

The Concept of Solid Waste Segregation for upgrade Waste Management

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ABSTRACT

Several studies and researches have been conducted on the segregation of solid wastes and proper management of waste to handle the adverse effect of inappropriate disposal. The present paper uses a descriptive approach to gather information from peer reviewed publications such as journal articles, environmental organizations reports and books. There is a need to clearly define what constitute solid wastes as this form the basis for regulation as segregation of solid waste continues to be a severe problem in India due to poor management and lack of knowledge among people. People are struggling to implement an affordable and sustainable model of management. The generation of waste is increasing every day especially in urban areas where population is growing at an annual rate of 1.05 per cent. The yearly increase in the overall quantity of solid waste is about 5 per cent. It is well understood that segregation improves collection and processing efficiency and lies at the heart of good waste management. But better infrastructure and strict compliance systems is required to ensure segregation. There is need to ensure that segregated waste is transported and processed properly. There should also be some bye-laws that support segregation. We recognize that there is still a lot that needs to go into adopting sustainable waste management regimes in our surroundings.

Keywords: segregation, wastes, sustainable

1. THE CONCEPT OF WASTE MANAGEMENT

Wastes are generated by mostly human activities. As the wastes are complex and diverse, it is difficult to reach the goals of waste management [2]. Since pre-historic period, the generation of wastes remain a major source of concern [3]. Now, the rate and quantity of waste generation is increasing day by day. As the quantity of wastes increases, so also does the quality and diversity of the waste increases [12]. In pre-historic period, wastes were produced in a very small amount because of small population and availability of vast amount of land to the people at that time. At that time, the total amount of waste produced was easily absorbed by earth and its environment. So, there was no issue regarding waste management [11].

As a result of industrial revolution, an increase in number of wastes began in the sixteenth century [15]. In sixteenth century, the migration of people from rural to urban areas led to an increase in population that in turn resulted in an increase in amount and diversity in composition of wastes. At that time glass and metals were found in large quantities in municipal waste stream [14]. Increase in indiscriminate littering and open dumping was the result of large amount of people living in cities. As a result of which dumps formed became the breeding grounds for rats and other vermin leading to significant health risks. The outbreaks of epidemics with a huge number of death rates were the result of improper waste management practices [11]. Consequently, public officials began to dispose waste in a proper controlled manner in order to safe guard public health [11].

The important thing to be understood in modern day wastes management is – what material exactly can be a waste that cannot be used again and how wastes can be segregated for upgrade waste management? The useless by product of human activities which physically contains the same substance that are available in the useful product is a waste [13]. Wastes are also defined as any product or material which is useless to the producer and need to be disposed of [1]. Although, wastes are the result of human activities, it is also found that these are the result of inefficient production processes whose continuous generation is a loss of vital resources [5]. A substance that can be a waste to one person can be a resource to another. Therefore, a material can only be considered as a waste when it has lost all its values from every dimensions. [7]. Despite this subjective nature of wastes, it is important to describe clearly, what constitutes a waste because the classification of a material as a waste will form the foundation for the regulations required to safeguard the people and the environment where the wastes are being processed or disposed of [6].

2. STATEMENT OF THE PROBLEM

Although it is generally agreed that wastes management services are essential services that must be provided in every society, nonetheless very little is known on classification of solid wastes for upgrade waste management. Knowing that the concept of segregation of waste is highly subjective, it is important to have a clear guide as to how wastes could be classified on the basis of their sources, benefits, issues to the environment and the technology available for processing them. The present research therefore examines the concept of segregation of solid wastes for upgrade waste management with a view to classify wastes and how they are managed.

3. METHODOLOGY

This paper is a review of literatures relied on secondary data as is the case with most desktop study where information is used for analysis and to draw vital conclusions. Some of the specific sources of data for the study includes books, journal articles, unpublished papers, organizational and private webpages. This research approach is employed when the intention of the study is to answer specific questions based on previous works. It is for these reasons that the present paper utilized this approach to examine what different researchers have said on wastes, its classification and management.

4. SOLID WASTE SEGREGATION

The lack of waste segregation at source is one of the most important fundamental problem as long as people put their recyclable, organic, hazardous and sanitary waste outside in an improper manner, the municipal corporation collects and dumps it the landfills. Recyclable waste can be sold to scrap dealer network instead of being discarded who keep a significant amount of waste out of landfills, thereby increasing their revenue as well. Organic waste too, can be dealt with through a process called ‘composting’. It is a biological process by which micro-organisms segregate organic matter into a nutrient rich, soil like substance called compost. If our residences, commercial establishments and institutions simply managed organic and recyclable waste properly, we can keep over 60% of our waste out of landfills [9].

4.1 Classification of Solid Waste

There are some major factors like viability and sustainability along with environmental implications that govern the solid waste management. There are some other key factors such as: i. The origin and quality of the solid waste. ii. Presence of hazardous or toxic waste. iii. Availability of outlets for energy recovered. iv. The market for the compost produced. v. Cost of waste processing such as land price, capital and labour costs. vi. Capability and experience of the technology used. Solid waste can be classified into various types depending on their sources. Table 1 details the general classification of solid waste [10].

Type of Solid Waste	Description	Sources
Food waste	Waste obtained as a result of preparation, cooking and serving of food. Wastes from market, waste produced due to handling, storage and sale of food are included.	Household wastes, restaurants wastes, street food corners, etc.
Rubbish waste	There are two types: (i) combustible (primarily organic)—tissue paper, cardboard, paper, cartons, wood, boxes, clothes, leather, bedding, grass, leaves, plastic, etc., and (ii) non-combustible (primarily inorganic)—metals, cement, stones, bricks, glass, etc.	Households, hospitals, commercial facilities such as hotels, stores, markets, institutions etc.
Ashes and residues	Waste obtained from the cooking of food and heating of buildings, clinkers, etc. as fire residue	Household waste, waste from small-scale plants, etc.
Bulky waste	Large appliances, tires, stoves furniture, trees, windows, etc.	Residual from shops, households' wastes etc
Street waste	It includes dirt, dust, leaves of trees, wrappers and animal droppings collected on streets.	Streets, sidewalks, vacant lots, parks etc.

Dead animals waste	It includes the dead bodies of dead animals such as buffaloes, oxen, cats, dogs, poultry, horses, cows, small animals, etc.	Streets, vacant lots, sidewalks, etc.
Construction and demolition waste	The solid waste obtained from the construction sites or industries such as lumber, rubble wires, etc.	Construction, demolition sites, etc.
Industrial waste and sludge	The solid waste obtained from industrial processes and manufacturing operations	Hospitals' wastes, laboratories, institutions, Research wastes, chemical factories, etc.
Hazardous waste	The solid waste obtained from pathological waste explosives, radioactive materials, etc.	hospitals, laboratories, institutions, chemical factories, institutions, etc.
Horticulture waste	The solid waste obtained from the horticultural activities like trimmings from trees, leaves, waste from gardens and orchards, etc.	Parks, gardens, sidewalks, etc.

Table 1 General classification of solid waste

4.2 Technologies for Processing, Treatment, and Disposal of solid waste

Various technologies for management of solid waste are available. In India, solid waste in mixed form is not eco-friendly as it poses a challenge to its treatment process. Lack of awareness among the people at various levels is the main problem for upgrade of waste management. Hence segregation of waste is important to get the best possible result and implement any strategies successfully. The broad waste types and their relevant techniques with benefits and issues have been given in Table 2 [10].

Types of Waste	The Technology Available for Processing	Benefits	Issues
Paper	Paper recycling	<ul style="list-style-type: none"> • End-use appliances for paper recycling generate writing a quality paper. • Runs successfully as a social model. • Efficiency is improving at a higher rate. 	<ul style="list-style-type: none"> • High capital investment is required. • Business development related activities are needed.
	Waste to Energy	<ul style="list-style-type: none"> • Converts the solid waste into usable energy. • No external fuel requirement which makes process easy 	<ul style="list-style-type: none"> • High capital investment is required. • Proper utilization of energy produced is to be ensured.
	Composting	<ul style="list-style-type: none"> • It is practically free • destructs pathogens and kills weed seeds • reduces mass and volume and odour. • reduces handling and transportation. • helps in conditioning soil and improves nutrient qualities. • decreases pollution from chemical fertilizers. • Efficiency is high. 	<ul style="list-style-type: none"> • Time-consuming • Odour and smell • Large land requirement • May attract pests and rodents
Organic and Garden	Vermicomposting	<ul style="list-style-type: none"> • Recycles Waste • low costs • It is practically free • destructs pathogens and kills weed seeds • reduces mass and volume and odour. • reduces handling and transportation. • helps in conditioning soil and improves nutrient qualities. • decreases pollution from chemical fertilizers. • Efficiency is high. 	<ul style="list-style-type: none"> • Long harvesting time • High Maintenance • Pest and pathogen problems
	Anaerobic digestion and methanation	<ul style="list-style-type: none"> • Generates gaseous fuel • Flexible scale. 	<ul style="list-style-type: none"> • Capital intensive technique

		<ul style="list-style-type: none"> • External power not required. • Reduction in greenhouse gas emission. • Free from rodent and fly problems • No bad odour. • No social resistance. • Efficiency is high. 	<ul style="list-style-type: none"> • Not good for solid waste with less biodegradable matter
	Pyrolysis/Gasification, Plasma Pyrolysis Vitrification (PPV)/Plasma arc process	<ul style="list-style-type: none"> • Energy recovery • Proper destruction of waste • Produces liquid/gaseous fuel to replace fossil fuels • Controls atmospheric pollution • Efficiency is high. 	<ul style="list-style-type: none"> • Significant solid waste sorting operations • Highly skilled personnel required • High capital investment
Inorganic	Sanitary landfills and landfill gas recovery	<ul style="list-style-type: none"> • Less capital required. • Potential for recovery of landfill gases as a source of energy is required. • Highly skilled personals are not required • Efficiency is low. 	<ul style="list-style-type: none"> • Land requirement is high
	Waste to energy (WTE)	<ul style="list-style-type: none"> • Landfill waste can be reused • Less capital required • Landfill sites can be mined so that material can be used as fuel • Efficiency is low. 	<ul style="list-style-type: none"> • WTE require high capital investment • They are complex
	Production of refused derived fuel (RDF)	<ul style="list-style-type: none"> • Coal substitute at low price • Easy storage and transportation of RDF pellets. • Efficiency is high 	<ul style="list-style-type: none"> • Significant solid waste sorting operations • Highly skilled personnel required • High initial capital investment
Plastic	Incineration	<ul style="list-style-type: none"> • Converts the solid waste into usable energy. • No external fuel requirement. • Easy Incineration Process. • Efficiency is high. 	<ul style="list-style-type: none"> • Wastage of energy which could be saved while recycling
	Plastic recycling	<ul style="list-style-type: none"> • Energy and natural resources are conserved • Plastic recycling conserves landfill space • Creates green jobs • Efficiency is high. 	<ul style="list-style-type: none"> • Not always cost effective • Recycling sites are often unsafe
Construction and demolition waste	Reuse	<ul style="list-style-type: none"> • Substitute for new products. • Donation or selling of products makes it beneficial. • Efficiency is moderate. 	<ul style="list-style-type: none"> • Materials which cannot be reused are disposed of at the lower costs
Chemical/Hazardous	Recycling	<ul style="list-style-type: none"> • Recycled into new products • Efficiency is low. 	<ul style="list-style-type: none"> • Skilled personal required
	Portland cement	<ul style="list-style-type: none"> • Skilled personal required • As per the Guidelines prescribed by Govt. of India for hazardous waste disposal system 	<ul style="list-style-type: none"> • Skilled personnel required • Initially requires high capital investment
	Incineration, destruction, and waste to energy	<ul style="list-style-type: none"> • Reduced air pollutants in the process. • Usable energy obtained. • Efficiency is high. 	<ul style="list-style-type: none"> • Involves high capital investment • More complex
	Hazardous waste landfill (sequestering, isolation, etc.)	<ul style="list-style-type: none"> • Minimum contact with hazardous waste. • Efficiency is low. 	<ul style="list-style-type: none"> • High capital investment • Space • Contact with hazardous chemicals.
Medical	Off-site	<ul style="list-style-type: none"> • Disinfection, collection, and transportation to a common area where it is disposed of by incineration. • Efficiency is high 	<ul style="list-style-type: none"> • Safe transportation required and high cost
E-waste	Recycling	<ul style="list-style-type: none"> • Conserves natural resources • Protects the environment 	<ul style="list-style-type: none"> • Electronic products contain hazardous

		<ul style="list-style-type: none"> • Create Jobs • Saves landfill space. • Efficiency is high 	materials which include poisonous chemicals
Metal	Metal recycling	<ul style="list-style-type: none"> • Energy and natural resources are conserved • Metal recycling conserves landfill space • Create green jobs • Efficiency is high 	<ul style="list-style-type: none"> • High capital investment • Large space required
Glass	Glass recycling	<ul style="list-style-type: none"> • Energy and natural resources are conserved • Metal recycling conserves landfill space • Create green jobs • Efficiency is high 	<ul style="list-style-type: none"> • High capital investment • Large space required

Table 2 Technologies available for processing, treatment and disposal of solid waste

4.3 What happens when we don't segregate?

When the waste produced is not segregated, there might be many problems. The most common practice is to systematically empty the day's trash, organics and recyclables combined, into the green corporation bins commonly found on every street. It is then collected by trucks and taken to transfer stations. Waste pickers try to recover as much recyclable material as they can to sell for money, after that the trash is taken either to landfills and dumped unscientifically. Landfills are supposed to be sanitary. Ground water gets polluted when toxic chemicals from hazardous waste seeps into the ground over time. Most people are unaware that the number of heavy metals, chlorides, fluorides and particulate matter in our water is much higher than permissible levels. Hazardous waste in landfills are also sources of dioxins and furans, extremely carcinogenic substances [9].

4.4 What could happen if we started segregating?

Farhaad Khazvini experienced a kind of change that can actually take place after greater degree of household segregation. Selling our recyclables to kabadiwallas reduces waste in the landfill and improves their revenue at the household level. About 60% of our waste is organic. If we composted our organic waste, that constitutes the largest chunk of waste being kept out of landfills improves the quality of soil and crops. Composting is simple process and if done correctly, odour-free, pest-free and hardly takes time off one's weekly schedule. Lack of awareness of what composting is, is the main reason behind this. Furthermore, many people find it difficult to get the hang of, simply because of a lack of knowledge of proper technique [9].

5. SOLID WASTE SEGREGATION FOR UPGRADE WASTE MANAGEMENT

A systematic approach is necessary to upgrade waste management. Broadly, the plan is divided into three phases—pre-implementation stage, implementation stage, and monitoring and evaluation stage. A decentralized waste management system can be set up in three years, with the pre-implementation stage requiring six months, implementation stage six–12 months, and monitoring and evaluation stage requiring 18 months. Step-wise adoption of a decentralized waste management plan by a city is as follows: A baseline study involves inventorization and gathering relevant background data of the city. This helps in the preparation of an effective solid waste disposal and its management plan. Usually, a city is divided into zones or circles, which are further divided into wards. For a decentralized waste management plan, mapping of wards is imperative. Resource requirement for propagation lists the resources required for effective propagation of a decentralized waste management plan in a city. The steps involved in propagation are as follows: Launch of door-to-door propagation in each ward, door-to-door propagation through volunteers, training of waste collectors for collection of segregated waste, regular follow-up. Waste collectors can either use the whistle-blow method in door-to-door collection of segregated waste or the public address method (in which a vehicle comes to a convenient designated place in the locality for collection of segregated waste from households). Segregated waste is transported to the local material recovery facility (MRF) or processing facility where wet waste can be further processed and dry waste segregated and channelized for recycling. Municipal corporations need to select sites for building compost pits or setting up biomethanization plants or MRFs. The sites need to be built as close to the source as possible to ensure decentralized transportation and processing. The sites need to have a covered shed. The following indicators can be designed to determine the progress of the initiative: i) Operational indicators ii) Environmental indicators iii) Financial indicators iv) Social indicators. Based on the aforementioned indicators, data has to be collected and a report card generated with

information. After completion of the implementation stage, local authorities need to collect data and rate the project as per the report card. This data can be collected on a quarterly- or a half yearly-basis. Based on the points allotted, if the city scores between 65 to 85 points, the project is successful. If it scores between 40 to 65 points, the project is partially successful, and if the score is less than 40 points, the city needs to rework on the implementation and improve upon the relevant parameters. A regular feedback and grievance redressal mechanism needs to be created by the local authorities. A subjective feedback through filling of forms can be collected from stakeholders—citizens, sanitation workers, private partners etc. A monthly or quarterly review mechanism should also be created by the concerned state urban development department to review the progress of the work [4].

6. CONCLUSION AND RECOMMENDATION

It is agreed that waste segregation is important as it makes the process of waste management easier. Separation of waste into hazardous and non-hazardous is important as hazardous waste requires special handling. It is clear that there will be no substantial change in the waste management without the adoption of segregation at home on a larger scale. We aim to constitute a citizen's resource base by connecting with as many individuals as possible who are currently segregating and composting. By effective segregation of solid waste, a community will be at the core of achieving a 60% reduction in waste going to landfills.

There are major advantages of waste segregation. Dependence on land for disposal of waste will be reduced. The space required for the landfills will be reduced by 90 per cent. Cost of collection and transportation will be reduced. On salary of staff and contractual workers, up to 40–50 per cent of municipal funds allocated for solid waste management are spent. On collection and transportation 20–40 per cent is spent and on disposal, only 5 per cent are spent. By adopting the systematic approach, the cost of collection and transportation will be reduced by at least 50 per cent, as waste will be treated much closer to the source. Composting and recycling will generate additional source, as more than 90 per cent of waste can be recycled and reused. This means an additional income for a large set of people (such as waste collectors, informal workers and recyclers) can be produced. The environmental costs incurred due to pollution of land, water and air from unsanitary landfills that increase environmental costs will also be reduced drastically. The above systematic approach is highly cost-effective and environmentally sustainable. It creates a large number of well-paying jobs because of its systematic and dignified approach. Informal waste collectors can also be blessed with decent earnings and dignity. This is a uniquely economical systematic approach of segregation of solid waste for waste management generating wealth from waste.

Since population is increasing day-by-day which in turn increases waste generation, strong efforts should be new and existing settlements to control possible waste generation in future. Environment should be protected by reducing toxicity, waste volumes and encouraging sustainable resource management. A predictable and stable framework should be provided to limit solid waste. In order to educate people to reduce solid waste, private/public should be strived. In establishing and enforcing new laws and regulations, be fair and seek equal opportunities for all market participants. Environmental costs should be recognized and reduced. All municipalities and districts should establish laws against burning and illegal dumping of waste. For research and development, some selected education programs and household hazardous waste programs, funds should be provided. It should be ensured that these funds are available for their right identified purposes and not for other purposes.

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