Smart Solid Waste Management

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***Abstract*—The rapid growth in the population automatically demands better infrastructure and more facilities. Employment and attaining balance in economy is an important concern for a nation having such rapid increase in its population, which finally results into evolution of new urban areas and cities. A smart city is created upon various particular components and strong waste administration is one of these crucial viewpoints. For example, today, to address the rising issue of carbon emissions in construction process, contractual workers are obligatorily made a request to use supplies according certain standards. Subsequently, to employ such operational standards we need dynamic investment and acknowledgment from the workers in using equipment according to the endorsed technologies. Essentially, the adequacy of strong waste administration framework relies on the involvement of the considerable number of stakeholders and natives. Strong waste administration is of grave significance to a urbanized locale which confronts the consistent growth in population, rising infrastructural requests and extending inflow of migrants. Understanding the idea and setting of waste isolation is additionally a key segment in the strong waste administration handle. This is the phase where India still lingers behind as against the universal partners. In a nation like Finland, just around 7 percent of the waste gets arranged into the dumping yard and the staying around 93 percent of the waste segment is reused. This level of adequacy in actualizing the strong waste administration framework is possible just because of subjective spread of civic sense, clear understanding and acknowledgment over the idea of waste segregation.**

***Index Terms*—: Smart Cities, Solid Waste Management, IoT Integration**

I. Introduction

AS Waste is generated wherever the human life survival is present and it has become a part of daily lifecycle. The report of World Banks review, in 2012, states that the world-wide Municipal Solid Waste generations were approximately 1.3 billion tons per annum. This statistic was anticipated to arrive at 2.2 billon tons per annum by the year 2025. The report also suggested that Per capita rates of waste generation will be around 1.2 to 1.42 kg per person (depending on different regions and countries) per day in the coming first decade or so. With the rapid growth in the population, urbanization and also due to considerable changes in the lifestyle of people, waste management is emerging as a big challenge for all countries even for developed ones. It is presumed that, by the year 2050, 64 percentage of population in the developing countries and greater than 84 percentage of population in the developed ones will be in urban places. Accordingly the urban administrative authorities have to overcome the challenges of waste management by implementing efficient and effective process for collecting, disposing and recycling of waste by taking into account the standard of health and environmental friendliness. India is the second largest populous nation in the world, with 1.33 billion population which is equivalent to 17.86 percent of world total population. Moreover, the urban population of India counts for 0.43 billion which is 32.8 percent of country population.. Moreover, the urban population of India counts for 4.39 billion which is 32.8 percent of country population. It is estimated that half of the population live in urban areas by 2050. With this sort of increasing in population the waste management has been emerged as a severe problem because of both environmental aesthetic concerns. As per the reports of Central Pollution Board of India, the country generates nearly 1.28 lakh Tons of municipal solid waste per day during 2011-12. Out of the total waste generated only 0.89 lakh tons nearly accounting to 70 percent of total waste generated is collected and only 0.15 lakh tons (12.45 percent) of waste is processed or treated. Segregation at collection source points, transportation and scientific disposal methods of waste are not occurring which results in degradation of environment and poor quality of life. The hierarchy of waste management

Fig. 1: Hierarchy of Solid Waste Management

is shown in Fig 1. In this paper we present the strategies of smart waste management and implementation methods. In Section II, we discuss about the Current situation in India. Section III, describes the Integrated smart waste management whereas, Section IV deals with integration of technology to waste management. At last we stated the applications and concluded the paper.

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II. CURRENT SITUATION IN INDIA

In Indian context, the municipal corporations are completely responsible for proper waste management in their respective cities. But many of the authorities are not fulfilling their duty to provide efficient ways of controlling the generation of waste at source, collecting, transporting, disposal of that waste well manneredly. Because of this inefficient collection of waste, the accumulated waste is often mixed with excreta of humans and animals in the drains and responsible for flooding of roads during rains, insect breeding and finally results into spreading of diseases.

Segregation at source itself is the important strategy for efficient waste management. Segregation in India is improper and is not seriously considered by households, commercial shops and offices. On an average 20 percent of total country's waste can be segregated properly at the source for recycling if proper practice of segregation methods are cultivated by individuals. According to CPCB Report 2013, no city in India attains 100 percentage segregation of waste and it claims that only 70 percentage of total waste is collected and segregated at dwelling points. The remaining 30 percentage of uncollected waste is remained in the environment itself or get mixed up. The major problem if only 12.45 percentage of the collected waste is processed under scientific conditions, whereas the remaining waste is dumped in the open areas.

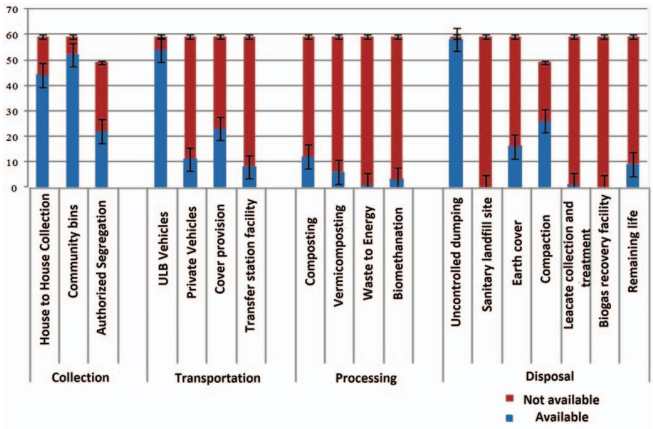

Fig. 2: Current Waste management statistics of Indian cities [1]

Waste generated in households and street sweeping wastes are generally transferred into community bins made from metal or concrete. Moreover these community bins also consists of waste generated by commercial sector and shops unless these commercial spaces pay some amount to municipal authorities for transferring of their waste for disposal.

As the waste disposed in community bins is not scientifically segregated, it is not suitable for optimal recycling, which can be utilized for producing recycled new products. In India the segregation and recycling in small scale is achieved by rag-pickers who segregate the waste and sell that for their livelihood and small vendors who buy newspapers, plastic items and other recyclable items from houses and process them for recycling.

Various transportation modes preferred India for Waste management are basically trucks, tractors, compactors and trailers. Trucks are generally used for transportation of waste in smaller town without proper cover system. These vehicles maintenance is carried out by municipal authorities of that city and small workshops are run by authorities for minor repairs. The overall collection and transportation comes to halt if there is any breakdown of the vehicles occurs.

III. INTEGRATED SOLID WASTE MANAGEMENT

The Integrated Solid Waste Management (ISWM) is mainly related to 3R (Reduce, Reuse and Recycle) Approach which mainly focus on the minimization of the solid waste generated from different sources and implementation of waste processing plants by involving the stakeholders. The ISWM Hierarchy is shown in Figure. The hierarchy consists of Reduction of waste at source itself, Recycling, Composting,Waste to Energy conversion and at last it prefers Sanitary Landfilling.

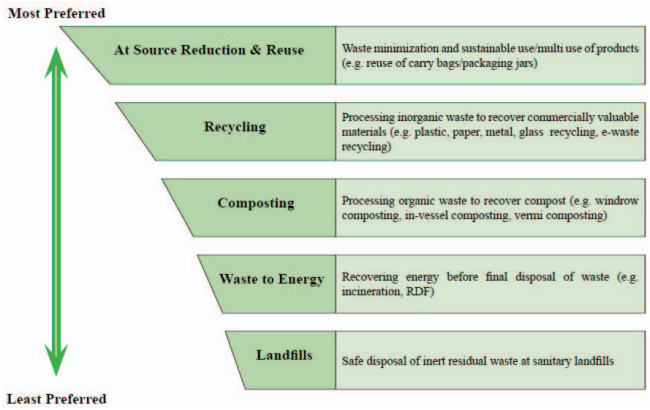

Fig. 3: Integrated solid waste management [2]

A. Waste Minimization

The ISWM Hierarchy prefers waste minimization at the generated sources as its first priority for efficient waste management. Due to waste minimization, the amount of toxicity of the waste gets reduced and the cost involved in the handling of these wastes gets decreased.

The strategies for waste minimization are: Minimizing the usage of packing materials, promoting the refill containers, introduce incentives for customers to return the package material, encouraging the environmental friendly design of products, promoting the development of eco industrial plants.

The local community should be encouraged and educated towards the segregation of wastes at the generation point. Source segregation can be termed as storing the inorganic and organic waste separately which helps in optimizing the waste processing further and treatment technologies. This aslo leads to high proportion of wastes to be recycled and reused which indirectly results in less consumption of the virgin material. Waste collected or generated from house should be stored at the generation source till it is collected by municipal workers. It is necessary to separate the wet (Kitchen waste) and dry waste (Recyclable waste), which is referred as primary segregation.

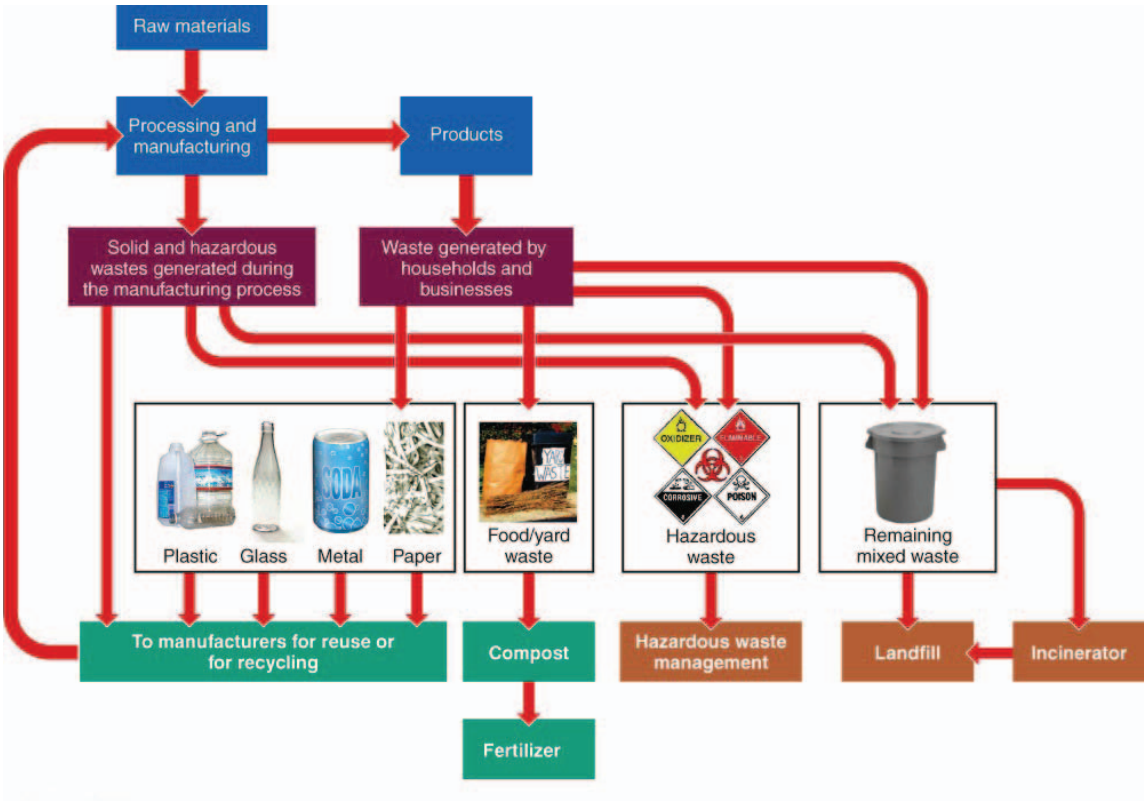

Fig. 4: Overview of Solid waste management [5]

B. Recycling

Recycling is the procedure by which materials that are generally bound for disposing are gathered, handled and remanufactured or reused. Reusing redirects a huge part of metropolitan, institutional and business waste away from transfer and, in this manner; it saves the rare resources and in addition decreases natural effects and the burden of waste administration on authorities. If proper mechanisms are built up for recycling, it can create incomes, adding to the general cost recovery for city solid waste administration.

There are lot many advantages by recycling the waste and some of them are: cost reduction involved in collection, transportation and disposal, Life span of Landfill sites increases, Imports of primary raw materials and resources are reduced, environmental effects are reduced.

Paper, glass items, plastic and metal are the recyclables things among the waste generated. It is approximated as 4000 to 5000 metric tons of plastic waste is generated in India per day which accounts for 4 to 5 percent of total solid waste generated. Currently, collection of plastic waste is done by informal sector. In the same way the about 95 percentage of waste paper collection is done by informal sector., by door to door collectors and rag pickers. Construction and demolition waste constitutes upto 10-20 percent of total solid waste. About e-waste generation rates are increasing year by year and study says that only 5 percentage of e-waste was recycled per year, of which about 95 percentage is operated by informal sector.

C. Composting

Composting is a controlled procedure of organically processing the city solid waste, so it might be reused for different purposes plant supplement, adjustment of soil in remediation process or soil correction for recuperation of poor soils. Natural waste adds to ecological contamination in more courses than one. Composting and other organic adjustment forms relieve the effect of uncontrolled deterioration of organic solid waste. Fertilizing the soil is a naturally gainful waste reusing component and not a waste disposal mechanism.

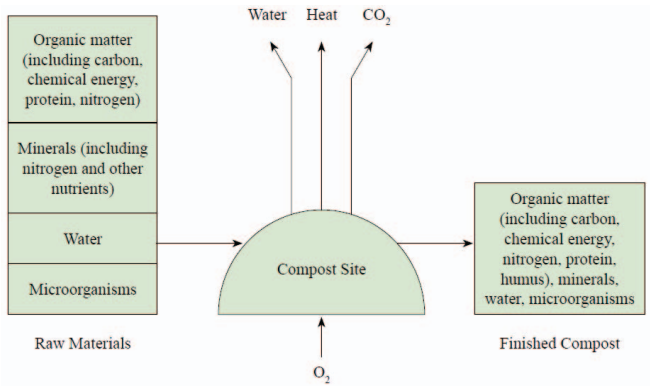

Fig. 5: Composting [2]

In aerobic composting, microorganisms oxidize natural organic mixes to Carbon dioxide, Nitrite and Nitrate compounds. Carbon from natural mixes is utilized as a energy source

while nitrogen is reused. Because of these synthetic responses generates heat, temperature of the mass increases.

D. Waste to Energy

The process of producing energy in the form of heat or electricity from municipal waste is termed as Waste to Energy. Incineration is the most common method followed for waste to energy production. In incineration the energy from municipal solid waste is recovered either as heat or electricity and producing the Refuse Derived Fuel (RDF). The combustion technologies in India should be compatible with high moisture and inert content as it is common in Indian waste. The efficient waste to energy technologies can be seen if door to door segregation, proper management of inert waste after segregation and pre-treatment of to separate high calorific fraction are followed.

Generally waste to energy technologies are bit expensive and also require highly skilled man power with high technologies. If the plants are not operated efficiently and proper emission control methods are followed then they cause several environmental issues.

E. Landfilling

Landfilling should be limited to non-biodegradable, inert waste and other wastes which are not appropriate for recycling or for energy conversion. Landfill sites should be distant from habitation, Parks, water bodies and places which are meant for cultural and historical importance. The site used for landfilling should be fenced and should a proper entrance with gate to ensure the vehicle flow and their waste disposal.

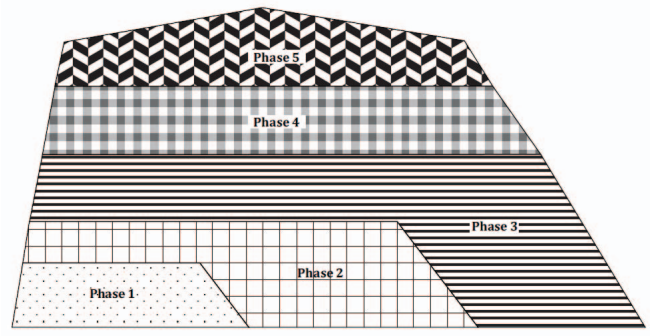

Fig. 6: Phases in Landfilling [2]

To limit harm to the landfill base layers and guarantee their proceeded with uprightness over the lifetime of the landfill and furthermore to limit potential for penetration of rain water, the removal of the base is done in phases. The degree of each phase is planned with the end goal that the proposed waste fill volume (in view of degree of base and waste fill forms) ought to be sufficiently huge for a time of atleast two-three a long time. The base of the whole landfill has to be uncovered inside the initial few stages and consequent waste position would just be over effectively put squander, until definite waste fill shapes are come to.

IV. INTEGRATION OF TECHNOLOGY

The integration of following sensors and recent technologies into existing waste management makes it smarter and highly efficient.

A. Ultrasonic Sensor

Each waste bin is attached with a ultrasonic sensor which detects the waste level of the bin. The ultrasonic sensor measures the level of the waste by sending a sound wave at a specific frequency and listens the reflected sound wave that is bounced back. It calculates the time taken by the wave for traveling and reflecting back, and measures the distance at which obstacle is present. The implementation of this ultrasonic sensor in the waste bins prevents the overflow the waste and also an alert is sent to collecting authority.

B. Moisture Sensor

The basic segregation of waste into dry waste and wet waste can be achieved by integrating moisture sensor. The moisture sensor detects the moisture content of the waste that is disposed into the bin and segregates and the waste is stored separately depending on the moisture content of waste. By segregating the waste using moisture sensor the further processing of waste can be more efficiently.

C. Integration of GPS, GPRS and RFID

The coordinated arrangement of RFID, GPRS and GPS makes the waste bin identification and customer information accumulation framework efficient. RFID has numerous applications in the field of environment. This innovation assumes a vital part in Solid Waste accumulation operations. The GPS and GPRS framework is generally implemented in the computerized/ electronic guide, the vehicle monitoring and administration system, the security navigation. Integrating of GIS and GPS innovation can show and track vehicle position in subject advanced maps. GIS mapping server is utilized for studying information of different areas. It takes the choice for dumping place selection. All the while the GIS server is refreshed utilizing the information stored to the system. Dissecting the capacity information, authority for waste administration can take change their strategy like fleet management, route administration, dumping area determination and so on.

D. Motion Detection Sensor

A motion detection sensor can be placed exterior of the waste bin for automatic closing and opening of the lid on the bin. The sensor detects if any person is there near to the bin for disposing any waste, and the lid is opened for throwing the waste. This automatic opening and closing of lid is necessary because if waste is waste is exposed to sunlight and external weather conditions it gets decomposed and bad smell will be released.

V. Conclusion

Advancements in innovation in different parts of life has made ways of sophisticated delivery of service. With the expanding population and changes in the way of life, waste administration is another area where current innovative collection can be connected in a more efficient way. Diverse environmental elements and partners are included in the waste management system. It is imperative to have a strong method for dealing with the waste, so that not just the process becomes efficient, additionally, the disposal of waste is done beneficially. Also, food industry, human healthcare, tourism, and other such departments can take profit by the accessible assets related with waste administration. In developing nations like India, it is essential to arrange and actualize feasible minimal cost SWM procedures. Absence of awareness, inappropriate information, deficient financing, unaccountability, execution of legislation and strategies are real explanations behind the failure of MSWM. Issues like appropriate site choice, satisfactory money related support, and inappropriate human resource administration, can be overcome with upgraded limit, enhanced methodology and training. The answer for the issues related with improvement and adoption of proper innovations and absence of trained labor will require at realistic time frame and government bodies, need to take different activities for reinforcing MSWM in the nation. Standards of SWM should be considered such that these take the ground realities and permit time for reasonable procedures and mechanisms to be created. Unfortunately, part of rag pickers in SWM has not been sufficiently perceived till now, who are one of the essential partners of the SWM in India. Their part should be suited in the best possible way to upgrade and lift their morale. The proper organised sector for reuse and recycling of waste should be set up to produce greater business and income, aside from decreasing the load on transportation and landfill.

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