CURRENT STATUS, CHALLENGES AND NEW APPROACHES FOR COLLECTION AND TRANSPORTATION OF MUNICIPAL SOLID WASTE IN BENGALURU- A REVIEW

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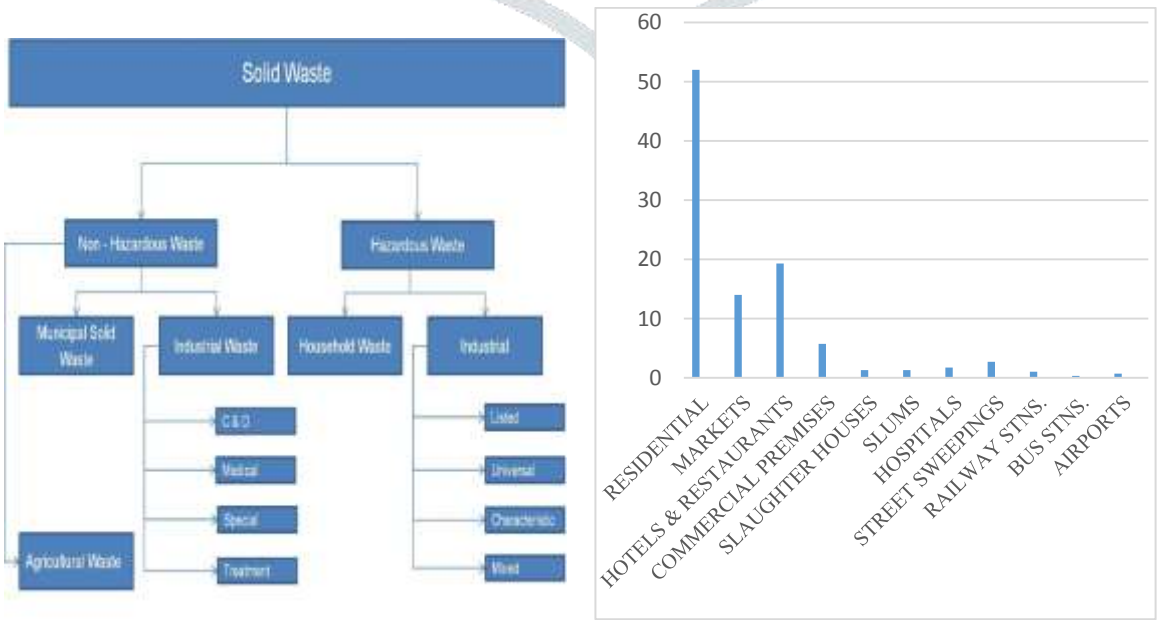
ABSTRACT: One of the major problems being faced by Bengaluru city is related to collection and transportation of Municipal Solid Waste (MSW) along with its disposal. Currently solid wastes are collected manually, which is labour intensive work and transported using trucks from collection point to disposal site which is harmful for workers and creates unsightly appearance during its transportation involving more fuel consumption. The harmful effects of the current system can be overcome by Automated Vacuum Waste collection system which transports waste at high speed through underground pneumatic tubes to collection point. This system facilitates easy collection and transportation of waste without creating much environmental menace, also helps in easy separation and recycling of wastes.

IndexTerms : Pneumatic, Vacuum collection, Municipal solid waste, manual collection, transportation.

I. INTRODUCTION

Rapid urbanisation and industrial diversification has led to generation of considerable quantities of municipal, plastic, hazardous and biomedical waste. Improper disposal of waste often results in spread of diseases and contamination of water bodies and soils. The impacts of these wastes on the economy cannot be ignored and managing them has become a major problem.In Karnataka, amongst the 3 types of waste generated in 2003, the largest amount generated is municipal solid waste at 21,43,280 metric tons followed by hazardous waste at 86,137 metric tons and biomedical waste at 27,095 metric tons. Solid wastes may be defined as discarded solids arising from human or animal life and activities. As regards municipal waste, on an average 40 to 50 percent of the total municipal waste is generated in the six municipal corporations of Karnataka and more than 70 percent of municipal waste is generated by the residential and market areas. The domestic waste generated by households comprises mainly of organic, plastic and paper waste and small quantities of other wastes. Plastic and glass are segregated at the household level or by rag pickers and sold. The remaining waste is disposed in community bins, which, also contains household hazardous wastes such as batteries, bulbs, discarded ointments and medicines. In addition, about 1 to 2 percent of biomedical waste also gets mixed with municipal solid waste in the community bins. Though, door-to-door collection has been introduced in a few wards of Bangalore and Mysore, the bulk of the municipal solid waste is still collected in community bins and the waste that reaches disposal sites is usually mixed, containing plastic, glass, metals, etc. Many times segregated waste gets mixed up while transporting. Of the total waste generated, each day about 500-600 tons of municipal waste generated from residential, city market and other commercial areas of Bangalore city is collected and transported to the sites maintained by Karnataka Compost Development Corporation, for composting through mechanical and vermi-composting techniques.



Solid Waste Generation and Sources

II. WASTE COLLECTION SYSTEM

The system of municipal solid waste collection in the state of Karnataka continues to be mostly manual and involves a labour-intensive system. The multi-container and door-to-door methods have been implemented in different parts of Karnataka according to budget limitations, public participation, urbanization age, and municipal and regional planning, among others.

Multi-container: In this system, citizens dispose of each fraction in specific containers located in two areas of the street at a maximum distance of 50 m from the citizens, containers are located for the organic and rest fractions. In areas with groups of containers, located at a maximum distance of 300 m from the citizens, containers for glass, paper and packaging are located.

Door-to-door: This system does not use containers situated in the street permanently for the collection of organic, paper, packaging etc. Citizens leave bins outside their house, separated according to a pre-established collection schedule. The organic fraction is taken to the street in a community bin (which after being emptied is returned to the building); and paper, packaging and rest fractions are left in plastic bags.

HAZARDS OF WASTE COLLECTION TO THE COLLECTORS

Waste collection can be practice as either an occupation or essential mean of survival which exposed them to various high work hazards, as are the risks of various morbidities and factors like socio-economic status which is low and their working environment make them more vulnerable to hazardous exposure. Risk of morbidities increases with the intensity and duration of exposure to hazards, as well with the age of workers. Workers performing waste collection, transportation and unloading operations are exposed to certain hazards which are primary related to high workloads, and that the manner in which work is organized may increase the baseline risk. Multidisciplinary aspects of Occupational hazards and injuries:

Immediate causes: are personal protective equipments provided but not used, hazardous handling (failure to watch for sharp or slippery objects and pinch points, lifting, loos grip, etc.), improper tool or no tools for handling waste given by employers, hazardous movement of workers (running stepping on, climbing over, throwing, etc.)

Un safe conditions (ineffective safety device, no safety device, hazardous house hold waste, equipment and tools are defective) and Safety management performance (inadequate instruction, rules not enforced, safety not planned as part of job, infrequent employee safety contacts, hazardous not corrected, safety device not provided)

Mental condition of workers (lack of safety awareness, lack of coordination, Improper attitude, slow mental reaction, lack of emotional stability, nervousness, tempramentalism and no attention in work). Physical condition of workers (Extreme fatigue, deafness, poor eye sight, lack of physical qualification of job, hearing condition, crippling and other handicap) [8].

External environments: design of vehicles, trade (engage in handling waste that is rear-loading versus side loading truck), waste producing sectors(residual or market waste)and their location, seasons (climate condition), residential supports, Types of authorities.

Working environment: There is significant difference between the job's formal definitions (by law, formal organization and management of waste collection), the work actually performed in the condition of constrains faced by both workers and management.

Due to open beds in tractors and trucks, the waste spills from the truck, during transport, thereby causing a nuisance.

The secondary storage system is not synchronized with the transport system. Problems arise when a transport fleet is modernized because waste at secondary storage system is still dumped on the ground[9].

Due to an inadequate number of vehicles, the area cannot be serviced properly.

Due to inadequate workshop facilities and maintenance procedures, the vehicles are poorly maintained. This problem leads to break down of trucks and become out of service for a long time[1].

Current Solid waste management practice

Segregation- There is no organized and scientifically planned segregation of MSW either at household level or at community bin. Sorting of waste, is mostly accomplished by unorganized sector and seldom practiced by waste producers. Segregation and sorting takes places under very unsafe and hazardous conditions and the effectiveness of segregation is reasonably low as unorganized sector segregates only valuable discarded constituents from waste stream which can guarantee them comparatively higher economic return in the recycling market. On a number of occasions, due to improper handling the segregated constituents got mixed up again during transportation and disposal.

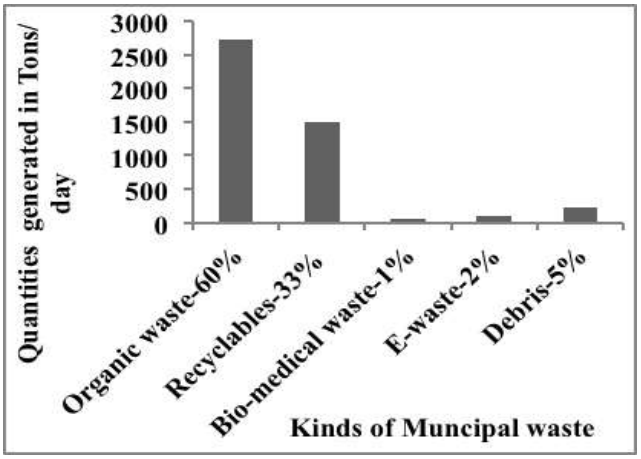
Collection Waste produced by houses is usually transferred into communal bins that are fabricated from metal, made from concrete or in combination of both. Street sweepings also find its way to community bins. These community waste bins are also used by other essential commercial sectors in the vicinity of disposal bins along with household waste except where some commercial complexes or industrial units engage municipal authorities for transfer of their waste to disposal site by paying some amount.

Reuse/recycle This entails activities like collecting those materials from the waste, which could be gainfully retrieved and utilized for making new products. Since unsegregated waste is dumped at community bins, its optimal recycling is not possible. However, rag-pickers usually sorted out and took and sell recyclable material like plastics, glass, etc. In Pondicherry, almost all recyclable material is sorted out by rag-pickers and absorbed in material stream through recycling.

Transportation Modes of transportation for MSWM practised in India are: bullock carts, hand rickshaws, compactors, trucks, tractor, trailers, and dumpers. In smaller towns trucks having 5–9 ton capacity are used without adequate cover system. Stationary compactors, mobile compactors/closed tempos, and tarpaulin-covered vehicles are used in the transportation of MSW and about 65, 15, and 20% of waste is transported through these compacters, respectively. The maintenance of vehicles used in for transportation of waste is usually done in workshop run by ULBs but most of these workshops can do minor repairs only. No wonder, in the event of breakdown of these vehicles, the overall collection, transportation, and disposal efficiency reduces drastically. Only few transfer stations can be found in some metropolitan e.g. Mumbai.

WASTE MANAGEMENT SCENARIO IN BANGALORE

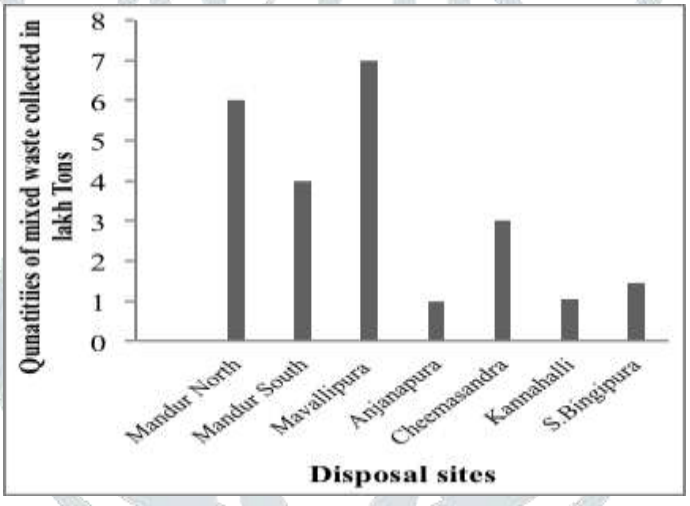
Bengaluru city generates around 5000tons of municipal solid waste. The break up for different categories of municipal waste as projected by the Bengaluru Corporation is depicted below



Kinds of Municipal waste generated and its quantities

Bangalore Corporation has established 15 dry waste collection centres with the objective of collecting the dry waste (both recyclables and non-recyclables) where secondary segregation is done and rejects are sent to the landfill sites. Also, there are around 150 informal dry waste collection centres collecting only recyclables having high economic returns. The collective effort by both formal and informal recycling centres is able to divert about 200tons of recyclables reaching the landfill site. Since, there does not exist any separate collection vehicle as well as separate collection schedule and segregation of waste at source is not strictly adhered to by the waste generators, mixed waste consisting of both organic and recyclables, reach landfill/processing centres[2].

Presently, Bengaluru does not have any scientific treatment method facilities for solid waste generated by municipal and industries around Bengaluru. This has led to the development of several illegal and unauthorized dump sites in Bengaluru.



Disposal sites of Municipal solid waste

Collection and Transportation

Source segregation is still a concern in Bengaluru though awareness in picking up slowly. BBMP manages about 30% of MSW and 70% of MSW activity starting from primary collection to disposal has been outsourced. The collection of solid waste is carried out in two phases. The first stage is a primary collection, in which the solid waste is collected on auto tipper & pushcarts. An Auto tipper has been provided for every 1000 households and a pushcart for every 200 households. About 20000 Pourakarmikas (Sweepers) are being utilized (both BBMP and contractors) in the door-to-door collection, street sweeping and transportation of MSW. The waste collected from the households is brought to a common point, i.e., secondary locations from where the waste is transferred to landfill sites/ treatment through tipper trucks & compactors**[3].**

III New probable approach: Pneumatic Waste Collection System

An **automated vacuum waste collection system**, also known as **pneumatic refuse collection**, or **automated vacuum collection** (**AVAC**), transports waste at high speed through underground pneumatic tubes to a collection station where it is compacted and sealed in containers. When the container is full, it is transported away and emptied. The system helps facilitate separation and recycling of waste.

The process begins with the deposit of trash into intake hatches, called portholes, which may be specialized for waste, recycling, or compost. Portholes are located in public areas and on private property where the owner has opted in. The waste is then pulled through an underground pipeline by air pressure difference created by large industrial fans, in response to porthole sensors that indicate when the trash needs to be emptied and help ensure that only one kind of waste material is travelling through the pipe at a time. The pipelines converge on a central processing facility that uses automated software to direct the waste to the proper container, from there to be trucked to its final location, such as a landfill or composting plant [5].

The mobile pneumatic system uses a network of urban pipes and pneumatic suction trucks. The system works like this: citizens dispose of each fraction of waste in inlet doors located in the street; these inlet doors are connected to containers located in underground tanks. A network of underground pipes interconnects the containers and transports the waste to suction points situated in the street, which are easily accessed by the trucks. To carry out the collection of a fraction, the truck is equipped with a pneumatic unit, which is connected to each

suction point. The truck's pneumatic unit produces an air flow in the pipes, which transports the waste from a group of containers to the truck. Once the collection is finished in a suction point, the truck drives off to the next point, where the action is repeated. Organic, paper, packaging and rest fractions are collected pneumatically at pre-set times for the different fractions. Additionally, glass is stored in underground containers, not connected to the pneumatic network, and is collected in top loader trucks[4].

SYSTEM ADVANTAGES

An AVAC system offers many advantages over a typical truck-based collection system. Among these are:

Quiet: Collection trucks in the collection areas are eliminated. There is virtually no noise above normal conversation level standing outside a collection inlet or the terminal station. Acollection inlet may operate a total of 10 minutes per day.

No odours: The collection system and terminal are sealed; inlets areemptied automatically as soon as they are full orare emptied on a scheduled time if the inlet has not been used within 1 hour. Waste cannot putrefy and result in odours in the system. And because collection trucks are eliminated, the odour of diesel truck emissions is eliminated.

Elimination of rats/vermin: The closed waste receptacle and leak tight system virtually eliminates the attraction of rats and vermin.

Air quality: Fewer heavy trucks result in less GHG emissions.

Long life: systems have performed on a continual basis more than 50 years before a major overhaul. Uptime is very high.

Better "curb appeal" and out of sight: Except for the terminal buildings and the stylish inlet receptacles, the system is underground. The terminal building can have a pleasing architectural style.

Less street wear and tear: No collection trucks mean less wear and tear on the street right of way. Street repair costs due to less heavy traffic can be reduced over time.[6]

Safer: Waste collection is one of the most dangerous professions in the US with workers continuing to be killed working in traffic. Removing the collection trucks from neighbourhoods can result in less accidents and injuries to workers and the public.

Reduced worker's compensation: The AVAC system requires significantly less labour to run and are far safer.

Collection trucks pose a safety hazard to pedestrians and the public in general on their routes, and workers have been injured or killed as well. For areas without automated collection trucks, worker compensation claims are high, and workers are often plagued with repetitive stress injuries for life.

Operation in natural disasters and climate resiliency: Rosina Abramson, Esq., the US representative in New York City for ENVAC, pointed out that theRoosevelt Island AVAC system continued to operate and collect trash during Super storm Sandy, even as the storm lashed the northeast leaving smelly and unsanitary piles of garbage in areas that were flooded for days since waste trucks could not gain access. AVAC systems, because they are fully sealed, can operate under water.

Reduces need for transfer station: In many cases, the terminal station eliminates the need for another transfer station.

International appeal: It is no secret that people from all over the world are investing, moving to, or spending significant vacation time in the US. An AVAC system can be part of the draw for these people, because many prefer its "sustainability" and better quality of life attributes[8].

IV CONCLUSION

This system provides an alternative to conventional vehicle-operated waste collection, as they offer advantages in terms of reduced traffic-related problems, such as noise, accidents, CO^2 emissions, congestion and improve overall safety and hygienic levels.The waste containers are placed underground in pre-fixed places. Thus, they are developed in a form of permanent infrastructure network to facilitate the waste collection activities, instead of being a house specific service employing waste bins, like typical collection systems. Nevertheless, this development can yield considerable results in both the better implementation of waste management and also the environmental protection. Automated vacuum (pneumatic) waste collection systems provide an integrated framework for the tacking of the waste handling problem. Not only do they provide temporal storage but also the transportation of waste is taking place through underground pipeline network to a waste collection terminal. This speeds up the whole garbage collection process, especially at overcrowded urban centers. These can either be placed in public places or even inside houses or apartment buildings. The automated underground vacuum waste transportation is expected to increase in the forthcoming years, especially in cases of densely populated urban areas. For the case of the developing countries, the implementation of underground collection system seems like the initial investment cost of stationary vacuum systems are high. Yet, such development can benefit communities with reduced operating cost and most importantly with enhanced hygienic and environmental conditions.

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