View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by DSpace at Waseda University

論　文

A Comparative Study of Municipal Solid Waste Management in India and Japan

Mahajan Niyati *

1．Introduction

Development activities across the globe leads to environmental burdens and the generation of waste is one among them. *World cities generate about 1.3 billion tonnes of municipal solid waste per year, which is expected to reach 2.2 billion tonnes by 2025* (World Bank "Global Review" 2012: 8). The situation is more severe *in lower income countries where waste generation rates would be more than double over the next twenty years* (vii). The Municipal Solid Waste (MSW) generation trend, questions one's readiness to pay the cost of rapid urbanization and industrialization. The improper management and disposal of waste causes emission of Green House Gases such as Methane, affects public health and results in severe land, water and air pollution. It is difficult to achieve absolute avoidance of pollution or risk to human beings, but it can be minimized by using cost effective technical and policy measures which would yield the greatest return to the society. Developed countries like Japan use incineration to reduce the overall quantity of waste disposed. In addition, it has introduced measures to increase the rate of solid waste recycling. Recycling has three main effects: resource recovery, reduced amount of waste disposal to landfills or incinerators, and reduced use of illegal dumpsites. To overcome the waste problem, developing countries like India are trying to make a shift towards the technologies and other methods adopted for waste management that are popular in developed countries. But before making such shifts it is necessary to understand the potential and risk involved in the process.

The paper makes a comparative study of solid waste management (SWM) practices and regulations in India and Japan. The developing countries like India have a scope to learn from the experience of Japan, but need to pragmatically assess the expectations of SWM systems. India need to use appropriate available technologies of waste disposal, increase its focus on recycling and involve the informal sector in waste management to improve the waste situation. The paper is divided into four sections. Section I gives a brief account of waste management regulations in India and Japan. Section II focuses on the waste quantity and composition. In Section III current waste management practices in both the countries have been examined. Section IV analyzes recycling as an

＊早稲田大学大学院社会科学研究科　博士後期課程３年（指導教員　黒川哲志）

option for the effective and efficient waste management and resource recovery.

2. Regulatory Framework

The section gives a brief outline of the regulatory framework on waste management in India and Japan. In India the regulations are more command and control types and have not been proven very successful in improving the waste situation. However, the waste management regulations in Japan are harmonious and have worked well due to community participation. In the British India creation of 'waste, dirt, filth and garbage' in the neighborhood was considered as public nuisance and it was a punishable offense under Indian Penal Code (IPC), 1898 (Klein 2008: 83). Yet the concern for environmental sanitation remained only on paper and hardly served any purpose. Post Independence, Indian Policy makers passed laws to reduce waste and pollution. Many rules have been notified for safe waste management under Environment Protection Act (EPA), like The Hazardous Waste and Chemical Rules (1989), The Biomedical Waste Rules (1998), The Recycled Plastic Manufacture and Use Rules (1999), The Municipal Solid Waste (Management and Handling) Rules (2000), The Batteries Rules (2001), Electronic waste Rules (2011). However, the regulatory framework have not been successfully implemented. For example, the Municipal Solid Waste Rules mandate segregation and storage of waste at source, door to door collection, abolition of open storage, transportation of waste in covered vehicles, waste processing by composting or energy recovery, disposal of inerts by sanitary landfilling and rehabilitation of the existing dump sites. But, a 2014 report of the Planning Commission of India states that in 128 cities except for street sweeping and transportation, compliance was less than 50 percent and in respect of disposal compliance was a dismal 1.4 percent (7). Further, only 22 States or Urban Territories have set up processing and disposal facilities and the rest of the States or Urban Territories have made no effort till 2013 (4). Some of the reasons for the noncompliance of rules include: lack of public awareness, motivation, education; noncooperation from households; non availability of primary collection vehicles and equipment for segregated collection of wastes; paucity of financial resources as well as lack of priority to waste management; lack of technical know-how and skilled manpower for treatment and disposal of waste and non-availability of appropriate land to set up waste processing and disposal facilities (Joseph 2012: 76).

In Japan, there is a high percentage consumption of the world resources, but at the same time it plays an active role in the preservation of resources through its different policy measures. In the 1960s, Japan was considered one of the most polluted countries in the world after the outbreak of Kogai but in subsequent years, it adopted adequate policy measures and made relevant technological changes to become an environmentally friendly country (Schreurs 1997: 150). In Japan the waste materials such as refuse, dust, and night-soil, had been long called the "filth" until the Waste Disposal & Public Cleansing Law was enacted in the year 1970 (Gotoh 1987: 15). Under the law, waste is classified as industrial waste or municipal waste. The law with its subsequent amendments set out the main statutory control of waste management. Mass production and mass

consumption in society, as well as disposal of resulting waste caused depletion of natural resources and high pollution levels. Hence, in 1990s Japan passed many new laws to promote recycling. In 1991, Law for Promotion of Effective Utilization of Resources was adopted to promote recycling at the production, distribution, and consumption stages, effective use of resources, decrease waste generation, and for environmental conservation. The law contains guidelines and targets for recycling of both municipal and industrial solid waste, for example, the target utilization rate of waste paper for the paper and paperboard industry was established for 1995 at 55 percent (Carbonnier 1996: 4). Further, Container Packaging and Recycling Law for the promotion of separate collection and recycling of packaging waste came into force in 1997. The law was designed to effect a shift to a recycling-based society in the 21st century (Tanaka 1999 14). The law ensures that consumers, municipalities, and producers share the responsibility of recycling. Encouraged by the Packaging Waste Recycling Law, producers can both decrease waste and lighten their own economic burden by cutting down on their containers and other packaging. The recycling rates of items like paper, cans, and bottles have been rising since the revision of the Waste Disposal and Public Cleansing Law in 1970 and the enactment of the Promotion of Use of Recyclable Waste Law in 1991. In 2000, a more comprehensive Basic Act for Establishing A Sound Material-Cycle Society was established with an approach to environmental protection and to combat the high consumption patterns. This has led to various legislative initiatives to promote the recycling of electrical home appliances, construction material, food waste and so forth. One of the most important components of laws related to sound material cycle society is the incorporation of Extended Producer Responsibility (EPR), which shifts the responsibility of processing general household waste from local governments to producer of products. For example, Under the Home Appliance Recycle Law, 2001, makers of products have a responsibility to take back and recycle four home appliances-waste fridges, washing machines, televisions and air conditioners. Thereby enabling system for recovery and recycling of iron, copper, aluminum and glass from these products. Retailers are obligated to take them back from consumers and deliver them to the appropriate producers or recycling agents and the consumers has obligation to pay for waste processing. The price of recycling is reflected in recycling processing cost of the products, thus it gives incentives for producer to reduce the cost of recycle processing and increase the competitiveness by increasing recyclability of products (Madu and Kuei 2012: 211). The shifting of responsibility from local authorities to producer ensures waste minimization and the recyclability of the products. Although it may appear to be a command and control type of regulation, however, it is more focused on giving incentives for voluntary actions and technological innovations to increase eco-efficiency. The rigorous regulation, adoption of technically oriented recycling measures and generally encouraging participation from public and private sectors, the recycling eventually becomes more of a habit rather than an approach regulated by authorities.

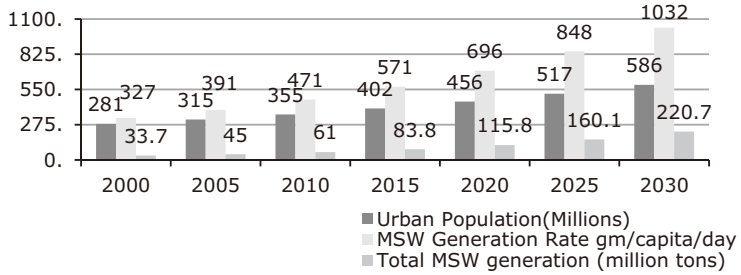
One of the most striking similarity between Japanese and Indian Laws is the incorporation of elements like EPR. For example, In India, E-Waste Management and Handling Rules, 2011 mandates producers of electrical

and electronic equipment to set up collection center or take back system in order to ensure proper recycling and disposal of their products. However, the rules have proven totally ineffective. It is common to see e-waste dismantler flout pollution and safety norms, risking both environment and health (Nandi 2014). In many cases, it is even difficult to locate producers as many micro and small enterprises are selling assembled products. The implementation of the rules is still a challenge with entrenched informal sector competing with formal recyclers, poor infrastructure, lack of administrative will and low public awareness. In Indian legislation, the 'Reutelization' approach has been very poorly developed and there is no concrete target set for recycling. The reuse or recycling practices mainly exist within the informal sector and done more for economic reasons. There is not much incentive left for municipalities to recycle the leftover waste, as most valuable recyclable materials are already removed through private waste trading and informal recycling sector. There is need to develop more concrete recycling laws in India as have been developed in Japan, while also taking steps for the formalization of the informal sector.

3. Waste Quantity and Composition

The section discusses how waste quantity and composition differs with the economic status of a country. The variation in quantity and composition brings into question the relevance and potential success of waste management strategies that work in developed countries like Japan to developing countries like India. The data can be crucial for designing the suitable disposal techniques and is essential for a successful management plan. The characteristic of waste changes over a period of time in term of quantity and quality, due to changes in the availability of products, technologies and services in the market. It also depends upon people's income, culture, geography and the socioeconomic condition of any society. According to Census of India, the population of the country increased by more than 181 million during the decade 2001-2011. It rose to over 1.21 billion in 2011. It accounts for 17.5 percent of the world population and its 377 million people live in the urban areas of the country. The MSW generation is increasing with the growing population and economic development.

Figure 1: Projected Municipal Waste Generation for Urban Population in India

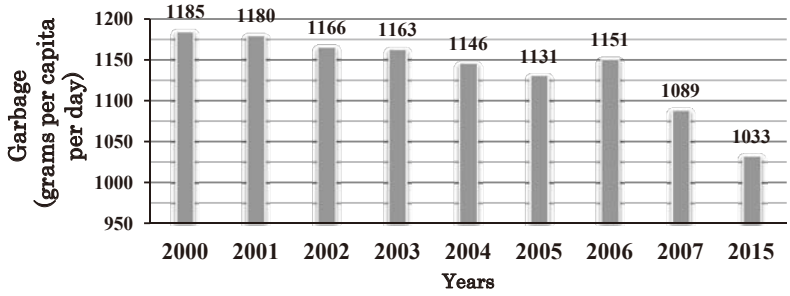


Source: Rajendra K. Kaushal et. al., Municipal Solid Waste Management in India-Current State and Future Challenges: A Review., 2012

The quantity of average MSW production ranges from 0.21 to 0.50 Kg per capita per day depending on the population of the cities (De 2003: 85). However, the MSW quantity is expected to increase from 34 million tonnes in 2000 to 221 million tonnes in 2030 (Fig 1). It also means that per capita per day production will increase to 1.032 kg, and urban population as 586 million in 2030. Municipal corporations of the country so far are not able to handle the increasing quantity of waste, which leads to uncollected waste on roads and other public places.

In comparison to India, the population of Japan has remained almost constant in the past few years with 126.9 million in 2000 to 128 million in 2010. Japan is a mountainous and highly volcanic country with only 10 percent land suitable for residential purpose (Williams 2005: 54). The shortage of land limits the availability of suitable landfill sites and is a driving force behind waste management policy. It has taken a number of measures to reduce the per capita waste generation or to make it constant. The policies are based on the 3R approach of waste reduction, reuse and recycling to minimize the waste that ultimately destined for landfill and the main route for waste disposal is incineration. According to Statistics Bureau of Japan, the quantity of average MSW production declined from 1.18 kg in 2000 to 0.97 Kg per capita per day in 2010. It generated around 52 million tonnes of MSW in 2000, 77.4 percent of which was incinerated, 5.9 percent landfilled and 16.7 percent recycled. In 2010 the MSW quantity reduced to 43 million tonnes out of which 79 percent incinerated, 1.5 percent landfilled and 19.4 percent recycled. According to Ministry of Environment, Government of Japan, the daily per capita waste was 1.18 kg in 2000 which decreased to 1.08 Kg in 2007, reduced by 8.1 percent from 2000 (Figure 2).

Figure 2: Changes in Waste Reduction in Japan



Source: Ministry of Environment, Govt. of Japan, Establishing a Sound Material-Cycle Society, 2010

By comparing data of India and Japan for the year 2010, it is clear that the per capita waste generation rate for India (0.47kg) is lower than that of Japan (0.97 kg) but due to the high level of population the total MSW amount is higher in India (61 million tonnes) than in Japan (43 million tonnes). It reflects, although the high-income countries are also affected by high quantity of waste generated, but for developing economies, it could

become a problem of very large proportions. There is an urgent need for low income countries to control the MSW problem with the right waste management strategy. The approaches for SWM should be compatible with the nature of a given society for its success. The waste compositions vary from country to country, making them difficult to adopt waste management strategies which may be successful in other places. Table 1 shows the difference in Gross Domestic Product (GDP), waste generation rates and composition in India and Japan.

Table 1: Waste generation rates and composition for India and Japan

Country	GDP (PPP) per capita estimated for 2007 (USD)	Waste Generation (kg/capita/day)	Composition (percent wet weight basis)						
			Biodegradable	Paper	Plastic	Glass	Metal	Textile/leather	Inert and Other
Japan	33,010	1.1	26	46	9	7	8	–	12
India	3,794	0.3-0.6	42	6	4	2	2	4	40

Source: Derived from Ashok V. Shekdar, Sustainable Solid Waste Management: An Integrated Approach for Asian Countries, 2008

The most notable difference in waste from two countries lies in the high proportion of recyclables like paper, metal and plastics in Japan, while greater portions of degradable organic matter and unidentifiable material such as dust and ashes in India. The reason for such fraction is due to the fact that wealthy communities form 'throw away societies' whereas poor communities have less to throw away and are more ingenious in reusing, recycling and refurbishing articles that a wealthier community would discard (Hope 1998: 12). There is high spending of rich countries like Japan on packaging material, absence of rag picking and low number of scrap dealers. The waste papers and old newspapers are generally put into the trash instead of storing at a point of generation for selling to scrap dealers. On the other hand, the developing countries like India use newspaper and other unsoiled paper for packaging including food items. The paper and other recyclable stuff are carried by the informal sector, which consists of scrap dealers, merchant and rag pickers. The number of old scrap merchants in India is high and house and offices sell old paper to these dealers. These dealers in turn sell them to recyclers and other end users. The huge number of rag picker picks all recyclable fractions of waste from residential and waste dump areas. The presence of the informal sector (consisting of scrap dealers, merchants and waste pickers) is one of the main reasons for very low amounts of paper, plastic, glass and metals in the Indian waste stream.

4. Municipal Solid Waste Management Practices

The section discusses current waste management practices in both the countries in order to explore their effectiveness and shortcomings. The waste management system in India suffers from a number of deficiencies.

For example, there is no organized and scientifically planned source segregation of MSW. Citizen prefers conventional mixed waste disposal over segregated waste as it requires less resources, say in terms of time (Mukherjee 2012: 180). The sorting of waste is practiced by informal sector rather than generators. The efficiency of segregation is quite low as the informal sector tends to segregate only those waste materials which have a relatively higher economic return in the recycling market. Similar to segregation, the collection systems are also inefficient and municipal authorities do not provide the service for door to door collection of waste, even though such service is mandated in the rules (Zhu 2008: 19). However, in some places, door to door collection is provided by NGOs and private operators.(1) The municipality collects waste only from communal bins or street collection points. It is common to see overflowing bins or littered waste around the community bins. Most often stray animal feeds on the waste dumped in these places. Another route for litter collection is street sweeping in which 60-70 percent expenditure of municipal budget is spent (Chandrappa and Das 2012: 71). In contrast, Japan controls the generation of waste at source by households, where the waste originates. The concept of *shared responsibility* has been effectively used. Citizens are supposed to separate the waste into combustibles, non-combustibles and recyclables (can, glass bottles, PET bottles each sorted separately). They should deposit the waste in specified transparent bags, at the locations specified by the municipalities on a particular day of the week by a specific time. Both municipalities and waste disposal agents sort out useful components of the collected waste and put them into a recycling route. To encourage voluntary recycling activities, municipality plays an active role through its various programmes. For example, in 1989, Tokyo Metropolitan Government (TMG) clarified the critical situation of waste disposal and started the "*Tokyo Slim*" campaign. TMG introduced a variety of measures and programmes like "My Bag campaign" to reduce packaging" and "Tokyo Rules" for the collection and recycling of waste. "*Tokyo Slim*" was a difficult policy change, but by the year 2000, with detailed and well inspected plans built for each ward, the city developed as a role model for resource recovery out of waste material. Since the start of the campaign, within 10 years, there has been an increase of the annual amount of recycling in 23 wards of Tokyo from 300,000 tons to about 1 million tons (Sorensen and Okata 2010: 35).

The generated waste is collected by collection vehicles to the transfer stations and the disposal facility. In India various types of transport vehicles exist, ranging from mostly used general purpose vehicles like trucks to highly mechanized compactors in some cities. Generally, the waste transportation fleet is obsolete and poorly maintained. Most of the municipalities are ill equipped and 70 percent of cities lack adequate waste transport capacities (Unnisa and Rao 2013: 48). Further, there are corrupt practices adopted like under utilization of municipal transport fleet and contracting out to private companies.(2) In Japan, there exist standardized designs for the vehicles, consistent with normal waste characteristics and working conditions. The compactor container transfer station method is used in which waste is dropped in the hopper, compressed in containers and reloaded to larger container trucks for disposal or landfill sites (Ministry of Environment "Recycling" 2012: 3). There

are difficulties associated with copying the designs of highly mechanized vehicles used in the developed-world in developing nations due to differences in local waste characteristics and operating conditions. However, appropriate designs are being developed through innovative approaches, extensive testing, and trial and error.

Solid wastes that cannot otherwise be processed, residues and other materials that are discarded after processing are ultimately disposed of by methods like sanitary landfilling or incineration. 75 percent of MSW generated in Japan is being treated by incineration, while 5 percent of MSW wastes treated by incineration in India (Malik 2012: 513). In 1990s the burring of waste in incinerators raised dioxins to dangerously high levels in Japan, but technological advances have since corrected the problem. In Japan, now the plasma arc technology (PAT) is used for incineration. It helps in more than 95 percent volume reduction of thrash ("Talking Thrash" 2012). PAT works at a very high temperature and can decompose more than 99.99 percent of the organic components. In the process, the dioxin formation is prevented and the clean gases are released into the atmosphere. PAT is a capital intensive technology. Klein estimates that the initial cost of plasma waste processing plant ranges between US $ 3 million to $ 12 million depending on size, complexity of treatment process and nature of waste (2008: 31). The general cost of waste treatment by plasma arc varies from US $ 400 to $ 2,000 per ton. There are 1873 incinerator in Japan and 13 alone are located in Tokyo (Azapagic 2004: 155). Japan has combined incinerators with energy recovery plants to achieve the dual objective of waste disposal and energy generation. For example, some Japanese cities have integrated their MSW incinerators in community complexes with indoor gardens, meeting halls, second hand shops and offices of NGOs. Tokyo's Toshima incinerator burns 300 tonnes of garbage per day, turning it into electricity, hot water and recyclable sand (Harden 2008). Incinerator ash is melted into sandy slag and is used in bricks and concrete. Though the incineration is widely used in developed countries, however in India, it is not considered as a feasible option for municipal solid waste. Incineration is a difficult option for developing countries due to lack of financial and technological resources, the high moisture content of the wastes, low quantity of combustible material as well as the high cost of processing and difficulties in maintaining the required operating conditions. In Delhi first incineration plant was set up at Timarpur in 1989 by a foreign company of Denmark, but due to low calorific value it could not function properly and now is defunct (Anand 2010: 268). The government planned to revive it, but faced huge opposition from environmental NGOs concerning harmful emission from the plant. In India there are only few Waste to energy (WTE) projects operating in the state of Hyderabad and Vijayawada in Andhra Pradesh and processing around 1,000 TDP of mixed waste (TERI 2009: 434). According to latest reports even these plants are now dysfunctional (Saldanha 2014). In 2013 the Ministry of Environment and Forest had withdrawn the controversial amendments to MSW Rules, 2000. The amendments had encouraged the use of incineration for MSW disposal (Suchitra 2013).

In India, more than 90 percent of MSW in cities and towns are directly disposed of on land in an unsatisfactory manner through open dumping (Sharholy 2008: 463). It not only affect the environment and

public health, but also results in scarcity of land. For example, in Delhi three main landfill sites in operation, located at Bhalswa, Gazipur and Okhla are already running at an overflowing stage. Since 1975, already 16 landfill sites have been filled up with garbage of Delhi. There are some municipalities which have used innovative methods like composting for waste treatment. At present, in India composting is used only around 10-12 percent (Kaushal 2012: 1482). The first large-scale aerobic composting plant in the country was set up in Mumbai in 1992 to handle 500 MT per day of MSW by Excel Industries Ltd (Sharholy 2008: 464). However, only 300 MT per day capacity is being utilized currently due to certain problems, but the plant is working very successfully and the compost produced is being sold at the rate of Rs. 2 (US $ 0.03) per kg. Over the years a number of other composting plants have been implemented in the principal cities of the country such as Delhi, Bangalore, Ahmadabad, Hyderabad, Bhopal, Lucknow and Gwalior. Yet such cheaper and environmental friendly techniques are not continuously supported by the municipality. In one of the biggest scam related to waste management, Brihanmumbai Municipal Corporation (BMC) has rejected a windrow composting based project, which required an investment of Rs 68.5 million (US $ 1.1 million) (Marpakwar 2009).[3] Instead the municipality opted for liner system and given the contract to United Phosphorus limited for a value of Rs 503 million (US $ 8.1 million) for closing Gorai dumpsite (Municipal Corporation of Greater Mumbai "Gorai"). On the same lines, BMC agreed to contract for closure of other dumping ground Deonar at a highly exaggerated cost of Rs 35 billion (US $ 0.5 billion), when it could have happened for almost free.[4] Environmental activists claim that for municipalities like BMC, waste management is purely a money making avenue rather than a civic, environmental or health issue. Citizen across the city launched a protest movement against the high closing costs of dumping ground and filed a Public Interest Litigation (PIL) for cancellation of project to stop the drainage of public money.

There are some initiatives carried out for composting, recycling and efficient disposal of waste at small scale institutions or in the society. For example, the Baba Atomic Research Center (BARC) installed biogas plant called Nisarguna for environmental friendly disposal of the waste generated in the kitchens of various canteens. By 2014, these plants have been set up at 146 locations and technology is transferred to 100 entrepreneurs.[5] Bangalore Corporation is planning to set up 12 Nisargruna biogas plants across the city to convert biodegradable waste into methane and organic manure. The Chennai Corporation and BMC have also initiated preliminary discussion with BARC. However, in the Indian scenario success of these processes is difficult because the waste arrives in a mixed form and contains a lot of non-organic material. When mixed waste is composted, the end product is of poor quality. In the absence of segregation, even the best waste management system or plant will be rendered useless.

In Japan organic waste recycling is done through the Food Recycling Law. It was amended in 2007 to promote a recycling loop that requires food industries to purchase farm products that are grown using food waste-derived compost or animal feed. In some cities like Kyoto and Hita biomass technology is used

for producing biodiesel fuel. Composting has limited potential, but some home based composting is done through technologies like Bokashi and Takakura method. Table 2 summarizes the main features of Solid Waste Management Practices in India and Japan, including Source Reduction, Collection, Recycling, Composting, Incineration and Landfilling.

Table 2: The main features of Solid Waste Management Practices in India and Japan

Activity/ Country	India	Japan
Source Reduction	Some discussion of source reduction, but rarely incorporated into an organized programme.	Organized education programme and rules that emphasize the '3R' and producer responsibility.
Collection	Transport fleet is obsolete. Collection rate varies between 50 to 80 percent.	Collection rate greater than 90 percent. Compactor trucks and highly mechanized vehicles and transfer stations are common.
Recycling	Informal sector involved in recycling markets,which are not well regulated.	Recyclable material collection services and processing facilities are technically advanced and regulated.
Composting	Large composting plants are not common due to contamination and lack of proper marketing.	Waste stream has a smaller portion of compostable waste. Some initiatives taken.
Incineration	Mostly failed.	Very Common.
Landfilling	Uncontrolled open dumps.	Limited landfill sites.

Source: Derived from World Bank, What a Waste: Global Review of Solid Waste Management, 2012

5. The Way Forward: 3R (Reduce, Reuse, Recycle) Initiatives

The section focuses on recycling practices in both countries and suggests that while formal recycling is common and successful in Japan, the informal sector is much more prevalent in India. Japan has played a leading role in promoting the 3R in Asia. The time-lined and goal-driven national and regional programmes have been launched in keeping with waste trend. The Eco Town Programme launched in 1997, to reduce resource use by optimizing waste management within designated areas is a successful example of 3R initiative at regional level. An Eco town plan is a combination of town planning, community recycling, outreach activities and proposal for specific innovative recycling plants. In a span of 10 years from 1997 to 2006, 26 Eco-Town plans were implemented with an investment of US$ 1.65 billion, with 61 government subsidized innovative recycling projects (Organization for Economic Cooperation and Development "Performance" 2010: 158). Kitakyushu is one of the Eco town that circulates resource circulation and Eco industries. It consist of 29 industrial plants, 16 research facilities and a WTE plant. The recyclable includes PET bottles, automobiles and electronic home appliances, mixed construction waste, fluorescent tubes and office equipment. All non recyclable residue is processed at WTE plant, which generates 99,870 MWh electricity, meeting all Eco town's electricity demand and reduces 380,000 tonnes of CO_2 per year (Organization for Economic Cooperation and Development

"Green" 2013: 41). In a city level 3R effort the Yokohama G30 plan was launched in 2003. It was targeted to reduce the waste to 30 percent by 2010 compared with 2001 by increasing the separation and recycling of MSW (Harris and Lang 2014: 185). The category of waste increased from 5 to 10 and in order to encourage citizens to separate their waste at home, around 12,000 meetings held to explain waste separation and 8,300 early morning events were organized to explain about collection centers. The improperly separated waste was left behind with a warning sticker and a non penal fine of US $ 25 was imposed if someone repeatedly failed to separate the waste properly. As a result, the MSW reduced by 42 percent compared with 2001, two incinerator plants were closed permanently and one temporarily, and the city made a cost saving of US $ 6 million on waste management. In another effort, TMG introduced schemes like Shinjuku Eco Jiman Point (An Eco point card) to control waste generation with the cooperation of household, business and shopping districts (Bortoleto 2014: 45). The consumers could accumulate points for every time they decline a shopping bag or undertakes a waste prevention action while shopping. They could exchange these points for privilege or prizes offered by stores. Overall, the 3R policy has been successful, however, further efforts are needed for waste prevention (reduction and reuse).

Indian policy makers have not shown much interest in the promotion of 3R philosophy, recycling industries or formally educate the society (Klein 2008: 80). The improper law enforcement, corruption, high population and immigration of people from rural to urban areas have resulted in the creation of inner-city slums and inefficient system of waste collection. In such situation poor and marginalized people choose waste picking for income. The ragpickers in India are often *Dalits* or *untouchables* and are essentially lowest in the caste system (Bose 2014; Nas and Jaffe 2004: 345). They are comparable to 'Burakumin' in ancient Japan (Tierney 2002: 43). The discrimination on the basis of caste is illegal today, but century old tradition still pervades in the Indian society (Medina 2007: 201). Ragpickers live in both developed as well as developing countries, but their number can vary significantly. In Japan waste pickers appeared mainly during the war period. However, now their number is limited to a few homeless people, for example, 5,000 in Tokyo, 1,000 in Kawasaki and 14,000 in Osaka hub (Karan 2005: 199). In India, the number of rag pickers is very high as much as 1.5 million. Gujarat state has around 100,000 rag pickers, Delhi has nearly 100,000 waste pickers, Pune has around 6,000 of them, Bangalore has an estimated 35,000 and Mumbai has 25,000 waste pickers (Chandrappa and Das 2012: 378).

Informal methods and techniques in waste management are generally labor intensive; while formal methods tend to be labor saving, but capital-intensive. Developing countries often have a surplus of cheap labor, but are short of capital; integration of this labor force in formal set up can be a step towards more cost-effective and sustainable waste management. There are successful examples of harnessing waste recycling potential of the country with the help of the informal sector. The International Labor Organization (ILO) supported programme in Delhi, whereby more than 10,000 shoes are put back into use each month rather than going to the garbage dump (Rogerson 2001: 251). Old shoes and clothing are obtained by women going to

the better off areas in Delhi and bartering steel utensils and crockery items. These shoes and clothes are sold at the local market to shoe renovators who resole and make the old shoes look new and re-dye light colored shoes. Beside shoe renovation, there are also sets of businesses based on paper bag manufacture, toy making and the selling of old clothes, all of which linked to recovery and recycling. In another example, Self Employed Woman's Association (SEWA) has been working for women who traditionally picked paper from streets in Ahemdabad, assisted these women to be more organized (Rowbotham 1994: 114). Further, there are some ragpicker cooperatives, associations and NGOs that have channelized the unorganized sector of rag pickers into the formal SWM system. However, these initiatives are very limited and majority of waste collector still suffer 'invisible' status as they are not seen as legitimate stakeholders in the society.

6. Conclusion

In developing economies like India the urbanization and changing lifestyles have been the major reasons for the growing waste menace. It has been observed that in spite of a stringent legislation in place, open dumping is the most widespread form of waste disposal. The present policy framework does not give a direction and thrust to environmentally sound waste management. It is necessary to broaden the scope of these laws. The framework should facilitate the planning and operation of the system by including relevant technical and other information. On the other hand, Japan with its well planned and organized SWM system, has achieved the goal of sustainability. In line with global trends, the innovating and integrated systems are used to resolve sustainability issues; mainly through legislative measures and the incorporation of 3R (reduce, reuse and recycle) policy. The waste management system in Japan is difficult to work out well in India, due to difference in waste composition of the two countries and presence of widespread informal recycling sector in India. Incorporating technologies like incineration (used commonly in Japan), is relatively expensive and not suitable for weaker economies such as India. India needs to use available human resources in the informal sectors to increase the recycling rates, make technological innovations and require time to time advancement in the regulatory system for achieving a sound waste management society.

〔投稿受理日2014. 12. 20／掲載決定日2015. 1. 29〕

Note

(1) Ahmedabad, Hyderabad, Rajkot, Bangalore, Jaipur, and Chennai are some of the cities where door-to-door collection services are carried out through RWA, NGO, and other private initiatives. In Ahmedabad, a door-to-door collection initiative involving RWAs and NGOs met with success and the new service covers more than 855,000 households, or 95 percent of households in the city. Under the memoranda of understanding signed with the RWAs and NGOs, the municipality provided subsidies of Rs 10 per household per month (Zhu 2008: 29).

(2) According to Controller and Auditor General of India (CAG) report, despite the huge fleet and surplus trucks, New Delhi Municipal Council hired private vehicles during 1997 to 2000 for lifting the garbage incurring avoidable expenditure of Rs 2.14 crores (Anand 2010: 141).

(3) A successful pilot project was carried out at one hectare plot at the Gorai dump yard in Mumbai, where a 6 m waste heap

was brought down to ground level in just 40 days using windrow technology by Vini Agro tech. However, the municipality rejected this project (Jain 2007).

(4) National Buildings Construction Corporation offered its assistance to Municipal Corporation in Deonar project. The company proposed to recover the expenditure on waste processing plant by selling products recovered from waste. However, the municipality rejected project of NBCC (Purohit 2010).

(5) Nisarguna can produce 25-30 kg of methane and 50-60 kg of organic manure from one tonne of biodegradable waste. Constructing a one tonne waste plant costs Rs.15 lakh (US $ 2,414) and it can be installed in two months (Prasad 2012).

References

Anand, Subhash. *Solid Waste Management*. Mittal Publicaions. 2010.

Azapagic, Adisa. *Sustainable Development in Practice*. Wiley. 2004.

Bortoleto, Ana P. *Waste Prevention Policy and Behavior: New Approaches to Reducing Waste Generation and its Environmental Impacts*. Routledge. 2014.

Bose, Atiya "Away from the Photo Ops" *Indian Express* 14 Nov. 2014.

Carbonnier, Sayuri. *Paper Recycling and Waste Paper Business in Japan.* International Institute for Environment and Development. 1996.

Chandrappa, R., and D. B. Das, *Solid Waste Management: Principles and Practice.* Springer. 2012.

De, Anil K. *Environmental Chemistry.* New Age International. 2003.

Delhi Municipal Corporation "Solid Waste Transportation Management System" Web 1 Sep. 2014 <http://mcdonline.gov.in>.

Gotoh, Sukehiro. "Waste Management and Recycling Trend in Japan." *Resources and Conservation*. 14 (1987): 15-28.

Harden, Blaine. "Japan Stranches Stench of Mass Trash Incinerators." *Washington Post* 18 Nov. 2008.

Harris, Paul G, and Graeme Lang eds. *Routledge Handbook of Environment and Society in Asia*. Routledge. 2014.

Hope, E. T. ed. *Solid Waste Management: Critical issues for Developing Countries*. Canoe Press Univ. 1998.

Jain, Minti. "Mumbai's Solid Waste Management Plans Expensive, Dangerous." *Down to Earth* 31 May 2007.

Joseph, Kurian et al. "Integrated Approach to Solid Waste Management in Chennai: An Indian Metro City." *J Mater Cycles Waste Manag* 14.2 (2012): 75-84.

Karan, P. P. *Japan in the 21st Century: Environment, Economy and Society.* Univ. Press of Ken-tucky. 2005.

Kaushal, Rajendra K. et. al. "Municipal Solid Waste Management in India-Current State and Future Challenges: A Review." *International Journal of Engineering Science and Technology* (*IJEST*) 4.4 (2012): 1473-1489.

Klein, Robert N. *Progress in Waste Management Research.* Nova Science Publisher. 2008.

Madu, Christian N., and Chu Hua Kuei eds. *Handbook of sustainability Management*. World Scientific. 2012.

Malik, Abdul. *Environment Protection Strategy for sustainable Development*. Springer. 2012.

Marpakwar, Prafulla. "Why Does BMC Want to Spend Crores on Deonar Dump?" *Times of India* 29 May 2009.

Medina, M. *The World's Scavengers*. Alta Mira Press. 2007.

Ministry of Environment, Govt. of Japan, "Establishing a Sound Material-Cycle Society." 2010.

---"Solid Waste Management and Recycling Technology of Japan." 2012.

Mukherjee, Sacchidanada. *Environmental Scenario in India*. Routlage. 2012.

Municipal Corporation of Greater Mumbai. "Gorai Dumpsite Closure" Web 3 Dec. 2014 <http://www.mcgm.gov.in/irj/portalapps/com.mcgm.solidwastemanagement/imag-es/gorai_presentation_addition.pdf>.

Nandi, Jayashree. "Electronic Companies and Pollution Board Flout Waste Rules: Report." *Times of India* 15 Oct. 2014.

Nas, Peter J. M., and Rivke Jaffe. "Informal waste Management: Shifting the Focus from Problem to Potential." *Environment, Development and Sustainability* 6 (2004) 337-353.

Organization for Economic Cooperation and Development. *Enviromental Performance Reviews Japan.* 2010.

---*Green Growth in Kitakyushu, Japan*. 2013.

Planning commission of India. "Report of the Task Force on Waste to Energy (Volume I), in the Context of Integrated MSW Management." May 2014.

Prasad, R. "Efficient Way to Turn Waste into Resource" *Hindu* 18 Oct. 2012.

Purohit, Kunal. "Citizens launch protest movement against 'high costs' on closing dump-ing grounds" *Hindustan Times* 3 July 2010.

Rogerson, Christian M. "The Waste Sector and Informal Entrepreneurship in Developing World Cities." *Urban Forum*. 12.2 (2001): 247-259.

Rowbotham, Sheila ed. *Dignity and Daily Bread.* Routledge. 1994.

Saldanha, Alison. "Mumbai: City of garbage hits a dead end." *India Express* 22 Jan 2014.

Schreurs, Miranda A. "Japan's changing approach to environmental issues." *Environmental Politics*. 6.2 (1997): 150-156.

Sharholy, Mufeed et al. "Municipal solid waste management in Indian cities-A review." *Waste Management* 28 (2008): 459-467.

Shekdar, Ashok V. "Sustainable solid waste management: An integrated approach for Asian countries." *Waste Management* 29.4 (2008): 1438-1448.

Sorensen, A., and J. Okata eds. *Megacities: Urban Forum, Governance and Sustainability.* Springer. 2010.

Statistics Bureau, Ministry of Internal Affairs and Communications. "Japan.Statistical Handbook of Japan." 2014.

Suchitra, M. "MoEF withdraws draft amendments to solid waste management rules" *Down to Earth* 14 Nov. 2013.

Tanaka, M. "Recent trends in recycling activities and waste management in Japan." J Mater Cycles Waste Manag 1.1 (1999): 10-16.

"Talking Thrash." *Economist* 2 June 2012.

TERI. *Teri Energy Data Directory.* Rajkamal Electric Press. 2009.

Tierney, Emiko Ohnuki. *Illness and Culture in Contemporary Japan: An anthropological Vew*. Cambridge Univ. Press. 2002.

Unnisa, Syeda A., and S. B. Rav. *Sustainable Waste Management*. Apple Academic Press. 2013.

Venkatraman, Tanushree "BMC to seek BARC help to replace dysfunctional biogas plant in Deonar" *Indian Express* 20 Aug. 2014.

Williams, Paul T. *Treatment and Disposal*. Willey. 2005.

World Bank, "What a Waste: Global Review of Solid Waste Management." 2012.

Zhu, Da et. al. Improving Municipal Solid Waste Management in India: A Sourcebook for Policy makers and Practitioners. The World Bank. 2008.