Waste Management Practices Used in the Attempt to Protect the Environment

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Abstract: Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is also carried out to recover resources from it. Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each. Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Management for non-hazardous residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator.

Key-Words: waste materials, effect on health, environment, solid, liquid, gaseous or radioactive substances

1 Introduction
It takes a lot of valuable energy and materials to create and manufacture products and the resulting industrial waste can be difficult to manage. Many cities and countries have put new laws into place to heavily tax companies that produce excess amounts of waste or create potentially harmful effects on the air and ecosystem. The extra taxes help to offset the environment damage by going toward environmental restoration, protection and spreading information to increase knowledge on these issues. People and companies need to educate themselves about the environment.
Hazardous waste is waste that poses substantial or potential threats to public health or the environment. What determines whether it's a hazardous waste is it's:

- ignitability (i.e., flammable)
- reactivity
- corrosivity
- toxicity

Major services include waste collection, treatment, and disposal; remediation; and recycling. Waste collection accounts for about 55 percent of industry revenue; treatment and disposal, 20 percent; and remediation, 15 percent. (Remediation involves the cleaning of crude oil spills and ground contamination, removal of asbestos and lead paint, and restoration of strip-mined areas.) Small companies usually operate in only one of these segments. Larger companies often have vertically integrated operations that include all of these components.

2 Waste management concepts

There are a number of concepts about waste management which vary in their usage between countries or regions. Some of the most general, widely-used concepts include:

- Waste hierarchy (Figure 1) - The waste hierarchy refers to the "3 Rs" reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. Waste minimization means reducing waste at source. In general this means practices such as:
  - Reusing (or promoting the reuse of) materials in their original form as far as possible
  - Separating waste into different streams at source, before it is collected for recovery and recycling purposes
  - Diverting waste from landfills through appropriate mechanisms and facilities
  - Facilitating the processing or treatment of any recyclable waste, in an economical and environmentally sustainable manner.

- Extended producer responsibility - Extended Producer Responsibility (EPR) is a strategy designed to promote the integration of all costs associated with products throughout their life cycle (including end-of-life disposal costs) into the market price of the product. Extended producer responsibility is meant to impose accountability over the entire lifecycle of products and packaging introduced to the market. This means that firms which manufacture, import and/or sell products are required to be responsible for the products after their useful life as well as during manufacture.

- Polluter pays principle - the Polluter Pays Principle is a principle where the polluting party pays for the impact caused to the environment. With respect to waste management, this generally refers to the requirement for a waste generator to pay for appropriate disposal of the waste.

- The Talloires Declaration is a declaration for sustainability concerned about the unprecedented scale and speed of environmental pollution and degradation, and the depletion of natural resources. Local, regional, and global air pollution; accumulation and distribution of toxic wastes; destruction and depletion of forests, soil, and water; depletion of the ozone layer and emission of "green house" gases threaten the survival of humans and thousands of other living species, the integrity of the earth and its biodiversity, the security of nations, and the heritage of future generations.

Figure 1. Diagram of the waste hierarchy.

Figure 2 Scheme of waste management
A waste audit is a key tool in measuring performance against waste plans, strategies, and targets and for identifying areas of non-compliance and inefficient waste management practices. (Figure 2).

3. Methods of disposal

3.1 Landfill

Disposing of waste in a landfill involves burying the waste, and this remains a common practice in most countries. Landfills were often established in abandoned or unused quarries, mining voids or borrow pits. A properly-designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Older, poorly-designed or poorly-managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid Leachate. Another common byproduct of landfills is gas (mostly composed of methane and carbon dioxide), which is produced as organic waste breaks down anaerobically. This gas can create odor problems, kill surface vegetation, and is a greenhouse gas.

A landfill compaction vehicle in action.

Design characteristics of a modern landfill include methods to contain leachate such as clay or plastic lining material. Deposited waste is normally compacted to increase its density and stability, and covered to prevent attracting vermin (such as mice or rats). Many landfills also have landfill gas extraction systems installed to extract the landfill gas. Gas is pumped out of the landfill using perforated pipes and flared off or burnt in a gas engine to generate electricity.

3.2 Incineration

Incineration is a disposal method that involves combustion of waste material. Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incinerators convert waste materials into heat, gas, steam, and ash.

Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. It is recognized as a practical method of disposing of certain hazardous waste materials (such as biological medical waste). Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants.

Incineration is common in countries such as Japan where land is scarcer, as these facilities generally do not require as much area as landfills. Waste-to-energy (WtE) or energy-from-waste (EfW) is broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam and/or electricity. Combustion in an incinerator is not always perfect and there have been concerns about micro-pollutants in gaseous emissions from incinerator stacks. Particular concern has focused on some very persistent organics such as dioxins which may be created within the incinerator and which may have serious environmental consequences in the area immediately around the incinerator. On the other hand this method produces heat that can be used as energy.

3.3 Recycling methods

The popular meaning of ‘recycling’ in most developed countries refers to the widespread collection and reuse of everyday waste materials such as empty beverage containers. These are collected and sorted into common types so that the raw materials from which the items are made can be reprocessed into new products. Material for recycling may be collected separately from general waste using dedicated bins and collection vehicles, or sorted directly from mixed waste streams. The most common consumer products recycled include aluminum beverage cans, steel food and aerosol cans, HDPE and PET bottles, glass bottles and jars, paperback cartons, newspapers, magazines, and corrugated fiberboard boxes.

PVC, LDPE, PP, and PS (see resin identification code) are also recyclable, although these are not commonly collected. These items are usually composed of a single type of material, making them relatively easy to recycle into new products. The recycling of complex products (such as computers and electronic equipment) is more difficult, due to the additional dismantling and separation required.

3.4 Sustainability

Waste Management is a key player in maintaining a business’s ISO14001 accreditations. Companies are encouraged to improve their environmental efficiencies each year. One way to do this is by improving a company’s waste management with a new recycling service. (Such as recycling: glass, food waste, paper and cardboard, plastic bottles etc)

3.5 Biological reprocessing

Waste materials that are organic in nature, such as plant material, food scraps, and paper products, can be recycled using biological composting and digestion processes to decompose the organic matter. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes. In addition, waste gas from the process (such as methane) can be captured and used for generating electricity and heat (CHP/cogeneration) maximizing efficiencies. The intention of biological processing in waste management is to control and accelerate the natural process of decomposition of organic matter.

Gasification and advanced Plasma arc gasification are used to convert organic materials directly into a synthetic gas (syngas) composed of...
carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam. An alternative to prolepsis is high temperature and pressure supercritical water decomposition (hydrothermal monophasic oxidation). There are a large variety of composting and digestion methods and technologies varying in complexity from simple home compost heaps, to small town scale batch digesters, industrial-scale enclosed-vessel digestion of mixed domestic waste (see Mechanical biological treatment). Methods of biological decomposition are differentiated as being aerobic or anaerobic methods, though hybrids of the two methods also exist.

Anaerobic digestion of the organic fraction of MSW Municipal Solid Waste has been found to be in a number of LCA analysis studies \cite{4,5} to be more environmentally effective, than landfill, incineration or pyrolysis. The resulting biogas (methane) though must be used for cogeneration (electricity and heat preferably on or close to the site of production) and can be used with a little upgrading in gas combustion engines or turbines. With further upgrading to synthetic natural gas it can be injected into the natural gas network or further refined to hydrogen for use in stationary cogeneration fuel cells. Its use in fuel cells eliminates the pollution from products of combustion (SOx, NOx, pariculates, dioxin, furans, PAHs...).

An example of waste management through composting is the Green Bin Program in Toronto, Canada, where household organic waste (such as kitchen scraps and plant cuttings) are collected in a dedicated container and then composted.

### 3.6 Energy recovery

The energy content of waste products can be harnessed directly by using them as a direct combustion fuel, or indirectly by processing them into another type of fuel. Recycling through thermal treatment ranges from using waste as a fuel source for cooking or heating, to anaerobic digestion and the use of the gas fuel (see above), to fuel for boilers to generate steam and electricity in a turbine. Pyrolysis and gasification are two related forms of thermal treatment where waste materials are heated to high temperatures with limited oxygen availability. The process usually occurs in a sealed vessel under high pressure. Pyrolysis of solid waste converts the material into solid, liquid and gas products. The liquid and gas can be burnt to produce energy or refined into other chemical products (chemical refinery). The solid residue (char) can be further refined into products such as activated carbon.

### 3.7 Avoidance and reduction methods

An important method of waste management is the prevention of waste material being created, also known as waste reduction. Methods of avoidance include reuse of second-hand products, repairing broken items instead of buying new, designing products to be refillable or reusable (such as cotton instead of plastic shopping bags), encouraging consumers to avoid using disposable products (such as disposable cutlery), removing any food/liquid remains from cans, packaging, \cite{6} and designing products that use less material to achieve the same purpose (for example, light weighting of beverage cans).

### 3.8 Waste handling and transport

Waste collection methods vary widely between different countries and regions. Domestic waste collection services are often provided by local government authorities, or by private industry. Some areas, especially those in less developed countries, do not have a formal waste-collection system.

In Europe and a few other places around the world, a few communities use a proprietary collection system known as Envac, which conveys refuse via underground conduits using a vacuum system. Other vacuum-based solutions include the MetroTaifun single-line and ring-line systems.

In Israel, the Arrow Ecology company has developed the ArrowBio system, which takes trash directly from collection trucks and separates organic and inorganic materials through gravitational settling, screening, and hydro-mechanical shredding. The system is capable of sorting huge volumes of solid waste, salvaging recyclables, and turning the rest into biogas and rich agricultural compost. The system is used in California, Australia, Greece, Mexico, the United Kingdom and in Israel. For example, an Arrow Bio plant that has been operational at the Hiriya landfill site since December 2003 serves the Tel Aviv area, and processes up to 150 tons of garbage a day.\cite{7}

### 3.9 Technologies

Traditionally the waste management industry has been slow to adopt new technologies such as RFID (Radio Frequency Identification) tags, GPS and integrated software packages which enable better quality data to be collected without the use of estimation or manual data entry.

- Technologies like RFID tags are now being used to collect data on presentation rates for curb-side pick-ups which is useful when examining the usage of recycling bins or similar.
- Benefits of GPS tracking is particularly evident when considering the efficiency of ad hoc pick-ups (like skip bins or dumpsters) where the collection is done on a consumer request basis.
- Integrated software packages are useful in aggregating this data for use in optimization of operations for waste collection operations.
- Rear vision cameras are commonly used for OH&S reasons and video recording devices are becoming more widely used, particularly concerning residential services and contaminations of the waste stream.
4 Conclusion
Waste management is the collection of all thrown away materials in order to recycle them and as a result decrease their effects on our health, our surroundings and the environment and enhance the quality of life. Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Waste Management flows in a cycle: monitoring, collection, transportation, processing, disposal or recycle. Through these steps a company can effectively and responsibly manage waste output and their positive effect they have on the environment.

Waste generation per capita has increased and is expected to continue to climb with growing population, wealth, and consumerism throughout the world. Approaches to solving this waste problem in a scalable and sustainable manner would lead us to a model that uses waste as an input in the production of commodities and value monetized, making waste management a true profit center. The conversion of waste as a potential source of energy has a value as a supplemental feedstock for the rapidly developing bio-fuels sector. A variety of new technologies are being used and developed for the production of biofuels which are capable of converting wastes into heat, power, fuels or chemical feedstock. Thermal Technologies like gasification, pyrolysis, thermal depolymerization, plasma arc gasification, and non-thermal technologies like anaerobic digestion, fermentation etc are a number of new and emerging technologies that are able to produce energy from waste and other fuels without direct combustion. Biodegradable wastes are processed by composting, vermi-composting, anaerobic digestion or any other appropriate biological processing for the stabilization of wastes. Recycling of materials like plastics, paper and metals should be done for future use.

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