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ISSN : 2454 – 308X | Volume : 03 , Issue : 11 | October – December 2017

Solid Waste Management in India

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Abstract: The abysmal state of and challenges in municipal solid waste management (MSWM) in urban India is the motivation of the present study. Urbanization contributes enhanced municipal solid waste (MSW) generation and unscientific handling of MSW degrades the urban environment and causes health hazards. In this paper, an attempt is made to evaluate the major parameters of MSWM, in addition to a comprehensive review of MSW generation, its characterization, collection, and treatment options as practiced in India. The current status of MSWM in Indian states and important cities of India is also reported. The essential conditions for harnessing optimal benefits from the possibilities for public private partnership and challenges thereof and unnoticeable role of rag-pickers are also discussed. The study concludes that installation of decentralized solid waste processing units in metropolitan cities/towns and development of formal recycling industry sector is the need of the hour in developing countries like India.

Keywords: urbanization; biodegradable; population; solid waste; rag-pickers; recycling,

Introduction: India is the second largest nation in the world, with a population of 1.21 billion, accounting for nearly 18% of world's human population, but it does not have enough resources or adequate systems in place to treat its solid wastes. Its urban population grew at a rate of 31.8% during the last decade to 377 million, which is greater than the entire population of US, the third largest country in the world according to population. India is facing a sharp contrast between its increasing urban population and available services and resources. Solid waste management (SWM) is one such service where India has an enormous gap to fill. Proper municipal solid waste (MSW) disposal systems to address the burgeoning amount of wastes are absent. The current SWM services are inefficient, incur heavy expenditure and are so low as to be a potential threat to the public health and environmental quality. 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.

The present citizens of India are living in times of unprecedented economic growth, rising aspirations, and rapidly changing lifestyles, which will raise the expectations on public health and quality of life. Remediation and recovery of misused resources will also be expected. These expectations when not met might result in a low quality of life for the citizens. Pollution of whether air, water or land results in long-term reduction of productivity leading to a deterioration of economic condition of a country. Therefore, controlling pollution to reduce risk of poor health, to protect the natural environment and to contribute to our quality of life is a key component of sustainable development. The per capita waste generation rate in India has increased from 0.44 kg/day in 2001 to 0.5 kg/day in 2011, fuelled by changing lifestyles and increased purchasing power of urban Indians. Urban population growth and increase in per capita waste generation have resulted in a 50% increase in the waste generated by Indian cities within only a decade since 2001. There are 53 cities in India with a million plus population, which together generate 86,000 TPD (31.5 million tons per year) of MSW at a per capita waste generation rate of 500 grams/day. The total MSW generated in urban India is estimated to be 68.8 million tons per year (TPY) or 188,500 tons per day (TPD) of MSW. Such a steep increase in waste generation within a decade has severed the stress on all available natural, infrastructural and budgetary resources. Big cities collect about 70 - 90% of MSW generated, whereas smaller cities and towns collect less than 50% of waste generated. More than 91% of the MSW collected formally is land filled on open lands and dumps. It is estimated that about 2% of the uncollected wastes are

burnt openly on the streets. About 10% of the collected MSW is openly burnt or is caught in landfill fires. Such open burning of MSW and landfill fires together releases 22,000 tons of pollutants into the lower atmosphere of Mumbai city every year. The pollutants include carbon monoxide (CO), carcinogenic hydro carbons (HC) (includes dioxins and furans), particulate matter (PM), nitrogen oxides (NOx) and sulfur dioxide (SO2).

MUNICIPAL SOLID WASTE (MSW): Waste is defined as any material that is not useful and does not represent any economic value to its owner, the owner being the waste generator (10). Depending on the physical state of waste, wastes are categorized into solid, liquid and gaseous. Solid Wastes are categorized into municipal wastes, hazardous wastes, medical wastes and radioactive wastes. Managing solid waste generally involves planning, financing, construction and operation of facilities for the collection, transportation, recycling and final disposition of the waste (10). This study focuses only on the disposal of municipal solid waste (MSW), as an element of overall municipal solid waste management or just solid waste management (SWM).

PERCENTAGE OF RECYCLABLES AND INFORMAL RECYCLING: A significant amount of recyclables are separated from MSW prior to and after formal collection by the informal recycling sector. The amount of recyclables separated by the informal sector after formal collection is as much as 21%. The amount of recyclables separated prior to collection is generally not accounted for by the formal sector and could be as much as four times the amount of recyclables separated after formal collection. Comparing the percentage of recyclables in MSW in metro cities with that in smaller cities clearly shows the increased activity of informal sector in metros and other large cities. Increased presence of informal sector in large cities explains the huge difference in recyclables composition between large and small cities, observed by Perinaz Bhada, et al. In metro cities, which generally have a robust presence of informal recycling sector, the amount of recyclables at the dump is 16.28%, whereas in smaller cities where the presence of informal sector is smaller, the composition of recyclables is 19.23%. The difference of 3% in the amount of recyclables at the dump indicates the higher number of waste pickers and their activity in larger cities.

ECONOMIC GROWTH, CHANGE IN LIFE STYLES AND EFFECT ON MSW: The waste generation rate generally increases with increase in GDP during the initial stages of economic development of a country (16), because increase in GDP increases the purchasing power of a country which in turn causes changes in lifestyle. Even a slight increase in income in urban areas of developing countries can cause a few changes in lifestyle, food habits and living standards and at the same time changes in consumption patterns (16). Therefore, high income countries generate more waste per person compared to low income countries due to the difference in lifestyles.

IMPACT ON MSW GENERATION AND COMPOSITION IN INDIA: Since economic reforms in 1992 – 1993, India has undergone rapid urbanization, which changed material consumption patterns, and increased the per capita waste generation rate. Since 2011, India underwent unprecedented economic growth and the urban per capita waste generation increased from 440 grams/day to 500 grams/day at a decadal per capita waste generation growth rate of 13.6%. The change in lifestyles has caused considerable change in the composition of MSW generated in India too. Following a trend expected during the economic growth of a country, the percentage of plastics, paper and metal discarded into the waste stream increased significantly and the amount of inerts in the collected waste stream decreased likewise due to changes in collection systems. From 1973 to 1995, the composition of inerts in MSW decreased by 9%, whereas organic matter increased by 1% and recyclables increased by 8%. However, from 1995 to 2005, inerts decreased by 11%, compostables increased by 10% and recyclables by only 1%. The increase in compostables and recyclables

observed. increase in recyclable wastes generated due to lifestyle changes, and b) decrease in the overall percentage of inerts due to improvement **in collection.**

POPULATION: India is the second most populous nation on the planet. The Census of 2011 estimates a population of 1.21 billion which is 17.66% of the world population. It is as much as the combined population of USA, Indonesia, Brazil, Pakistan, Bangladesh and Japan. The population of Uttar Pradesh, one among 28 Indian states is greater than that of Brazil, the fifth most populous nation in the world. India's urban population was 285 million in 2001 and increased by 31.8% to 377 million in 2011. Indian urban population is greater than the total population of USA (308.7 million), the third most populous nation.

POPULATION GROWTH: Indian population increased by more than 181 million during 2001 – 2011, a 17.64% increase in population, since 2001. Even though this was the sharpest decline in population growth rate registered post-Independence the absolute addition during 2001-2011 is almost as much as the population of Brazil, the fifth most populous country in the world. It is clear that the scale of populations dealt with in case of India and China are entirely different from any other country in the world. The third most populous nation after China and India is US, with a population of 308.7 million, which is only a quarter of India's population. Urban population in India alone, which is 377 million, exceeds this figure. Indian urban population increased by 31.8 % during 2001 – 2011, which implies an annual growth rate of 2.8% during this period.

IMPACT ON MSW GENERATION AND DISPOSAL: Population growth and rapid urbanization means bigger and denser cities and increased MSW generation in each city. The data compiled for this report indicate that 366 cities in India were generating 31.6 million tons of waste in 2001 and are currently generating 47.3 million tons, a 50% increase in one decade. It is estimated that these 366 cities will generate 161 million tons of MSW in 2041, a five-fold increase in four decades. At this rate the total urban MSW generated in 2041 would be 230 million TPY (630,000 TPD).

HIERARCHY OF SUSTAINABLE WASTE MANAGEMENT: The Hierarchy of Sustainable Waste Management (Figure 10) developed by the Earth Engineering Center at Columbia University is widely used as a reference to sustainable solid waste management and disposal. This report is presented in reference to this hierarchy. For the specific purpose of this study, "Unsanitary Land filling and Open Burning" has been added to the original hierarchy of waste management which ends with sanitary landfills (SLFs). Unsanitary land filling and open burning will represent the indiscriminate dumping and burning of MSW and represents the general situation of SWM in India and other developing countries.

RECYCLING: Reducing and reusing are the most effective ways to prevent generation of wastes. Once the wastes are generated and collected, the best alternative to handle them would be recycling where the materials generally undergo a chemical transformation. Sometimes, reusing can also happen after collection, in cases where informal traders collect materials of no use from households, reshape or repair them and sell in second-hand markets. Unlike reusing a used material, recycling involves using the waste as raw material to make new products. Recycling thus offsets the use of virgin raw materials. It is known that as much as 95% of a product's environmental impact occurs before its discarded (21), most of it during its manufacturing and extraction of virgin raw materials. Thus, recycling is pivotal in reducing the overall life cycle impacts of a material on environment and public health. Recycling however requires a separated stream of waste, whether source separated or separated later on (after collection).

REFUSE DERIVED FUEL (RDF): Refuse Derived Fuel refers to the segregated high calorific fraction of processed MSW. RDF can be defined as the final product from waste materials which have been processed to fulfill guideline, regulatory or industry specifications mainly to achieve a high calorific value to be useful

as secondary/substitute fuels in the solid fuel industry. RDF is mainly used as a substitute to coal (a fossil fuel) in high-energy industrial processes like power production, cement kilns, steel manufacturing, etc, where RDF's use can be optimized to enhance economic performance. The organic fraction (including paper) in RDF is considered to be a bio-fuel and is thus renewable. Since the carbon dioxide released by burning the organic fraction of RDF arises from plant and animal material, the net green house gas (GHG) emissions are zero. The overall green house emissions from RDF are however not zero. This is due to carbon emissions from burning the plastics fraction left in RDF. The amount of GHG emissions from RDF depends upon the composition or organics and plastics in the MSW stream it is being processed from. Using RDF prevents GHG emissions from landfills, displaces fossil fuels, and reduces the volume of waste that needs to be land filled, thus increasing their operating life.

Recommendation:

- There is a dire need to educate and make aware the people to change their habits , so as to store waste at source, and dispose off the waste as per the direction of Municipal council and effectively participate in the activities of Municipal council.
- Clear guidelines relating to the kind of storage receptacles, segregation of waste etc. should be issued, offenders should be penalized.
- There should be segregation of non biodegradable recyclable waste at sources or at secondary collection point and methods like compositing should be used for biodegradable waste.
- There should be segregation of waste at the city level also for disposing the recyclable waste and hazardous waste properly.
- The food waste, vegetable and organic waste produced at sources which are biodegradable should be stored in non corrosive container preferably with cover / lid.
- Dry and recyclable waste should be stored in bag sacks made of plastic / paper / cloth etc.
- All the domestic hazardous waste, electronic equipment waste should be stored in bags / sacks and should be disposed in notified safe areas.
- Separate community bins should be provided for dry and wet waste.

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