



Evolution of Solid Waste Management and Sorting

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Abstract: Waste Management and sorting has been a matter of concern for decades and has been rapidly rising by the escalation in the population. This paper focusses on the evolution of various technological methods that emerged over the years to make this process more cost-effective and implementable. The techniques proposed were not necessarily implementable but provided some sought of advancement that helped in understanding what is feasible and in which area there is a necessity for improvement.

Index Terms – Waste Management, Waste Sorting, Recycling, Dumping, Incineration, Waste-to-Energy, Reduce, Reuse, Recycle

I. Introduction

According to an article issued by The World Bank in 2018, the solid municipal waste produced annually crossed over 2.01 billion metric tons worldwide with at least 33 percent not managed in an environmentally safe manner. Furthermore, these figures were expected to touch a staggering 3.40 billion metric tons annually by the year 2050.^[1] These figures indicate the alarming need for proper waste management and sorting.

There are plenty of shreds of evidence that indicate the problem of waste disposal was insignificant in earlier times due to less population and optimal utilization of resources.

II. The Evolution Timeline

The below events account of the major events that took place in the waste management history:

2.1 History of Dumping waste

In 500 BC, the first-ever municipal dump program was initiated in Athens.^[2] In 6,500 BC it was estimated that the increase in the use of products led the Native Americans in the present state of Colorado to produce about 5.3 pounds of waste per person per day.^[3] Dumping became so regular that in the year 1388, the English government banned waste disposal in waterways and ditches. Then in 1400 in Paris, it was observed that the garbage piles became so high that it interfered with the city's defence system.^[4]

2.2 The Beginning of the Recycling era

Although recycling is a very old phenomenon that can be traced to around 400 BC but was very insignificant. The first major attempt to minimize the waste was initiated by the Japanese in 1031 as the Paper Production moved from the hands of the state's control to the public due to the decline of the Japanese Imperial court in the Heian Period. Then the privates started setting up paper mills to meet the demand. Within a short period, recycling and re-pulping of the paper began to take place and was largely accepted by the locals.^[5]

Then again in 1690, a big step was taken in the history of recycling, the first paper mill in America was set up by the German-born William Rittenhouse (Wilhelm Rittenhausen) in Philadelphia. It used rags for the production of paper and was operational till the mid-18th century.^[6]

2.3 The sorting and detection

It is often said that “need is the mother of invention”

and this saying was proved in the late 1700s when the Americans were engaged in a war against the British for their independence, a dire need for supplies in the defence led to the sorting and recycling of metal. 42,088 bullets were made from melting and recycling the statue of King George III situated in New York City, after the declaration of independence.

In 1813 Benjamin Law laid the foundation of manufacturing recycled wool from old rags and clothes in Batley, West Yorkshire. For the production of yarn, he took the help of the ‘tatters’ which collected the old fabric from various industries. This whole process involved sorting of various fabric types then washing them with soap to remove dirt and grease, ‘willeying’, scribbling and carding, then even amounts of wool was rolled, milled, fullled and then for finishing the wool was dyed.^[7]

2.4 The age of Sanitation

In England during the 1800s, daily the females collected waste from the households using movable bins and sorted manually. The materials like glass, metals, etc. were given back to the shopkeepers or manufacturers for reuse. Then in 1834, in Charleston, West Virginia, a law was legislated which outlawed hunters from hunting vultures that fed on garbage. This did not work for a long period, a report issued in 1842 claimed that a disease was spread due to the unsanitary environmental circumstances, which led to the beginning of the age of sanitation. This gained momentum in the year 1848 when the Public Health Act was imposed under which regulation of waste was done.^[8]

2.5 The Incineration

In 1874, in England's Nottingham, the process of incineration was introduced. The process was to convert the waste into heat/ash via combustion. For its implementation, a machine called 'The destructor' was used which prevented the release of methane in the air. This technology was again used for the first time in USA's Governor's Island in NY.

2.6 The North American Dilemma

With the exponential growth of waste, the lands started running insufficient for its proper disposal. One such major event was encountered in 1889 when Washington DC reported exhaustion of suitable land for refuse. To overcome this issue, in 1896, waste reduction plants were introduced, which aimed at the extraction of grease and oil from organic waste by compressing. But it was observed that this process, emitted noxious fumes and had to be shut. In the same year, 760000 cubic yards of waste was dumped into the Atlantic, off the Virginia coast. Then in 1897, NY set up 'picking yards' where all the garbage was collected and sorted various types of papers, metals, etc to facilitate material recovery. The recovery was mainly done by either reusing or recycling.^[10] In the year 1898, in New York, the first plant which generated energy through incineration was set up.^[4] With all these advancements, suspensions and implementations the century came to an end.

2.7 The First Two Decades

In 1900, piggeries were developed to eat fresh or cooked waste. The norms were not followed strictly and as a result, an outbreak of vesicular exanthema killed thousands of pigs an year later. Laws were passed to ensure that pigs will only be served cooked food.^[2] Manhattan residents were producing 1500lbs of waste annually, 80% of which was ash from burning of coal and wood to incinerate waste.^[9] In the 1900s the reuse programs embraced the phrase 'Waste as wealth' to describe the greens earned by recycling and reselling the waste. In 1904 the first major recycling plant was inaugurated in Cleveland and Chicago, simultaneously the waste was increasing exponentially.^[3] By 1911 the NYC citizens produced 4.6 pounds of refuse daily. BY 1914, 300 incinerators were working in the US for burning household waste.^[2] In 1916 due to massive shortages of raw materials during World War I, the Federal government creates the Waste Reclamation Service with the motto “Don't Waste It – Save It”.^[3] In 1918, due to these complications violating the marine and harbor protection act 1888 the NYC resumed the dumping of waste at sea.^[10]

2.8 The Acts

As the cities grew and the industrialization gained momentum, the waste disposal became a big challenge for the government due to its adverse effect on the health and environment. The dumping of waste in the landfills and in the ocean became very common and led to a miserable condition of the aquatic life. Beaches became foul due to the waste that was pushed along with the tides. Then many laws were imposed, and much emphasis was given for the reuse and proper recycling of products were given much emphasis. There was a major initiative taken in Olympia Washington in 1954 when it announced to pay money for bringing empty aluminum cans back. Then in 1965, the US Government imposed the Solid Waste Disposal Act (SWDA).^[12] This law was aimed at improving the solid waste disposal methods and provide minimum safety guidelines for the landfills. But this act was amended in the year 1970 by The Resource Conservation and Recovery Act (RCRA).^[13] This act grew the engagement of the government in handling waste. Also, in the same year, the Environmental Protection Agency (EPA) was created and the first Earth Day was also celebrated.

2.9 The beverage industry innovation

In the latter half of the 20th century, the waste grew enormously. The majority of the beer producers shifted from using traditional glass bottles to metal cans and no-return bottles. The beverages at first continued to be sold particularly in refillable glass bottles requiring a deposit but later they also were sold in a 'consumer-oriented, non-return, one-way' cans or bottles. This resulted in the burst of beverage trash and to improve the situation, in 1971, Oregon passed the first bottle bill (also known as a deposit law) in the United States. According to this bill, the purchaser had to deposit a little sum of money on every beer and beverage container. By 1986, almost 10 States in the US imposed some sort of deposit on the purchase of the before-mentioned. These bills were not only meant to lessen the litter but also to raise the capital for recycling, preserving the natural resources and, reduce the quantity of solid waste running to the landfills. The percentage of beverage waste earlier reaching from 70-83 percent decreased to 30-47 percent.^[14]

In 1977, UK's Glass Manufacturing Federation (GMF) established the first bottle bank in Barnsley used for recycling glass. It was also installed in South Yorkshire and Oxford the same day, and successfully collected 500 tonnes of glass in the first six months.

3.0 The 3 R's

The 'Reduce, Re-use, and Recycle' slogan, which was used originally introduced on the first Earth Day in 1970 began to gain momentum. To promote this, the Blue Box Recycling System (BBRS) was initiated by the Canadian Municipalities in 1992. Under this system, the government collecting household waste, and the recyclable waste was sorted and kept separately in the blue bins. This made it easier to sort and recycle waste. In 1987, Ontario Multi Material Recycling Incorporated (OMMRI) promised 20 million dollars in funding over four years, which was equated by municipalities and the Ontario government to finance the Blue Box recycling program.^[17] This method was effective and is in use till date.

3.1 The new waste

Towards the end of the century, the use of electronic devices rose, and consequently, the difficulty in the disposal of e-waste also expanded. The e-waste management was of much need because of the environmental side-effects it had if not disposed of properly. They have toxic elements present which could be harmful to the environment as well as humans. So, in the year 1991, in Switzerland, the Swico recycling system began to recycle old refrigerators, free of cost for the consumer, and later started recycling all sort of e-waste. With this, the new century began and reforms regarding waste management were taken all over the world. India drafted a completely new set of rules in 2000 for the regulation of waste dumping. Several committees were formed all over the country to ensure proper implementation of the fore stated. While in 2003, the EU set up various revised directives as concrete laws for faster and effective waste dumping or incineration. In the same year law of providing every household, the facility of collection of recyclable material came into action. In the year 2006, the computer manufacturers offered provision for recycling its products which were considered a great initiative in America and many companies took inspiration from it and started the same policy. UK had multiple revisions of the directives of the EU and implemented its expanded variant. To discourage the use of single-use plastic bags England in 2015 charged an amount of five pence for use of single-use plastic bags throughout the shops of England. There was 80% dip in the use of plastic bags due to the same. Also, in the same year, California enacted the first-ever, state-wide ban on plastic bags in grocery and convenience stores. Cal Recycle, the agency tasked amidst administering and implementing California's laws related to waste management published an article highlighting the outcomes of a survey of thousands of shops and grocers. The investigation found that in the six months following the bag ban around 86 percent of customers brought their bags and didn't purchase a paper or reusable bag. As a result, there was an 85 percent decrease in the quantity of plastic bags and a 61 percent decline in the number of paper bags catered to customers.^[17]

3.2 The Further Advancements

In the year 2016, the Japanese scientist discovered an enzyme that feeds on plastic commonly used in drinking water bottles (PET). This created a possibility to reduce the waste. Earlier China used to import waste from other countries but in 2018 it banned the import due to the excessive cost and lesser outcome. At present the reaches are concentrating on improving the waste management by the use of artificial intelligence and advancement in machine learning, and the list goes on.

IV. Conclusion

The above was a brief account of the significant progressions and trends in the technology employed for waste management. And the new technology forthcoming is aimed at being more cost-effective, and feasible.

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