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An Analytical Study on Municipal Solid Waste Management in India –Special Reference to Rohtak City

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Abstract: *Waste Management is one of the most pressing environmental issues the world is facing today. India is second largest populated country in the world. Urbanization & industrialization leading to migration of people which leads to expansion of cities. Pressure on basic services and infrastructure is increasing which causes serious problem of solid waste management across many Indian cities. Unmanaged MSW disposal at landfills or dumpsites, annual GHG emission from MSW causing environmental, social and economic problems. This is due to the absence of waste segregation-at-source, deficient management capacities, a lack of data regarding waste stream composition and insufficient financing and enforcement of existing regulation and policies. Waste management encompasses everything from collection and handling to disposal by incineration, landfill and other methods, and recycling. Also included implications on the health of people and the environment. Solid waste in most cities of developing countries is a serious threat to urban environment. 20 wards are covered under Door-to-Door collection in Municipal corporation Rohtak. 100%Door to Door collection is placed. Segregation of waste at source, segregation of plastic waste, littering of waste, open burning of waste at village level, Lack of awareness among public. Encouraging waste reduction, segregation at source, composting, public awareness & building capacities of municipalities have been recommended for effective and successful waste management in the Rohtak city.*

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I. Introduction

Rapid growth in consumption of goods, globalization, technological advancements lead to huge generation of waste. The world is now facing serious environmental issues from such waste dumping connected to other problems such as climate change, water pollution, air pollution, soil contamination and many more. The environmental and economic impacts of these impacts are now becoming increasingly real. The world is also now confronting the serious issue of rapidly dwindling resources. There is an urgent need for research and solution for sustainable waste management strategy and models that helps in pursuing economic development in an environmentally sustainable manner. Environmentally sound management of municipal wastes is one such areas of major concern today in almost all countries.

II. Review of Literature

The increasing & changing lifestyles of people are the main reasons for continuous growth of Municipal Solid Waste (MSW) generation in urban bodies of the country. The annual waste generation has been observed to increase in proportion to the rise in population and urbanization, and issues related to disposal have become challenging as more land is needed for the ultimate disposal of these solid wastes (Idris et al., 2004). During the last three decades, the National Environmental Engineering Research Institute (NEERI) has carried out studies in more than 50 cities and towns in India. Characterization of MSW indicated that the waste consists of 30–45% organic matter, 6–10% recyclables, and the rest as inert matter. The organic matter in solid waste in developing countries is much higher than that in the waste in developed countries (Bhide and Sundersan, 1983), and organic matter can be converted into useful products to reduce the burden on existing landfills (Richard, 1992). The environmentally sound management of solid wastes issue had received attention of international and national policy making bodies and citizens. At the international level, the awareness regarding waste began in 1992 with the Rio Conference, where efficient handling of waste was made one of the priorities of Agenda 21. (source: http://www.un.org/esa/sustdev/agenda21.htm). The Johannesburg World Summit on Sustainable Development in 2002 focused on initiatives to accelerate the shift to sustainable consumption and production, and the reduction of resource degradation, pollution, and waste. (source: http://www.un.org/esa/

sustdev/csd/aboutCsd.htm). A review of existing literature reveals that a number of studies on municipal solid waste management have been undertaken. In India, municipal authorities are responsible for managing municipal solid waste and are often unable to perform their duties effectively because of lacking in-house capacity to handle the complexities of the process (World Bank, 2010). The quantity of municipal solid waste generated depends on factors such as food habits, standard of living of people, seasonal variations and the number of commercial activities being taking place. Since solid waste is an environmental health hazard, its effective management by local authorities is a problem. The municipal corporations are always exploring new management strategies to deal with this huge quantity of solid waste generation. To design an appropriate collection and disposal system of municipal solid waste it is necessary to have complete data on quantity generation and variation of the solid waste produced. Due to industrialization and population explosion India has led to the migration of people from villages to cities, which generate thousands of tons of MSW daily.

III. Current status of municipal solid waste management (MSWM) in India

Municipal solid waste quantity and generation rate

In India approximately 143,449 MT of MSW is being generated daily, out of which around 111,000 Metric tonnes collected, and about 35,602 Metric tonnes are treated (S. Kumar et al., 2017). City wise generation of waste shows significant variation in the waste per capita/day generation at an exponential rate strictly (0.24 to 0.85) from the year 2001 to 2018 presented by CPCB in their annual report 2018. which is likely to increase shortly at a rapid rate (CPCB India 2018 a) (S.kumar et al 2017) (Kumar. Akhilesh., Agrawal Avlokita., 2020)

SOLID WASTE GENERATION IN 46 METROCITIES

Rank	City	Population (2011)[3]	Waste Generation (TPD)			
			1999- 2000	2004-05	2010-11	2015-16
1	Mumbai (Mh)	12,442,373	5355	5320	6500	11,000
2	Delhi i	11,034,555	400	5922	6800	8700
3	Bangalore (Krn)	8,443,675	200	1669	3700	3700
4	Chennai (TN)	7,088,000	3124	3036	4500	5000
5	Hyderabad (Tel)	6,731,790	1566	2187	4200	4000
6	Ahmedabad (Guj)	5,577,940	1683	1302	2300	2500
7	Kolkata (WB)	4,496,694	3692	2653	3670	4000
8	Surat (Guj)	4,467,797	900	1000	1200	1680
9	Pune(Mah)	3,124,458	700	1175	1300	1600
10	Jaipur (Raj)	3,046,163	580	904	310	1000
11	Luck now (UP)	2,817,105	1010	475	1200	1200
12	Kanpur (UP)	2,765,348	1200	1100	1600	1500
13	Nagpur (Mh)	2,405,665	443	504	650	1000
14	Visakhapatnam (AP)	2,035,922	300	584	334	350
15	Indore (MP)	1,960,631	350	557	720	850
16	Thane (Mh)	1,818,872	--	-	-	700
17	Bhopal (MP)	1,798,218	546	574	350	700
18	Pimpri-chinchwad (Mh)	1,729,359	-	-	-	700
19	Patna (Bhr)	1,683,200	330	511	220	450
20	Vadodara (Guj)	1,666,703	400	357	600	700
21	Ghaziabad (UP)	1,636,068	-	-	-	-
22	Ludhiana (Pb)	1,613,878	400	735	850	850
23	Coimbatore (TN)	1,601,438	350	530	700	850
24	Agra (UP)	1,585,704	-	654	520	790
25	Madurai (TN)	1,561,129	370	275	450	450
26	Nashik (Mh)	1,486,973	-	200	350	500
27	Vijayawada (AP)	1,476,931	-	374	600	550
28	Faridabad (Hr)	1,404,653	-	448	700	400
29	Meerut (UP)	1,309,023	-	490	520	500
30	Rajkot (Guj)	1,286,995	-	207	230	450

31	Kalian-dombivali (Mh)	1,246,381	-	-	510	650
32	Vasai-virar (Mh)	1,22,1,233	-	-	-	600
33	Varanasi (UP)	1,201,815	412	425	450	500
34	Srinagar (JK)	1,192,792	-	428	550	550
35	Aurangabad (Mh)	1,171,330	-	-	-	-
36	Dhanbad (Jh)	1,161,561	-	77	150	180
37	Amritsar (Pb)	1,132,761	-	438	550	600
38	Navi Mumbai (Mh)	1,119,477	-	-	-	675
39	Allahabad (UP)	1,117,094	-	509	350	450
40	Ranchi (Jh)	1,073,440	-	208	140	150
41	Howrah (WB)	1,072,161	-	-	-	740
42	Jabalpur (MP)	1,054,336	-	216	400	550
43	Gwalior (MP)	1,053,505	-	-	285	300
44	Jodhpur (Rj)	1,033,918	-	-	-	-
45	Raipur (Chh)	1,010,087	-	184	224	230
46	Kota (Rj)	1,001,694	-	-	-	-

Source: cpcb.nic.in

India needs to improve its municipal solid waste management with the triple objective of resource recovery, improving public health conditions and mitigating the risks associated with anthropogenic GHGs emission causing global warming & climate change has been commissioned the responsibility of carrying out the assessment.

IV. Challenges related to MSWM in India

I. Environment, Ecosystem and health

Human health is very much associated with environmental degradation (Shukla et al., 2000). There is direct health risk to the formal and informal workers without the use of proper gloves, uniforms, and safety equipment. (Kumar., 2020) A high percentage of gastrointestinal parasites worm infects those who live near to the disposal sites (Giusti, 2009). Under anaerobic conditions open dumps release methane from the decomposition of biodegradable waste under anaerobic conditions even found causing fires and explosions, a vast contributor to global warming (Slagstad and Bratteb, 2013). There are problems associated with odour and migration of leachates to receiving water and soil (Unnikrishnan et al., 2006) (Muhammad et al., 2020) (Dasgupta et al., 2013). Uncontrolled burning of waste at dumpsites releases fine particles & smog, which are a significant cause of respiratory diseases (Sridevi et al., 2012), (Annepu, 2012) (Ghosh, 2016a). The poorly maintained landfill sites & unsanitary methods lead to serious health concern prone to groundwater contamination because of leachate production.

Some ecosystems, such as marine and coastal ones, can be severely affected by poor management of waste, or by littering and have access to river and sea. Marine litter is a growing concern, and not only for aesthetic reasons: ingestion and entanglement constitute severe threats to many marine species.

Waste impacts the environment indirectly as well. Whatever is not recovered or recycled from waste represents a loss of raw material and other inputs used in the product life cycle, i.e. in the production, transport and consumption phases of the product. Environmental impacts in the life-cycle chain are significantly larger than those in the waste management phases alone.

Waste affects our health and well-being in many ways either directly or indirectly: methane gases contribute to climate change, air pollutants are released into the atmosphere, freshwater sources are contaminated, crops are grown in contaminated soil and fish ingest toxic chemicals, illegal dumping, burning or exports also play a part, but it is difficult to estimate the full extent of such activities, or of their impacts.

Solid waste causes aesthetic environmental damage, ugliness of street litter and degradation of the urban environment and beauty of the city. Leaching of contaminants to surface water bodies and ground water is also a problem. Air pollution can be caused from the inefficient burning of wastes, either in open air, or in plants that lack effective treatment facilities from the gaseous effluents.

Even though the quantity of waste generated is expected to grow significantly, service levels in the MSWM space continue to be below par. The major gap exists in the coverage of collection services, scientific processing and disposal of the waste.

II. Waste as a resource

Waste as a resource can scale down the demand for extraction of new resources. Using existing resources, fewer materials would help avert some of the impacts created along the chain. Unused waste also represents a potential loss. There is the need to ensure high-quality recycling, limit energy recovery to non-recyclable materials, eliminate landfilling, and stop illegal shipments of waste. Kitchen and gardening waste constitutes the biggest fraction of municipal solid waste. This type of waste, when collected separately, can be turned into an energy source or fertilizer. Anaerobic digestion produces biogas and residual material, which in turn can be used as fertilizer, like compost.

Both waste-to-energy and the circular economy bring other benefits as well as mitigation. Lowering pollution by shifting from disposal to energy recovery which brings good health and cleaner environment. By reducing extraction of raw materials, the impacts caused due to mining on humans and ecosystems are also reduced.

V. SITE DESCRPITION

Rohtak city of Haryana is our study area as shown in Fig.1. Rohtak city lies between longitude 760 31'47.764" to 760 42'43.071" and Latitude 280 49'53.354" to 280 56'33.819" (Fig.1) and situated at a mean sea level of 220 meters. As increase in population and urbanization the municipal limits also extended which was 30.96 Km2 in 2007, this limit was extended in 2012 the municipal corporation included surrounding nine villages due to which limits became 139.4 Km2 with a population 4.8 lac (Municipal Corporation Rohtak (MCR), 2013).

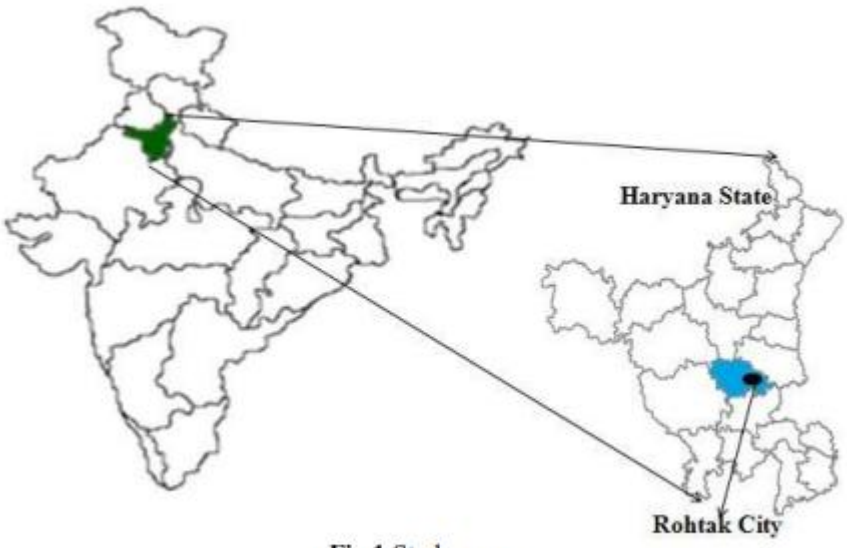

Fig.1 Study area.

All 20 wards are covered under Door-to-Door collection in Municipal corporation Rohtak, 100%Door to Door collection is placed. All the waste collected from the Municipal corporation Rohtak area is centrally segregated and processed scientifically (waste to compost). 42 Garbage tipper and 37 tractor trollies are placed for collection of waste. (www.mcrohtakgov.in) For proper management, Rohtak city is divided into six zones. A critical component in any waste management program is public awareness and participation, in addition to appropriate legislation, strong technical support, and adequate funding. Waste is the result of human activities and everyone needs to have a proper understanding of waste management issues, without which the success of even the best conceived waste management plan becomes questionable. (ref: Haryana- State Policy and Strategy on Solid Waste Management). Solid waste characteristics and quantification. the solid waste generated in Rohtak city is approximately 188.2 MT/day with collection efficiency 80%. The per capita generation is 0.49 Kg/Person/Day. The chemical characteristics of solid waste are as follows: moisture (33.72%), Bulk density (0.32 gm/cc), Dry density (0.24 gm/cc), C/N Ratio (36.6), and CV (816 Cal/Kg). Municipal solid waste is a complex waste stream, where many different types of waste aggregate from domestic, commercial and industrial sources within a single waste stream. Waste quantities, volume, and composition in different geographical areas vary as it depends upon socio-economic, population, cultural traditions, consumption behavior, the degree of industrialization and climate.

Solid waste management in Rohtak is aimed to solve the challenges faced by local authorities in managing solid waste. Advanced technology, illegal dumping and management skills on disposal and landfill

system. The concessionaires are expected to improve and ensure high-quality services in solid waste management, and provide recommendation and implementation policies and strategies pertaining to solid waste management services, as well as promoting participation and awareness among the public.

The study revealed some problems from Municipality that affected implementation like inadequate human & financial resources, lack of integrated solid waste management plan, public unawareness, inadequate land for final disposal of waste, lack of integrated solid waste management plan, public unawareness, lack of availability of modern technology and poor enforcement of Solid Waste Management Rule, 2016. Providing adequate resources, encouraging workers, developing a strong policy, incorporating technological innovations, providing monetary incentives for recyclable items, support from political leadership, encouraging waste reduction, composting and recycling techniques have been recommended for effective and successful waste management in the Rohtak city.

Composting is a process of controlled decomposition of the organic waste, typically in aerobic conditions, resulting in the production of stable humus-like product, i.e., compost. Considering the typical composition of wastes and the climatic conditions, composting is highly relevant in India and should be considered in all municipal solid waste management (MSWM) concepts.

VI. Integrated Solid Waste Management

The ISWM (Integrated Solid Waste Management) hierarchy of waste management priortise waste minimization (reduction at source and reuse) as the most preferred waste management strategy.
The hierarchy indicates that all options of source waste minimization should be utilized before appropriate treatment technologies are selected and implemented.

- At source reduction and reuse: Waste minimization and sustainable use/multi use of products (e.g. reuse of carry bags/packaging jars
- Recycling: Processing non-biodegradable waste to recover commercially valuable materials (e.g. plastic, paper, metal, glass and e-waste recycling)
- Composting: Processing biodegradable waste to recover compost (e.g. windrow composting, in-vessel composting, vermi-composting)
- Waste to Energy: Recovering energy before final disposal of waste (e.g. RDF, biomethanation, co-processing of combustible non-biodegradable dry fraction of MSW, incineration)
- Landfills: Safe disposal of inert residual waste at sanitary landfills after recycling and reuse to the maximum extent possible.

(ref: Swachh Bharat Mission, MSWM Manual, MoUD, 2016)

Reduce, reuse, recycle methods of waste reduction, waste reuse and recycling are the preferred options when managing waste. There are many environmental benefits that can be derived from the use of these methods. They reduce or prevent greenhouse gas emissions, reduce the release of pollutants, conserve resources, save energy and reduce the demand for waste treatment technology and landfill space. Therefore, it is advisable that these methods be adopted and incorporated as part of the waste management plan.

Sound practice of MSW in different cities in India have adopted different strategies to deal with solid waste. Solid waste management in Rohtak is aimed to solve the challenges faced by local authorities in managing solid waste. It is essential to improve and ensure high-quality services in solid waste management, and provide recommendation and implementation policies and strategies pertaining to solid waste management services, as well as promoting participation and awareness among the public. In Rohtak, major issues of MSWM are: people are not following segregation of waste at source, Lack of awareness among public, segregation of plastic waste, littering of waste, waste causing choking of drains & sewerage system, open burning of waste practice in villages.

VII. Conclusions

Population growth and development of cities is making SWM in India enhances waste generation. Many cities have inadequate waste management infrastructure and inappropriate waste dumping. Major issues associated are with public participation in waste management and there is generally a lack of responsibility towards waste in the community. There is a need to cultivate community awareness and change the attitude of people towards waste, as this is fundamental to developing proper and sustainable waste management systems. Sustainable and economically viable waste management must ensure maximum resource extraction from waste, combined with safe disposal of residual waste through the development of engineered landfill and waste-to-energy facilities.

The decentralized approach is one of the effective methods to solve the problems of waste management in India as it has potential to reduce the quantity of waste by changing the mindset of the people and reduces the transportation cost, reduces the traffic congestion, reduces the amount of air pollution, road maintenance cost, and contamination of ground water through the seepage of leachates. More important, it

reduces the amount of waste in landfill sites as the land is a major constraint of the solid waste management system. Providing adequate resources, encouraging workers, developing a strong policy, incorporating technological innovations, providing monetary incentives for recyclable items, support from political leadership, encouraging waste reduction, composting and recycling techniques have been recommended for effective and successful waste management.

For Rohtak, increasing public awareness is important, but simply creating awareness is not enough to promote the people's participation in SWM. Building capacity of the municipality is a key to facilitating the public participation process and fostering longer term sustainability. Equally, there should be a strategy that involves educating people, developing knowledge and self-reliability that is necessary for them to actively participate in the entire management process of solid waste. Segregation should be promoted at all levels, litter awareness and prevention plan at city level, ban on open burning, door-to door collection of waste at village level, providing regular training to workforce and adopting most preferred and appropriate methods like composting, waste-to energy, recycling and use of plastic waste in road construction have been recommended for effective and successful waste management in the Rohtak city.

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