countries generate more wastes per person compared to low income countries. The average per capita waste generation in India is quite low (about 0.34kg/day) as compared to that in china (1.02kg/day), France (1.92kg/day), Germany (2.11kg/day), Australia (2.23kg/day), Denmark (2.34kg/day), United States of America (2.58kg/day) and Switzerland (2.61kg/day) (Hoornweg and Tata, 2012). Solid waste management, therefore, should not be difficult in India. There are three stakeholders in solid waste management system : The common citizen as the generator of solid waste, the Municipal authority / District authority as the Processer / Manager of solid waste and the Central / State Pollution Control Board as the Guideline Maker / Technology provider for proper disposal of solid waste. As per rule the local authorities

(Municipality or District Administration) are responsible for the development of infrastructure for collection, storage, segregation, transportation, processing and disposal of Municipal solid wastes. But at present all the stakeholders should be serious about their responsibility and accountability.

The common citizens, the first stakeholders generate lots of solid waste during various activities but do not feel for its proper disposal and throw away those without segregation either by the side of roads or inside drains or in empty places or in Municipality dustbin. They, on the other hand, feel that removal or disposal of waste materials is the responsibility of Municipality or District Authority. Ecological awareness and citizen participation to segregate waste at source play most critical role to improve the efficiency of waste management system. Joshi and Ahmed (2016) has also mentioned that there is no segregation of garbage at source in India which leads to various environmental problems and it becomes very difficult to segregate waste at transfer station or in landfill or treatment site.

Being second stakeholder, all municipalities or district authorities complete their responsibility by spending 60 percent of their annual budget in collection of solid wastes from various places as well as dustbins using their sweepers and in transportation of those collected wastes to some low lying areas earmarked as dump yard or landfill. The consideration about MSW as an important resource material for further processing of its beneficial use is almost overlooked by the authority everywhere, sometimes due to paucity of infrastructural facility or funds.

Pollution Control Boards (Central or State), the third stakeholder though suggest for different types of processing based on nature of wastes but proper monitoring system is lacking due to lack of experienced manpower. All stakeholders should co-operate each other in proper solid waste management system for saving both mankind and Nature.

5. EXISTING STATUS

Scientific technologies are available for producing good quality organic manure (Compost and Vermicompost) and also for generating good quantity biogas from different biodegradable municipal solid wastes. Considerable quantity of Electricity can be produced from burnable organic and plastic wastes available in Municipal solid wastes. Similarly different non-biodegradable materials like metal scrapes, glass material and plastic wastes can be recycled by respective factories for producing fresh materials, thus saving the vital natural resources.

Used plastics are melted to obtain plastic materials required for making different toys and hard plastic sheets. Used plastics are also chopped, mixed with pitch and used for construction of durable and long lasting road. Indian

Institute of Petroleum, Dehradun has also developed technology to convert plastics into gasoline, diesel or aromatics through the use of a combination of suitable catalysts. The fuels obtained through this process are sulphur free and of ultra high-quality meeting Euro-III standards (Vashishtha, 2014).

Arora Fibres Limited, Silvassa in Dadra & Nagar Haveli recycles 18,000 tons of discarded plastic bottles into polyester yarn used as packaging materials since 1994. The polyester fibre has a huge market in many industries such as automobiles and is also used as packaging material for beverages, food products, pharmaceuticals, consumer and industrial products. Plastic is found clearly profitable for Arora Fibres which touched Rs 34 crore in revenues during financial year 2012-2013. By recycling 10 billion PET bottles, Municipality can save one million square yards of landfill space and eliminate 0.25 million tons of carbon dioxide released into the atmosphere (Nayak, 2013).

As Central Pollution Control Board 2013 status report, some Municipalities have already started processing their solid wastes by constructing composting / vermicomposting plants, Biogas production plants and RDF plants (Table 4 and 5). But the mechanical composting system was found not much popular since the semi mechanized machinery was imported and any mechanical fault led to breakdown due to non-availability of spare parts. Pulverisers got frequently clogged with pieces of rags, plastics, and rubber, etc. and blades were broken due to metal or glass pieces. Waste to Energy combustion (WtoE) for production of electricity from non-segregated solid wastes is no doubt expensive process but it is the best technological solution to recover the energy by reducing the mixed waste up to 90 %

Table 4: Composting/vermicomposting plants installed in different states of India**.**

State	Number of plants (Composting / vermicomposting)	State	Number of plants (Composting / vermicomposting)
Andhra Pradesh	32	Madhya Pradesh	4
Chhattisgarh	15	Maharashtra	125
Delhi	3	Meghalaya	2
Goa	5	Orissa	3
Haryana	2	Punjab	2
Gujarat	86	Rajasthan	2
Himachal Pradesh	13	Tripura	13
Karnataka	5	Uttarakhand	3
Kerala	29	West Bengal	9

Source : CPCB (2013).

Table 5: Number of energy recovery plants in different states of India.

State	No. of RDF plants/waste to Energy plants (PP) / Biogas (BG) plants	State	No. of RDF plants/waste to Energy plants (PP) / Biogas (BG) plants
Andhra Pradesh	3 – RDF, 4 PP	Delhi (UT)	1 – RDF, 1 PP
Chandigarh (UT)	1 – RDF	Gujarat	2 – RDF
Chhattisgarh	1 – RDF	Kerala	2 – BG
Maharashtra	19 – BG		

Source : CPCB (2013).

with better pollution control. Though attempts were taken to install W to E plants first at Timarpur in 1985 and recently at Okhla in Delhi, Bibinagar in Hyderabad and Karimnagar in Vijayawada, but the track record of Waste to Energy in India is not encouraging. The reasons identified for past failures are a) mismatch of the quality of incoming waste with the plant design calorific value, b) inadequate solid waste collection systems, c) high percentage of inert materials and d) manual handling of wastes. The failures are also due to bad planning, lack of inter-institutional cooperation, and lose implementation of contracts and laws (Sannigrahi, 2015). Hence the solid waste utilization scenario in India is not at all encouraging and most of the Municipalities still prefer open dumping of solid wastes.

In India people generally throw both biodegradable and non-biodegradable wastes together. Biodegradables create unhygienic environment as it decomposes quickly. Among non-biodegradables sharpen materials and plastic wastes are trouble creators. Sharpen materials in the form of metal scraps, broken glass materials, shaving blades, rusted pins & nails, etc are available in non-segregated municipal solid wastes thrown in dustbin. The Municipal workers during handling MSW suffer leg and hand injury due to those sharpen wastes present in MSW and infect themselves with many dreaded diseases like eczema, intermycosis, hepatitis, tuberculosis, dysentery, typhoid, cholera, hookworm, roundworm, yellow fever, etc. Plastic wastes block the drains causing overflowing of drain waters and creation of unhygienic environment. Street animals also die due to eating plastic wastes.

In some cities though initiative was taken for making people aware about segregation of solid waste at house itself and for collecting different wastes (biodegradable, non-biodegradable and hazardous waste) separately by putting different types of bin, but it was noticed that Municipal sweepers / workers mixed all wastes together during transportation to dumping ground defeating the original purpose of source separation. Management of mixed wastes is really very challenging job (Sannigrahi 2015).

The compost production following Mechanical Biological Treatment (MBT) technique from non-segregated municipal solid waste is found not much popular in India since the semi mechanized machineries are imported and any mechanical fault led to breakdown due to non-availability of spare parts. Pulverisers get frequently clogged with pieces of rags, plastics, rubbers, etc. and blades were broken due to metal, stones or glass pieces. The majority of the compost samples prepared from mixed wastes fell below the quality control standards for total potassium, total organic carbon, total phosphorus and moisture contents and also exceeded the quality control limits for heavy metals (lead, nickel, cadmium and chromium). According to Saha et al. (2010) 19 MBT plants are installed in Maharashtra, 11 in Himachal Pradesh, 9 in Chhattisgarh, 7 in Orissa, 4 each in Gujarat, Tamilnadu and Uttar Pradesh, 3 in Madhya Pradesh, 2 each in Andhra Pradesh, Assam, Haryana, Karnataka, Pondicherry and Punjab besides one each in Bihar, Delhi, Kerala, Meghalaya, Rajasthan and West Bengal for making compost from non-segregated solid wastes but the high percentage of rejects (about 60 percent) cannot reduce the requirement of large landfill area. Use of source segregated organic portion of MSW will, on the contrary, help to produce good quality compost. Sannigrahi and Sannigrahi (2006) suggested to follow two stage composting technique (initially heap composting in open space followed by vermicomposting following windrow system on the cemented or plastic covered floor surface under the shade) for quick conversion of different organic wastes to nutrient rich compost. If vermicomposting is carried out in low depth tanks connected with 1 inch pipe outlets, Vermi- T, the liquid fertilizer can be produced along with vermicompost, the solid organic manure (Sannigrahi, 2015).

Transportation of solid waste to dump yard is usually carried out using old diesel truck or Tractor-Trolley creating nuisance of air pollution due to falling of unhygienic wastes on road sides and also from excessive diesel burning during running vehicles many times. Existing status of collection of non-segregated municipal solid wastes and its transportation to dumping ground is, therefore, really created alarming situation often objected by general public throughout India.

6. NEEDS FOR PARADIGMS SHIFT IN THOUGHT PROCESS

Instead of waste materials if common people start considering municipal solid waste as important resource material for producing electricity, compost, biogas, fresh metals, fresh plastics, fresh glass, etc. then they will not throw those here and there but they will, on the contrary, take proper care for all materials by segregating at the source. Present approach of segregation of waste materials during collection from dustbin by municipal workers is not at

all preferable being unhygienic since decomposition starts immediately inside the dustbin. If Municipality motivates people to segregate waste materials at source and to keep those separately in a systematic manner then it can purchase all saleable non-biodegradable waste materials from the houses by paying the prices usually offered by local scrap dwellers. In that situation citizens will not throw any waste materials at the outside. Infrastructure is required to store different non-biodegradable materials separately for selling those to respective buyers. Proper time bound door to door collection system and ward wise composting facility require a large number of manpower and this will ultimately help to generate more employment to poor and less educated local people. Then the quantity of non-sellable inert waste will automatically be very less in comparison with present situation, resulting requirement of less landfill area and less transportation charge. Savings of expenditure by considerable reduction in MSW transport requirements can be utilized by Municipal authority for payment of salary to newly recruited employees (Sannigrahi, 2015).

It is also interesting to note that whenever the problem of MSW is discussed everyone suggests stopping use of polythene or plastic materials. In fact plastic is the cheapest packaging material. It is not safe to transport any materials without plastic packaging especially during rainy season. Actual trouble creator is thin plastic packets (< 10 micron) used for bringing fish, meat, sweet, food and grocery materials since due to throwing habit of people after use those are either dumped in drains / rivers / landfills or eaten by stray animals. Production of those thin packets should be stopped not the thick plastic packets or sheets.

In place of three stakeholders, it is suggested to consider five stakeholders : the common citizen as generator of waste, the municipal authority / district development authority / local bodies as processor / managing authority of solid waste, the non-governmental organization (NGO) / community association as awareness creator & compost producer, the Pollution control board as latest technology provider and last but not the least one monitoring committee in every district to judge the responsibility and performance of every stakeholder. In solid waste management rule 2016, the Indian government has already constituted a Central Monitoring committee under the Chairmanship of Secretary, Ministry of Environment for monitoring the overall implementation of the rules. The committee constituted with members each from 4 Central Govt. Ministries (Urban Development, Rural Development, Chemicals & Fertilizers, Agriculture), Central Pollution Control Board, 3 States Pollution Control Boards, 3 State Urban Development Departments, 2 State Rural Development Departments, 3 Urban local bodies, 2 census towns, Federation

of Indian Chambers of Commerce & Industry (FICCI), Confederation of Indian Industry (CII) and two subject experts. This 23 members committee will meet once a year for monitoring the implementation of solid waste management rules 2016 (PIB Release, 2016). In the similar pattern every district should have one monitoring committee headed preferably by District Collector to monitor the solid waste management works of the district on half yearly interval.

All stakeholders should share their responsibility seriously for getting success in solid waste management. It has been clearly mentioned above that segregation at source is most vital for reusing and recycling of municipal solid wastes. Every citizen is to be serious on reduction and segregation of waste before handing over the waste materials to municipal workers deployed in door to door collection system. They have to be cautious in keeping close vigil on municipal workers for avoiding remixing of waste materials or burning / throwing of wastes in outskirt. In latest Solid Waste Management Rule, 2016 it is clearly mentioned that 'Generators of solid waste' will have to pay 'User Fee' to waste collector and 'Spot Fine' for littering and non segregation (PIB Release, 2016).. This will not only help to reduce waste creation by common people and its throwing outside but also encourage all for segregation of waste materials at source. The NGOs will organise different awareness program on benefits of segregation and systematic handing over of wastes particularly for residents in residential areas, for students at respective school and colleges, for visitors at bus stand and railway station, for commercial people at markets and for municipal workers at municipality premises. Different NGOs will take the responsibility of ward wise compost farms for producing compost from segregated biodegradable waste materials. For initial start up Government or District authorities have to extend financial help to NGO or to encourage new Entrepreneurs under proper PPP mode, but afterwords this processing will be self sustainable by generating income from selling of composts to farmers. A Cooperative of NGOs may be formed to look after the selling of composts in the pattern of 'AMUL'. Community based biogas system can be installed to utilize kitchen wastes along with animal husbandry wastes under the supervision of community associations. Municipal authority has to be serious on strict implementation of 'door to door' collection system and proper placing of wet / biodegradable wastes in compost yards, dry / non-biodegradable but sellable wastes to respective storing areas and domestic hazardous / inert wastes to scientific landfills. High powered monitoring committee should be unbiased and strict in implementation of 'spot fine system' from defaulters. It has to be kept in mind that all members of municipality, NGOs, district authority, Pollution board and monitoring committee are also generator of waste as common citizen and all of them have to support actively the solid

waste management system of their locality. Municipal authority will empower some of its worker to collect spot fine from defaulters. Pollution Board has to take responsibility to guide different NGOs busy in processing wastes with latest and suitable technology as well as maintenance of product quality. Change in thought process of every citizen is, therefore, necessary to realise that solid waste management is not a single man's job, collectively everyone has to take part in process and play his / her role effectively.

CONCLUSION

Since the starting of Industrialisation all countries are facing problems of proper disposal of municipal solid wastes. In developing and under developed countries where people are not much aware on problems of dumping solid wastes to man and environment and not serious about health and hygiene, the solid waste management system is non-scientific and problematic. But in developed countries the awareness and cautiousness of common citizens forced stakeholders to implement scientific techniques strictly in solid waste management system. No one is daring to throw wastes outsides there. In western countries management of MSW is not at all problematic. Every Municipal authority in India is asking the respective state government either for more land area to use as dumping ground or for costly machineries to process the solid wastes but it is seen that medium scale composting within Municipality area is more economical due to less investment, less transportation cost, easy selling of compost and larger success. It also generates more employment opportunity. Hence Paradigms shift in thought process of every citizen is must for getting success in municipal solid waste management in India.

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