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AN ASSESSMENT OF SOLID WASTE MANAGEMENT IN MANGALURU CITY, KARNATAKA: A CASE STUDY

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Abstract:

Mangalore has become a city which is developing very rapidly in recent years, along with increase in the amount of solid waste generated in the city. Present Mangalore city is facing serious problems as a result of current waste disposal activities, incurring high cost due to lack of infrastructural facilities. Additionally, open dumping in the city zone present several problems to infrastructural built up on these old dumps. Much of the solid waste dump in the open area poses health risk to near residents. At present in Mangalore city corporation area, an average of 330 TPD of municipal solid waste is generated and collected every day. It includes all kinds of solid waste i.e. wet waste, dry waste, sanitary waste, hazardous waste and e-waste. One more important thing to note here is MCC doesn't handle industrial wastes. Primary and secondary data were used for analysis. This research includes a measurement of the amount of waste produced in Mangalore city. This study examines how solid waste can raise day by day, as well as the changing solid waste scenario. We have used simple statistical approach in this case. The primary data have been gathered from the Mangalore City Corporation (MCC) and the secondary data have been collected from the internet, books, public agencies, reports, journals, and sources. The current attempt to identify determinants that have asset the changes respect to solid waste management in Mangalore.

Key words: Solid Waste, Urbanization, swachh bharat, CPCB, Etc.

Introduction:

Almost everything that we use degenerates and loses its utilities over a period of time. Many things become unusable after we use them only once. We then throw them away. Everything we discard after it loses its usability is known as "SOLID WASTE" or "GARBAGE" Solid waste refers to all non-liquid wastes. In general it doesn't include excreta, although sometimes nappies and faces of young children may be mixed with solid waste. Solid waste can create significant health problems and very unpleasant living environment if not disposed off safely and appropriately. There are different sources from where the solid waste or garbage is generated everyday from individual households (domestic waste) and from industries and commercial establishments. However all such wastes are not uniform in nature? Broadly speaking, solid wastes can be divided into distinct categories;

i. Biodegradable waste
ii. Non- biodegradable waste

- We define biodegradable waste materials as those substances made of organic matter, such as plant and animal matter that can be easily broken down by nature. For example, vegetable peels and other kitchen waste, vegetables, fruits, tea leaves, paper, wood etc.
- Non- biodegradable waste materials are those materials, which cannot be broken down easily, and retain their form for a long period of time. For example: metals, tin, glass, plastics etc.

Solid waste disposal: The garbage that we generate everyday has not only increased in volume phenomenally, but also has changed its composition due to changes in our lifestyle and consumption pattern. For instance, there is now an increasing use of non-biodegradable materials such as plastics, metals and glasses, specifically in urban areas. Technological progress /

advancement has further brought in an increasing use of electronic items and gadgets. These are useful for us, but when discarded [known as E-waste] they can be harmful to the environment and human health, particularly for the workers associated with this occupation. In addition, we seem to have lost our aesthetic and civic sense and carelessly litter garbage around on the roads, in the market place, in open drains, ponds, rivers, seas and so on. In fact, we keep throwing a lot of garbage every day.

Solid waste management: Solid waste management or waste disposal includes the processes and actions required to manage waste from its inception to its final disposal. This includes the collection. Transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste – related laws, technologies, economic mechanisms. Waste management deals with all types of waste, including industrial, biological, radioactive waste, household, Municipal, organic, biomedical. Health issues are associated throughout the entire process of waste management either directly or indirectly.

- Waste management is intended to reduce adverse effects of waste on human health, the environment, planetary resources and aesthetics.
- The aim of waste management is to reduce the dangerous effects of such waste on the environment and human health. A big part of waste management deals with municipal waste which is created by industrial, commercial and household activities.

Waste management practices are not uniform among countries [developed and developing nations], regions [urban and rural areas], and residential and industrial sectors can all take different approaches. Proper management of waste is important for building sustainable and livable cities, but it remains a challenge for many developing countries. A report found that effective waste management is relatively expensive, usually comprising 20% - 50% of municipal budgets. A large portion of waste management practices deal with municipal solid waste (MSW) which is bulk of the waste that is created by household, industrial and commercial activities. According to the Intergovernmental Panel on Climate Change (IPCC), municipal solid waste is expected to reach approximately 3.4 GT by 2050; however policies and law making can reduce the amount of waste produced in different areas and cities of the world. Rapid population growth, urbanization, and industrialization have resulted in serious waste management issues in many cities throughout the developing and under developed world, including India. While municipal solid waste a necessary component of every community lacks the destructive potential of either global warming or stratospheric ozone depletion, it has long posed threats to environmental quality and human health. Uncontrolled population, monthly income, standard of living, percentage of urban population, dwelling population, consumption habits, size of housing units, geographical location, age, productive activities, land use pattern and cost of living are some common factors that influence the rate of unit waste generation. Estimating the amount of solid waste generated in a city is critical for proper solid waste management. Although most developed countries regarded their waste as commodities, inadequate waste management has become a difficult problem for developing country governments. Municipal solid waste is commonly characterized as waste generated in a municipality in developing economies. Most municipal solid waste produced in developing countries is not segregated and thus may be hazardous or nonhazardous. On general, the effect of urban solid waste on the atmosphere and quality of life is primarily relates to air, water, soil pollution. It is also linked to odors, room use and aesthetic bias. Waste collection is at a crossroads due to lack of suitable facilities to handle and dispose of the large quantities of municipal solid waste produced daily in metropolitan cities. Municipal solid waste accumulates in every nook and corner due to poor collection and insufficient transportation. Because of poor waste management, waste has become a source of pollution, causing a variety of environmental effects as well as risks to human health and safety. Solid waste production is frequently the most significant threat to the fragile ecosystem.

Sources of solid waste: In most emergency situations, the main sources of solid waste are;

- Medical centers
- Food stores
- Feeding centers
- Food distribution points
- Slaughter areas
- Warehouses
- Agency premises
- Markets
- Domestic areas
- Solid domestic garbage
- Solid waste material from various industries
- Solid agricultural waste
- Plastic, glass, metals, e-waste, etc.
- Construction waste, sewage sludge.

Appropriate solid waste management strategies may vary for institutional, communal and domestic sources, depending on types and volumes of waste. Waste from medical centers poses specific health hazards.

Types of solid waste: The type and quantity of waste generated in emergency situations varies greatly. The main factors affecting these are:

- The geographical region (developed or less developed country or region)
- Socio-cultural practices and material levels among affected population
- Seasonal variations (affecting types of food available)
- The stage of emergency (volume and composition of waste may change over time)

- The packaging of food rations

Guidelines values suggest that each person is likely to produce 0.5-1.0 liters of refuse per day with an organic content of 25 to 35% and moisture content between 10 and 60%. However, this is likely to vary greatly and estimates should be made locally.

Different categories of solid waste include

Organic waste: waste from preparation of food, market places etc.
Combustibles: paper, wood, dried leaves, packaging for relief items, etc. (high organic and low moisture content)
Non-combustibles: metal, tin cans, bottles, stones etc.
Ashes/dust: residue from fires used for cooking
Bulky waste: tree branches, tyres, etc.
Dead animals: carcasses of domestic animals and livestock
Hazardous waste: oil, battery acid, medical waste
Construction waste: roofing, rubble, broken concrete, etc.

Key components of solid waste management

Solid waste management can be divided into 5 key components:

- Generation
- Storage
- Collection
- Transportation
- Disposal

Generation: Generation of solid waste is the stage at which materials become valueless to the owner and since they have no use for them and require them no longer, they wish to get rid of them. Items which may be valueless to one individual may not necessarily be valueless to another. For example, waste items such as tins and cans may be highly sought after by young children.

Storage: Storage is the system for keeping materials after they have been discarded and prior to collection and final disposal. Where on-site disposal systems are implemented, such as where people discard items directly into family pits, storage may not be necessary. In emergency situations, it is likely that affected population will discard domestic waste in poorly defined heaps close to dwelling areas. If this is the case, improved disposal or storage facilities should be provided fairly quickly and these should be located where people are able to use them easily. Improved storage facilities include:

- Small containers: household containers, plastic bins etc.
- Large containers: communal bins, oil drums etc.
- Shallow pits
- Communal depots: walled or fenced-in areas.

In determining the size, quantity and distribution of storage facilities, the number of users, types of waste and maximum walking distance must be considered. The frequency of emptying must also be determined and it should be ensured that all facilities are reasonably safe from theft or vandalism.

Collection: Collection simply refers to how waste is collected for transportation to the final disposal site. Any collection system should be carefully planned to ensure that storage facilities do not become overloaded. Collection intervals and volumes of collected waste must be estimated carefully.

Transportation: This is the stage when solid waste is transported to the final disposal site. There are various modes of transport which may be adopted and the chosen method depends upon local availability and the volume of waste be transported. Types of transportation can be divided into 3 categories;

- Human powered: open hand cart, hand cart with bins, wheel burrow, and tricycle.
- Animal powered: donkey-drawn cart.
- Motorized: tractor and trailers, standard truck, tipper truck.

Disposal: The final stage of solid waste management is safe disposal where associated risks are minimized. There are 4 main methods for the disposal of solid waste.

- Land application: burial and land filling
- Composting
- Burning or incineration
- Recycling (resource recovery)

On-site disposal options: The technology choices outlined below are general guidelines for disposal and storage of waste on-site, these may be adopted for the particular site and situation in question.

Communal pit disposal: Perhaps the simplest solid waste management system is where consumers dispose of waste directly into a communal pit. The size of pit will depend on the no. of people it serves. The long-term recommended objective is 6 cubic meters per fifty people. The pits should be fenced off to prevent small children falling in and should generally not be more than 100m from the dwellings to be served. Ideally, waste should be covered at least with a thin layer of soil to minimize flies and other pests. It is easy to implement, and requires little operation and maintenance but the distance to communal pit may cause indiscriminate disposal; and waste workers required to manage pits.

Family pit disposal: Family pits may provide long-term option where there is adequate space. These should be fairly shallow (up to 1m deep) and families should be encouraged to regularly cover waste with soil from sweeping or ash from fires used for cooking. This method is best suited where families have large plots and where organic food wastes are the main component of domestic refuse. No external waste workers are needed and community mobilization can be incorporated into hygiene promotion programmed, yet it involves considerable community mobilization for construction, operation and maintenance of pits; and considerable space is needed.

Communal bins: Communal bins or containers are designed to collect waste where it will not be dispersed by wind or animals, and where it can easily be removed for transportation and disposal. Plastic containers are generally inappropriate since these may be blown over by wind, can easily be removed and may be desirable for alternative uses. A poplar solution is to provide oil drums cut in half. The base of these should be perforated to allow liquid to pass out and to prevent their use for other purposes. A lid and handles can be provided if necessary. In general, a single 100-litre bin should be provided for every 50 people in domestic areas, every one hundred people at feeding centers and every 10 market stalls. In general, bins should be emptied daily. Bins are potentially a highly hygienic and sanitary management method and final disposal of waste well away from dwelling areas. Significant collection, transportation and efficient management is essential.

Family bins: Family bins are rarely used in emergency situations since they require an intensive collection and transportation system and number of containers or bins required is likely to be huge. In the later stages of an emergency, however, community members can be encouraged to make their own refuse baskets or pots and to take responsibility to empty these at communal pits or depots.

Communal disposal without bins: For some public institutions, such as markets and distribution centers solid waste management system without bins can be implemented, whereby users dispose of waste directly onto the ground. This can only work if cleaners are employed to regularly sweep around market stalls, gather waste together and transport it to a designated off-site disposal area. This is likely to be appropriate foe vegetable waste but slaughterhouse waste should be disposed of in liquid-tight containers and buried separately.

- **transportation options**

Where bins or collection containers require emptying, transportation to the final disposal point is required. As described, waste transportation methods may be human-powered, animal-powered or motorized.

Human-powered: Wheelbarrows are ideal for the transportation of waste around small sites such as markets but are rarely appropriate where waste must be transported considerable distances off-site. Handcarts provide a better solution for longer distances since these can carry significantly more waste and can be pushed by more than one person. Carts may be open or can be fitted with several containers or bins.

Animal-powered: Animal powered transportation means such as a horse or donkey with cart are likely to be appropriate where they are commonly used locally. This may be ideal for transportation to middle distance sites.

Motorized: Where the distance to the final site is great, or where the volume of waste to be transported is high, the use of motorized vehicle may be the only appropriate option. Options include tractor and trailer, a standard truck, a tipper-truck, the final choice depending largely on availability and speed of procurement. For large volumes of waste it may sometimes be appropriate to have a two-stage transportation system requiring a transfer station. For example, waste is transported by a handcart to a transfer station where it is loaded into a truck to be taken to an off-site disposal site several kilometers away.

Off-site disposal options: The technology choices outlined below are general options for the final disposal of waste off-site.

Land filling: Once solid waste is transported off-site it is normally taken to a landfill site. Hence the waste is placed in a large excavation (pit or trench) in the ground, which is back-filled with excavated soil each day waste is tipped. Ideally, about 0.5m of soil should cover the deposited refuse at the end of each day to prevent animals from digging up the waste and flies from breeding. The location of landfill site should be decided upon through consultation with the local authorities and the affected population. Sites should preferably be fenced, and at least one km downwind of the nearest dwellings.

Incineration: Although burning or incineration is often used for the disposal of combustible waste, this should generally only take place off-site or a considerable distance downwind of dwellings. Burning refuse within dwelling areas may create a significant smoke or fire hazard, especially if several fires are lit simultaneously. Burning may be used to reduce the volume of waste may be appropriate where there is limited space for burial or landfill. Waste should be ignited within pits and covered with soil once incinerated, in the same manner as land filling. The same constraints for sitting landfill sites should be applied here also.

Composting: Simple composting of vegetables and other organic waste can be applied in many situations. Where people have their own gardens or vegetable plots, organic waste can be dug into the soil to add humus and fiber. This makes the waste perfectly safe and also assists the growing process. This should be encouraged wherever possible, particularly in the later stages of an emergency program. Properly managed composting requires careful monitoring of decomposing waste to control moisture and chemical levels and promote microbial activity. This is designed to produce compost which is safe to handle and which acts as a good fertilizer. Such systems require considerable knowledge and experience and are best managed centrally. In general, they are unlikely to be appropriate in emergencies.

Recycling: Complex recycling systems are unlikely to be appropriate but the recycling of some waste items may be possible on occasions. Plastic bags, containers, tins and glass will often be automatically recycled since they are likely to be scarce commodities in many situations. In most developing countries context there exists a strong tradition of recycling leading to lower volumes of waste than in many more developed societies.

Effective 'waste management' involves the practice of **"7R",** i.e.

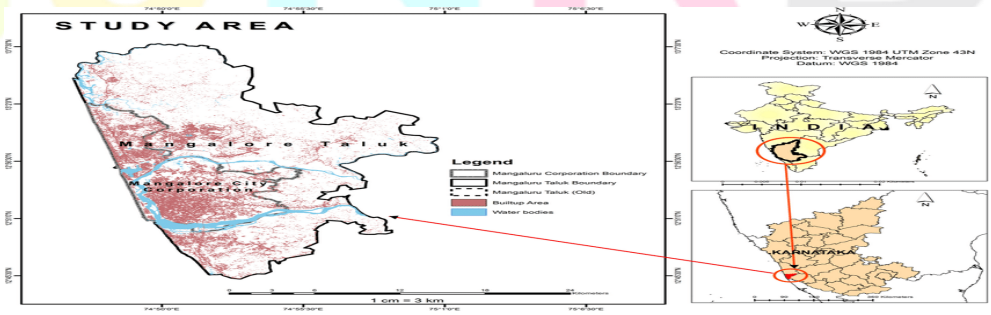
- Refuse
- Reduce
- Reuse
- Repair
- Repurpose
- Recycle
- Recover

Among these 7R's, the first two ('Refuse' and 'reduce') relates to the non- creation of waste by refusing to buy non-essential products and by reducing consumption. The next two ('reuse' and 'repair') refers to increasing the usage of the existing product, with or without the substitution of certain parts of the products. 'Repurpose' and 'Recycle' involves maximum usage of the materials used in the product, and 'Recover' is the least efficient waste management practice involving the recovery of embedded energy in the waste material. For example- burning the waste to produce heat (and electricity from heat). Human activities produce waste, which is an unavoidable consequence. Urban society rejects and generates solid materials on a regular basis as a result of rapid increase in production and consumption, resulting in a significant increase in the volume of waste generated from various sources such as domestic waste, commercial waste, institutional waste and industrial waste of various categories. According to the Central Pollution Control Board (CPCB), India produced 1,43,449 tons of municipal solid waste per day (TPD). 80% of municipal solid waste was collected in 2014-15. The Ministry of Urban Development started the Swachh Bharat Mission (SBM) in 2014 to promote municipal solid waste management in cities. Swachh Bharat Mission's major goal is to organize and to manage municipal solid waste trash in a methodical manner.

Location and Study Area

Mangalore is the fourth largest city in Karnataka state and is located on the west coast of southern India. Growing cities like Mangalore along with various environmental problems have rising solid waste problems. It is the largest urban coastal city in the state and the headquarters for the district of Dakshina Kannada.

The latitudinal and longitudinal extension of the city is 12 50'30" N and 13 01'00" N and 74 48'0" E to 74 55'00" E. the city is situated at the confluence of the Netravati and Gurupura rivers, with the Western Ghats to the east and the Arabian sea to the west. Three national highways pass through the district, including NH-13 which connects Mangalore and Sholapur, NH-17 connects Panvel and Kanyakumari, while NH-48 connects Mangalore and Bangalore. The city has an international airport at Bajpe. Mangalore City Corporation was established in the year 1865, and at present, it has 60 wards. MCC area (172 sq.kms) is sharing its boundary with the Arabian sea on the west, Kerala state on the south, on the north with Udupi district, and on the east with Bantwal taluk. It is a rapidly growing city in terms of education, commerce and industry. Mangalore has now become a medical hub. The city which has population of over 6 lakh people also faces solid waste management challenges.



Topography: The city's topography consists of a plain that stretches up to 30km (18.64mi) from the coast and undulating, hilly terrain towards the east near the Western Ghats. The local geology is characterized by hard laterite soil in hilly tracts and sandy soil along the sea shore. The Geological Survey of India has identified Mangalore as a moderately earthquake- prone urban centre and categorized the city in the Seismic III Zone.

Climate: Under the Koppen climate classification, Mangalore has a tropical monsoon climate and is under the direct influence of the Arabian Sea branch of the southwest monsoon. It receives about 95% of its total annual rainfall between May and September

but remains extremely dry from December to March. Humidity is approximately 75% on average and peeks during June, July and August. The maximum average humidity is 93% in July and average minimum humidity is 56% in January. Mangalore experiences moderate to gusty winds during day time and gentle winds at night. The driest and least humid months are from December to February. The summer gives way to the monsoon season, when the city experiences the highest precipitation of all urban centers in India due to the influence of the Western Ghats. The rains subside in September but there is occasional rainfall in October.

Objectives

- To know the changing scenario of solid waste in Mangalore city
- To evaluate the major waste generated and
- To know the disposal system in the study area

Objectives of solid waste management in general:

The National policy on solid waste was instituted by law no. 12,305 of August 2, 2010. The legislation established goals and objectives for individuals and companies related to waste management to existing laws and regulations, environmental preservation by reducing the use of landfills and the reverse logistics of post-consumer waste. Considered a milestone in Brazilian environmental legislation for defining responsibility for the management of solid waste, the PNRS was in process for 20 years and established goals such as ending the disposal of waste in dumps by 2014, which ended up being extended to 2023. However, even in 2020, the goal was not achieved in several locations.

Protection of public health: Waste management is also a way of taking care of public health after all waste can cause a number of diseases. The dumps contaminate the soil and water causing health problems for the population that eventually has contact with some virus, bacteria or toxic substances. In addition, they emit greenhouse gases which cause climate change. According to the scientific article 'Urban Solid Waste- socio- environmental impacts and the perspective of sustainable management with social inclusion' by Nelson Gouveia, from the Preventive medicine department at the university of USA, there are several environmental impacts generated from the disposal of solid waste that pose worrisome risks to human health. Contaminated soil and air release high levels of organic compounds and heavy metals in communities that are close to waste disposal sites. People living in these regions have high levels of these compounds in their blood, which can cause cancer, abnormalities and harm to newborn children. The National Policy on solid waste determines that the public and the private sectors carry out waste management to prevent these materials from being sent in correctly to landfills. With support of research development and innovation from companies specialized in waste management, the energy capacity of the materials can be calculated allowing for example the targeting for more noble treatment systems. In this way, it is possible to avoid disposal in landfills and promote the circular economy.

To reduce, to reuse and to recycle: Decreasing the amount of waste generated is a goal of PNRS and an objective to be achieved by each waste generator. The internal reuse of waste is a reality and there are already companies that establish this practice as one of the ways of complying with the policy, since these are the quantitative and mandatory goals to be stipulated in this solid waste management plan. In the case of materials that cannot return to the production chain, companies must carry out the environmentally correct destination, making it possible to value the process, observing the valuation characteristics of each type of waste. Reducing the amount of materials in landfills and promoting conditions that make it possible to return to industries as low material is one of the promises of PNRS, reducing environmental impacts and pollution risks and promoting the circular economy.

Encouraging the Adoption of Sustainable Production and Consumption Patterns: The National solid waste policy was another source of incentive for waste generators to practice sustainability in all their processes. Some companies have started to look at the matter more carefully, measuring the ability to highlight their brand by investing in actions that promote the circular economy.

Development and improvement of clean technologies: Another PNRS objective that is worth highlighting is development of clean technologies to minimize environmental impacts. Today, there are research centers specialized in development and innovation, capable of studying waste and its characteristics, developing sustainable technologies to promote the circular economy.

Encouraging the Recycling Industry: The incentive to the recycling industry to encourage the use of raw materials and inputs from materials that have been recycled. In doing so, the company starts to spend less with the purchase of raw materials. In addition, you can create a new production line and promote the market with a sustainable product The objectives of solid waste management are to efficiently and effectively handle and dispose solid waste in a manner that minimizes the negative impact on human health, the environment, the society as a whole.

Methodology: Primary and secondary data were used for analysis. This research includes a measurement of the amount of waste produced in Mangalore city. This study examines how solid waste can raise day by day, as well as the changing solid waste scenario. We have used simple statistical approach in this case. The primary data have been gathered from the Mangalore City Corporation (MCC) and the secondary data have been collected from the internet, books, public agencies, reports, journals, and sources.

Solid waste management in Mangalore: Mangalore has become a city which is developing very rapidly in recent years, along with increase in the amount of solid waste generated in the city. Present Mangalore city is facing serious problems as a result of current waste disposal activities, incurring high cost due to lack of infrastructural facilities. Additionally, open dumping in the city

zone present several problems to infrastructural built up on these old dumps. Much of the solid waste dump in the open area poses health risk to near residents. At present in Mangalore city corporation area, an average of 330 TPD of municipal solid waste is generated and collected every day. It includes all kinds of solid waste i.e. wet waste, dry waste, sanitary waste, hazardous waste and e-waste. One more important thing to note here is MCC doesn't handle industrial wastes.

Source: Different kinds of waste are generated from various sources every day. It may be from hotels, households, complexes, various institutions, markets etc.

Table no. 1

Estimation of waste produced in the city every day in tons (2009)

Numbers	Types	Quantity of waste generated (kg/day)	Total waste generated (tons/day)
55419	Medium and high income households	1.00	55.419
28192	Low income households	1.00	28.192
2512	Slum households	1.20	3.014
11000	Shops (small)	0.75	8.250
3000	Shops (large)	1.00	3.000
400	Garages	2.00	0.800
100	Hotels and P.G	20.00	2.000
70	Boarding and lodging	10.00	0.700
90	Commercial complexes (medium and big)	19.00	1.710
40	Major choultaries and temples	250.00	10.00
20	Small choultaries and temples	90.00	1.800
105	Major institutions	8.00	0.840
9	Hotels (big)	20.00	0.180
40	Hotels (medium)	10.00	0.400
170	Hotels (small)	09.00	1.530
1	Market (big)	11000.00	11.00
8	Market (medium)	2700.00	21.60
9	Market (small)	900.00	8.100
60	Meat shop	3.00	0.180
145	Hospitals (include nursing homes and clinics)	100	14.50
-	**Total**	-	**173.215**

Source: *Mangalore city corporation, Karnataka, India*

In this table, there is a high amount of waste generated from medium and high income households which is nearly 55.00 tons and low income households are generating 28.192 tons of solid waste. Here households are producing more waste because approximately 83,192 (high, medium, low income) households are located in Mangalore city. Markets are producing second highest waste. Total 18 markets are located and they produce up to 40.10 tons of solid waste and the major one is the Central market. After households and markets, hospitals produce more biomedical waste per day. This is because Mangalore city is the medical hub in Karnataka after Bangalore and Mysore. Mangalore has more no. of hospitals and also a quarter no. of population from Kerala will come for treatment in Mangalore. Hospitals are followed by choultaries, shops, garages, meat shops, commercial complexes, educational institutions etc.

Table no. 2

Estimation of waste produced in the city every day in tons (2019)

Types	Numbers	Quantity of waste generated (kg/day)	Total waste generated (tons/day)
Medium and high income households	85000	1.00	85.000
Low income households	47192	1.00	47.192
Slum households	4104	1.00	4.104
Shops (small)	19689	0.40	7.8756
Shops (large)	9623	0.80	7.6984

Garages	911	2.00	1.822
Hotels and P.G	180	10.00	1.800
Boarding and lodging	100	5.00	0.500
Commercial complexes (medium and big)	175	16.00	2.800
Major choultaries and temples	70	200.00	14.00
Small choultaries and temples	39	60.00	2.340
Major institutions	170	8.00	1.360
Hotels (big)	30	20.00	0.600
Hotels (medium)	300	10.00	3.00
Hotels (small)	970	09.00	8.730
Market (big)	01	9000.00	9.00
Market (medium)	19	2300.00	43.70
Market (small)	25	600.00	15.00
Meat shop	200	3.00	0.600
Hospitals (include nursing homes and clinics)	210	100	21
Total	**-**	**-**	**278.48**

Source: *Mangalore City Corporation, Karnataka, India*

Table no. 2 shows the data of 2018-19, from where solid waste is generated and collected more. We can analyze that there is more amount of solid waste generated from medium and high income households than low-income households. Because of growing population more amount of waste is generated. Secondly markets produce more waste and especially the central market which generates 9 tons of waste per day. It is the main spot for selling all kinds of vegetables, fruits and flowers in a wholesale rate. This market has all kind of merchandisers, distributors and wholesale dealers. Vegetable, fruits and flowers come from various other districts, other states. From here all products will be distributed to medium and small markets. After markets, hospitals are the 3rd highest waste generating zone followed by choultaries, temples, shops, hostels and PGs, boarding and lodging, commercial complexes, meat shops etc. These are the important factors that can cause a solid waste increase in Mangalore city.

Table no. 3

Estimate of waste production in the Mangalore city corporation area

Year	Population	Waste in tons/day
2009	4,49,068	173
2012	4,84,924	192
2015	5,24,658	221
2017	5,87,312	249
2019	6,03,689	278
2023	7,49,000	330

Source: *Mangalore City Corporation, Karnataka, India.*

Table no.3 shows the changing scenario of solid waste from 2009 to 2023. Here, in 2009, population OF 4,49,068 produced 173 tons of solid waste per day whereas in 2023 it has been increased to 330 tons per day. In this span of years more than 100 tons of waste is increased in Mangalore city. It is because of the migration of people from other places of Karnataka and India in search of educational facilities, health care and job opportunities.

Collection: Currently, an average of 330 TPD of municipal solid waste is being generated and collected every day. Under the guidelines of Mangalore City Corporation, all wards of Mangalore city have door to door collection of waste through jeep tipper vehicle. It is transferred to secondary vehicle. The secondary vehicle then transports it to the processing plants. All kinds of solid waste (dry, wet, sanitary, hazardous, e-waste) except industrial waste is collected. E-waste collection centers are located in MCC Lalbagh and Surathkal and the waste is then sent to authorize recycling agents for processing. Same collection process is followed throughout the year. Due to increase in the moisture content during rainy season more time is consumed for processing of waste.

Waste in Mangalore is being collected by

- Street sweeping collection
- Door to door collection
- Dustbin collection
- Hand cart/ trolley

Primarily city corporation will allot some groups to collect waste, as per that groups they will collect waste from street sweeping, door to door collection, dustbin collection, and hand cart or trolley collection. After this collection they will transfer waste to collection vehicles, through that vehicle they will shift the waste to dumping yard. In that yard, they will segregate it into dry waste, wet waste etc.

Segregation and processing: Segregation and processing task is the difficult task in solid waste management as it involves much labor work and also consumes more time especially during the rainy season. After collecting the wastes from its source, it transported to the dumping yard where it is segregated first. One such dumping and processing unit is MUNICIPAL SOLID WASTE PROCESSING PLANT- located in Pachanady, on a vast area of 77.93 acres.

This unit collects waste from 60 wards that are under Mangalore City Corporation. It has capacity of 300 tons of solid waste per day.

The type of waste collected here are:

1. Wet waste
2. Dry waste
3. Tender coconut residue
4. Mix waste

Wet waste is processed to form compost that are used for the plants as manure, which is an organic fertilizer. It is processed using Trommel method. A trommel is a cylindrical separation device that rotates and performs size separation. It is a screen curved into a cylinder. The machine spins the cylindrical screen to sort through the material as you feed it through. During the process, the wet material tumbles around. Air gets added, and the soil, mulch or sand becomes lighter and drier Wet waste which includes chicken waste is dried and powdered and finally converted into compost. Mutton waste cannot be processed further hence it is buried. 60-70 tons of wet waste is collected here per day. The company named Ento- protein undertakes the production of compost out of dry waste in Mangalore. And the compost produced here is titled as ENTO – COMPOST. It is sold from here itself. This company, using trommel technology uses bio mechanization and black soldier flies to form the compo 16 varieties of dry waste is collected on every Fridays. It consists of paper, glass, thermocol, Styrofoam, rubber, metal, cloth, empty bottles, stationeries, etc. firstly they are separated or segregated using manual and conver system and later can be recycled into new products. On an average 160 tons of dry waste is collected on every Fridays. Since Mangalore is a coastal town and coconut plantations are vast in number, tender coconut residue is commonly seen. Tender coconut waste is also processed using trommel method to form the core material as well as coco pit. Around 20 tons of tender coconut waste is collected per day 120 to 130 tons of mixed waste is also collected which includes all kinds of waste materials like plastic, glass, domestic waste etc. Industrial waste is not much collected here. Because industrial wastes are directly collected by the recycling vendors or the main recycler. Agricultural waste or organic residue is processed using Windrows method. In agriculture, windrow composting is the production of compost by piling organic matter or biodegradable waste, such as animal manure and crop residues, in long rows – windrows and aerating them periodically by either manually or mechanically turning the piles.
Windrow method of composting: Plastics items which can be recycled are sent to the recycling units where they produce a new item from it. Nothing can be done with the non-recyclable plastics. Hence they are sent to the cement industries. Sanitary waste is processed in incinerators and hazardous and unused waste goes to the landfill.

Condition of the waste collectors or workers: The service of the people who collect this waste is really commendable. They work day and night in the processing units and their condition is considerably pathetic sometimes. They work hard even in emergency situations, irrespective of hot summer, stormy rain or chill winter. Pachanady processing plant has around 160 workers including office staff. Working hours vary for the waste collectors and segregators, office workers etc., usually it is morning 9 to evening 6. These workers work for less wages. The laborers are given regular training related to waste collection and segregation. There is also provision for periodic health checkups for the safety of Poura karmikas. They get the benefit of various government schemes like ESI etc. they are also provided with PPE kits, safety gears, gloves, masks etc for their safety of health.

Awareness in public regarding solid waste management: Mangalore City Corporation has come up with many awareness programs and various activities to educate the common public regarding proper waste management. Through newspaper articles and notifications, it always strives for cleaner Mangalore. It includes social media awareness, anti-littering signage, plastic ban activities, public awareness campaigns, street plays, awareness drives, rallies about plastic ban, source segregation, RRR campaign, ban of SUP, city beautification, black spot clearance, door to door awareness and many more.

Conclusion

The evolving trends in the quality and characteristics of municipal solid waste are posing a growing challenge to the authority charged with enforcing the municipal solid waste mandate. The evolving nature of waste highlights the importance of segregation for the effective operation of waste management facilities. To manage municipal solid waste, authorities should support waste collection, storage and segregation in a way that doesn't establish hazardous or unsanitary conditions. Waste reduction is difficult, and useful goods out of waste can be derived from it, leading to green employment and the improvement of society and the environment. The Indian government and local governments should collaborate with its partners to encourage source separation, increase recycling rates, and produce high-quality compost from organic waste. While this is being accomplished and recycling rates are rising, plans should be put in place to deal with the non-recyclable wastes that are currently being generated and will continue to be generated the future. State governments should be proactive in utilizing their power to

maximize resource efficiency. It is critical to improve SWM in Mangalore. Improper SWM puts public health, environment and quality of life in jeopardy. Improved SWM necessitates the recovery of materials and energy from waste. It not only adds value and makes SWM projects more economically viable, but it also makes them more sustainable.

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