Assessment of Municipal Solid Waste Management in Kochi City

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***Abstract*— Considering the case of Kochi City (Ernakulam, Kerala), Solid waste management is a major issue. Improper Management of MSW (Municipal Solid Waste) leads to air, water and soil pollution. Kochi City have been facing issues related to the collection, treatment and management of solid waste. Therefore, there is an urgent need for an improved planning and implementation of comprehensive solid waste management system for upgrading the environmental scenario of the city.**

Keywords—Municipal Solid Waste

I. INTRODUCTION

Municipal solid waste management (MSWM) is a methodical approach that includes storage, collection, transportation, resource recovery, processing and disposal of solid waste. Municipal Solid Waste management is important since it impacts health, environment and aesthetics of the society, if not treated properly. MSWM plan follows the principles of Integrated Solid Waste Management (ISWM) Hierarchy. In ISWM, suitable techniques, technologies and management programs covering all types of solid wastes from all sources are used. The main objectives of ISWM are (a) wastereduction and (b) effective management of waste still produced after waste reduction. Due to Urbanization and rapid growth of population, solid waste generation and its management has become a huge problem these days.

II. CITY PROFILE: KOCHI

Cochin also known as Kochi is situated in the Ernakulam district of the State of Kerala. The city is administrated by the Kochi Municipal Corporation (KMC). Kochi has 74 wards within seven administrative zones. The Kochi Municipal Corporation extends to an area of 94.88 sq.km. As per census of India, the population of Kochi Corporation in 2001 is 5, 95,575 and the population in 2011 is 6, 01,574. The density of the city is 6,340 persons per sq. km against a density of 819 persons per sq. km in Kerala, 382 persons per sq. km in India and a world average of 46 persons per sq. km in 2011 (Census2001,2011)

A. Sources of MSW in Kochi

The common sources of MSW comprises of Residential, Commercial, Industrial, Agricultural, Construction and Demolition, Industrial and Municipal Wastes.

III. MATERIALS AND METHODS

For proposing an Integrated Solid Waste Management system in the city, primary and secondary data were collected. Also physical and chemical analysis of the waste, population forecasting of Kochi city were conducted.

A. Primary and Secondary data collection

The details of the primary and secondary data were collected from the ULB (Urban Local Body), i.e the Cochin corporation office. All the primary data were collected directly from the officials of Health and Engineering Department.

TABLE I. DATA COLLECTED FROM COCHIN CORPORATION OFFICE (AS OF DECEMBER 10, 2020)

Sl No	Item	Description
1	Name of Municipal Body.	Cochin Corporation
2	Total quantity of Solid waste generated tons per day	326 ton
3	Composition of Solid Waste (Tons per Day)	Wet-226 Dry-100
4	Quantity of waste collected tons perday	314 tons
5	Area considered for collection of waste	98 sq.km
6	Number of sanitary workers	1823
7	Number of trucks	55
8	Number of Hand Carts	500
9	Approximate quantity of waste at site	100000 ton
10	Quantity of waste processed	250 ton
11	Quantity of waste disposed by landfilling	99750 ton

B. *Waste Characterization*

MSW Characterization has been done to find out the physical and chemical components of MSW being generated from parts of the city. Samples of MSW from selected locationsof different parts of city were collected for analyzing the physical & chemical Characteristics of MSW. The physical and Chemical characteristics of the collected waste was analysed.

C. *Waste Composition Analysis by Segregation*

Waste composition analysis is a process of physically separating, weighing and categorising waste. The composition of MSW varies from one place to another. Such variations mainly depend on the lifestyle, economic situation, population, commercial and industrial activities, food habits, cultural traditions, climatic conditions etc. The quantity and the composition of MSW is critical for the determination of the appropriate handling and management techniques of these wastes.

- Samples were collected from 5 different wastecollection points in the city.
- Collected samples are then mixed and weighed askilogram.
- The samples were characterized as food waste, glass,textiles, metals, paper, plastics, others.
- These characterized wastes were then weighed separately

TABLE II. WASTE COLLECTION DETAILS

Sampling Point	Quantity of waste collected (Kilogram)
A	2
B	2
C	2
D	2
E	2
Total quantity of waste collected	10

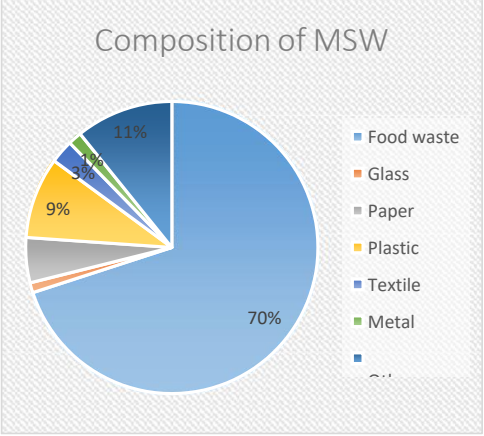

Fig 1: Composition of MSW

TABLE III. WASTE COMPOSITION (FROM PHYSICAL ANALYSIS)

Sl No	Components	Quantity (Kilogram)	Percentage by weight
1	Food waste	7	70
2	Glass	0.11	1.1
3	Textiles	0.26	2.6
4	Metals	0.15	1.5
5	Paper	0.5	5
6	Plastics	0.9	9
7	Others	1.08	10.8

D. *Quartering and coning method*

By quartering & coning method, representative sample of around 0.5 kilogram was prepared. The collected samples werealso analyzed for its chemical characteristics.

Fig 2: Shredded waste sample taken for Testing

TABLE IV. RESULTS OF COLLECTED WASTE FOR SELECTED PARAMETERS

Parameter	Test Method	Results
pH	IS3025(P) 11-1983RA2017	4.21
Carbon as C	PCL/SOP/SL/04	37%
Sodium as Na	IS 3025(P) 45-1993RA2014	0.04%
Phosphate as PO4	IS 3025(P) 31-1988 RA2014	0.9%
Nitrogen as N	IS 3025(P) 34-1988 RA2014	0.3%
Potassium as K	IS 3025(P) 45- 1933 RA2014	0.02%

E. *Population Details and Population Projections*

To arrive at the population of the city for a design period of 20 years, three population projection methods have been used. These methods are as follows:

1. Arithmetic increase method
2. Geometric increase method
3. Incremental increase method

TABLE V. AVAILABLE POPULATION DETAILS

Year	Population
2011	601574
2012	628464
2013	656116
2014	685313
2015	715809
2016	747662
2017	780932
2018	815683
2019	851980
2020	889893
2021	929493

TABLE VI. PROJECTED POPULATION

Year	Projected Population		
	Arithmetic Increase Method	***Geometric Increase Method***	***Incremental Increase Method***
2031	962285	970763	963698
2041	995077	1013865	999316
2051	1027869	1058880	1036347

Population is estimated by Arithmetic increase method, Geometric increase method and Incremental increase method. However geometric increase method is taken into consideration since this method projects higher value than the other.

IV. EXISTING WASTE MANAGEMENT PRACTICES IN KOCHI CITY

A. Door to Door Collection

The corporation has provided separate waste collection bins to each household, one for collecting bio- degradable waste and the other for collecting non bio- degradable waste. The corporation has also authorised certain individuals (from kudumbashree) for collecting waste from each household. Initially these waste collectors were under the control of the residents association, but now they are under the direct supervision of the local councillors. The corporation has provided them with handcarts for the purpose of transporting waste to common collection points. The corporation, through the resident's association has requested the households to segregate the waste at source itself and deposit the non- biodegradable and bio-degradable waste in the respective baskets provided. The door-to-door waste collectors would come to each household early in the morning each day except public holidays and Sundays and would take away the waste kept in the respective baskets. Non bio-degradable wastes are collected once in a week. These waste collectors are paid a fixedremuneration of Rs.150 per month by each household. Each door-to-door waste collectors covers on an average of 150 households each day. Towards the afternoon, these waste collectors bring all the waste collected by them in the morning to the common collection points from where they would load the wastes onto the corporation lorries which would carry the waste away. Sometimes the corporation fails to carry away wastes from common collection points leading to the accumulation of wastes at such spots.

B. Transportation

The collected wastes from the collection point are transported to dumping yard in Brahmapuram, with the help of lorries covering all portions of the city. The available number of trucks are not sufficient for the current waste collection.

C. Final Disposal of MSW

The existing plant has two main components, i.e., 'windrow composting' and 'open dumping'. There is a non- functional RDF (Refuse Derived Fuel) Facility, Vermicomposting Plant, Plastic Shredding and Bailing Unit. Also, the windrow composting capacity is less than the actual waste collected on daily basis, i.e. windrow composting capacity is 250TPD and the current waste generation is about 314TDP. The current waste treatment practices at the city cannot be considered as sustainable. The problems related to open dumping of inorganic waste are crucial rather than the decomposition of biological waste. Here an integrated waste management solution is suggested.

V. PROPOSED SOLID WASTE MANAGEMENT SYSTEM

Due to rapid increase in the waste generation in the city, it is imperative to improve the waste management infrastructure of the city. The proposed solid waste management system includes recommendation for treatment of both Biodegradable and Non-Biodegradable wastes.

A. Recommendation for Treatment of Biodegradable Waste

1. Household Level Treatment

To promote source-level treatment for interested households and establishments.

a) Pot composting (including 3 pot composting)
b) Kitchen bin, Ring Compost
c) Bucket composting
d) Bio-composter
e) Indoor vermicomposting

2. Institutional Level Treatment

As per SWM Rules (2016), Markets, Restaurants, and all institutions and gated communities having an area greater than 5000m² are made mandatory to treat biodegradable waste within their premises. Use of Biogas plants or composting facilities such as organic waste converters, vermicomposting units, bio-bins, aero bins, etc. can be used depending on the quantity of waste generated

within their premises. The setup of processing facility should be encouraged within their own premises and they should be built on a raised platform.

3. Community level treatment

The use of Bio bins may be promoted in high rise building and large housing complexes. The treatment facility up to 5 TPD (Tones Per Day) can be setup in community level. The use of Bio gas plant at community level can be promoted at suitable locations where biogas could be utilized for the community kitchen or for slums, informal settlement, etc. Increasing the number of storage container at collection points could be encouraged.

4. Community Participation

Active Community participation should be the main component of Integrated Waste Management in populated city like Kochi. Also achieving this target may be difficult task i.e. creating awareness among residents about waste and its management practices. The Kochi Municipality along with other organizations can organize awareness programs for source level waste minimization, segregation methods, promoting the use of recycling of the waste. Conducting public awareness campaign through public rallies, meetings, street plays and distributing pamphlets. Meetings should be held withmunicipal authorities and local representatives at suitable intervals for discussions and for the active communityparticipation.

B. Recommendation for Centralized treatment of Biodegradable waste

Assuming that about 18-25% of the total biodegradable waste will be treated in the household level or institutional level or community level, the rest of the waste needs to be treated and disposed.

1. Technologies not recommended:

Based on the geographical conditions of Brahmapuram, heavy monsoon occurs seasonally, open windrow composting technology is not found suitable throughout the year. Also, vermicomposting technology cannotbe promoted in coastal areas, since they are more prone to heavy rains, floods, and high-water tables. More innovative and efficient methods are to be adopted in these areas.

2. Technologies recommended:

- Aerated Static Pile Composting technology
- In-vessel composting including Rotary Drum technology
- Bio-methanation technology
- Biogas to Compressed Biogas (CBG) technology
- Biogas to Thermophilic High Solid AD technology
- Biogas to Electricity generation technology
- Co-processing of biodegradable waste with septage technology

C. Recommendation for Management of Non - Biodegradablewaste

1. Material Recovery Facility (MRF)

SWM rules, 2016 mandates the efficient use of MRF. Although MRF facilities are established, they are not built under the SWM Rules. Since the current Material Recovery Facility are non-functional, the municipal authorities should setup the Material Recovery Facilities to handle all kind of Non- biodegradable Wastes. The segregated wastes in MRF may be used as Recyclable Material, Non-Recyclable Material (shredded and used for road construction), Combustible waste (used as RDF for cement Kilns).

2. Setting up of sanitary landfills at a regional level

Properly designed sanitary landfill which is managed in a professionally and environmentally acceptable manner should be set up in the city. Proper arrangements for storage, drainage, landfill gas and leachate collection system and other considerations should be ensured. The existing dumpsites in Kerala are floating in legacy waste. With this there is no place for the disposal of waste that being produced every day. Due tothis, large area of land is getting wasted and polluted.

3. Biomining/Processing of Existing waste

The process of bio mining helps out here. Agencies like NGT (National Green Tribunal) and CPCB (Central Pollution Control Board) guidelines suggests this method. In this, segregation of waste is carried out in to compostable matter, recyclable, non-recyclable, combustible and inert material. These segregated materials undergo different processes according to their type. They can be recycled, reused as a resource for manufacturing of another product, converted to RDF etc...

For the restoration of the lands it's necessary to know their level of contamination. It can be done with the help bore logs. While the lands which are contaminated with heavy metals may need a longer period and scientifically suitable treatments for their restoration. Thereby only inert and rejected material end up disposed in landfills, and the remaining lands can be used for developing new treatment facilities, MRFs. By this around 60-70 % of land can be recovered and can be used for an efficient SWM.

D. Integrated MSW Management system

From studies it's clear that there is a need for a scientific MSWM system in the city. The proposed solution consists of integration of methods, i.e., 4R (Reduce, Recycle, Recover, Reuse), composting, gasification and land filling. It's important that the method like 4R should be followed by every single citizen. By carrying out all these methods properly it's possible to improve the efficiency of waste management.

During Recycling the waste is used as the resource for the production of another product. By adopting reducing method one limits the use of resources and helps to conserve it. Recovering is the process in which energy values from waste is being recovered. Whereas reuse is simply using the waste afterprocesses like refurbishing and repairing.

The process of production of compost by piling up biodegradable waste or organic matter in long windrows(rows) is called windrow composting. The current insufficiency of land for windrow composting will be resolved after biomning. In Gasification process low or medium BTU (British Thermal Unit) gas is produced by the devolatilization of solid or liquid hydrocarbons. It's an effective method for the recovery of energy from the waste. This energy being produced can be usedfor the operations of the plant. Unlike conventional combustionmethod it uses less oxygen and thereby reduces the formation of dioxins, NOx and SOx.

VI. CONCLUSION

All the main problems related to the waste management are identified. Assessing the main problems and considering all the alternatives, recommendations in each stage for the MSWM are suggested. This paper suggests an integrated municipal solid waste management plan for Cochin City. Future studies should be carried out for checking the efficiency of the proposed methods.

This study introduces various alternatives for the MSWM. The most economical and viable methods can be used for treating the waste from the city. The physical and chemical characterization of the waste indicates that the wastes are rich in biodegradables and plastics. The population forecasting details show that the waste produced in the future years are much higher and it keeps on increasing. Through the combined efforts of individuals from household and a proper MSWM system, Kochi city will be able to dispose waste generated and in future, piling up of legacy waste can be avoided.

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