# Reverse Logistic of Solid Waste Management

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## I. INTRODUCTION

Environmental pollution is the major problem associated with rapid industrialization, urbanization and rise in living standards of people. For developing countries, industrialization was must and still this activity very much demands to build self-reliant and in uplifting nation's economy. However, industrialization on the other hand has also caused serious problems relating to environmental pollution. Therefore, wastes seem to be a by-product of growth. The country like India can ill afford to lose them as sheer waste. On the other hand, with increasing demand for raw materials for industrial production, the non-renewable resources are dwindling day-by-day. Therefore, efforts are to be made for controlling pollution arising out of the disposal of wastes by conversion of these unwanted wastes into utilizable raw materials for various beneficial uses. The problems relating to disposal of industrial solid waste are associated with lack of infrastructural facilities and negligence of industries to take proper safeguards. The large and medium industries located in identified (conforming) industrial areas still have some arrangements to dispose solid waste. However, the problem persists with small scale industries. In number of cities and towns, small scale industries find it easy to dispose but it makes difficult for local bodies to collect such waste. In some cities, industrial, residential and commercial areas are mixed and thus all waste gets intermingled. Therefore, it becomes necessary that the local bodies along with State Pollution Control Board (SPCB) work out requisite strategy for organizing proper collection and disposal of industrial solid waste.

The term 'Logistics' is used interchangeably to mean supply chain management (SCM). It refers to the strategic management of the overall supply chain including procurement, manufacture, distribution and waste disposal. It is the process that involves the flow of materials in an optimal and organized way from the supplier to a consumer. Logistics involves planning, creating and monitoring flows of goods and information. The issue with the first definition is that packaging materials are left out. It focuses on both economic gains and sustainability. Reverse logistics, being a new subject in the area, has been perceived to mean reversed logistics, returns 15 logistics or reverse distribution. However, with all these definitions, there is an element of resource recovery and as such are taken to mean the same thing. However it should be noted that reverse logistics focuses more on collection, value addition and final disposal (Fig. 1). The European Working group incorporates reverse

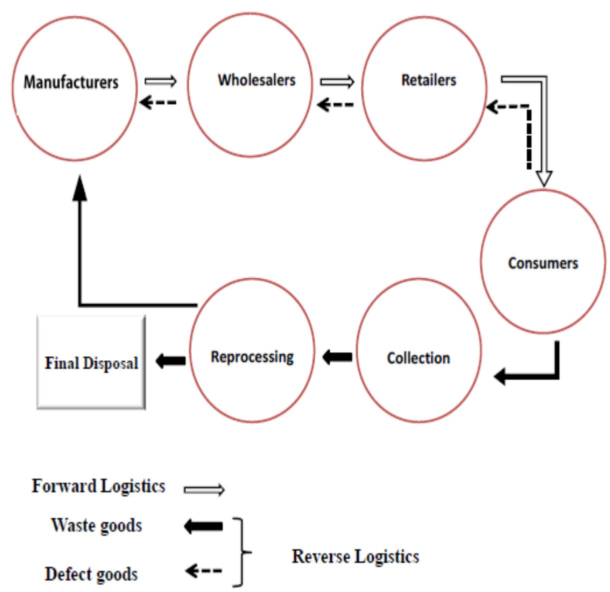


*Figure 1.* Integration of forward and reverse logistics

Figure 1.

## II. DISTRIBUTION NETWORK

Reverse distribution management of product return flow starts with the product generators, usually called the suppliers, and these include the households, restaurants, market places and business centers. These provide waste that is normally dumped and unsegregated. This waste is later collected from the temporary collection points by a number of actors, including waste pickers, street children, refuse loaders and waste pickers, who enter into the distribution chain up to the landfill. Waste with these actors undergoes activities such as collection, transporting, separation, cleaning, washing, grading, packaging selling and buying. At the landfill, small-scale traders, small-scale plants, agents and factories enter the chain. This brings about competition from information flow and product acquisitions (Fig. 2). At the landfill in Kiteezi this involved the removal of defective and environmentally hazardous materials.

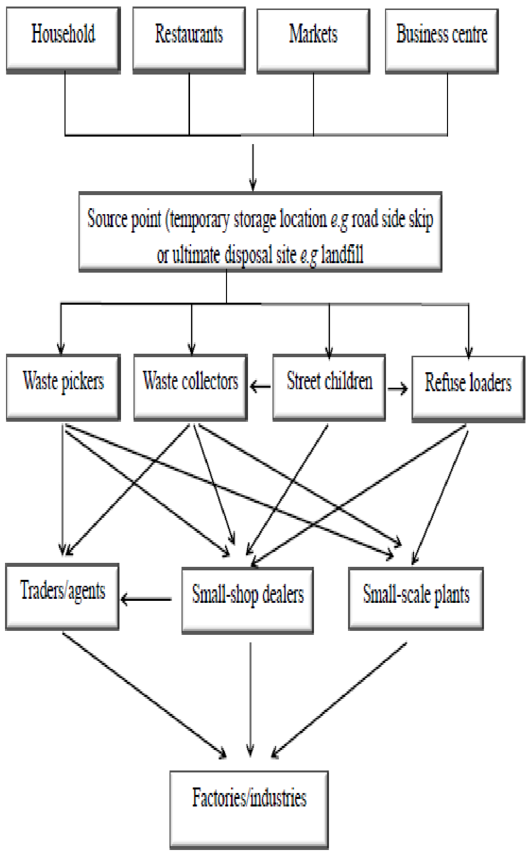


Figure 2. Reverse logistic distribution network channels.

In India, reverse logistics as a topic is not known, but the activities embedded with in it are being practiced by the people in some form of product recycling. Unlike the sophisticated reverse logistics chain and recycling systems in developed countries, In Indian system it has developed the traditional collection of organic matter mainly to feed animals, and then evolved to include the collection of metal scrap from all sources. The recovery of reusable materials is performed by people working in the informal sector who are driven by poverty and the activity acts as a source of income for many poor communities. The waste recycled and reused includes plastics, metals, food waste, polyethylene bags and sludge. There are no clear definitive conclusions that can be made on how much waste is recycled or reused due to the current lack of information.

Despite the low application of reverse logistics in developing countries, it has attracted significant attention in some operations organizations and waste management systems. For instance no matter what the product is, how it is sold or who the customers are, every organization needs to focus on recovering the maximum value from returns. The application of reverse logistics in waste management involves the movement of products in the opposite direction of the supply chain, from a customer back to the supplier

Many cities, especially in developing countries, are facing challenges in the management of solid waste. The aim of the study was to develop effective logistics systems for solid waste management in urban areas of developing countries. City leaders are faced with several challenges in their effort to streamline waste management services. A few of the pressing issues include rapidly increasing quantities and diverse characteristics of waste, the undesirable consequences of conventional methods of waste management, and failure to tap the resource value of waste.

We live in a world of increasing scarcity. Raw materials from natural resources are limited, financial resources are often insufficient, and securing land for final disposal is getting more difficult. Clearly, city authorities should set policy directions aiming for resource efficient, recycle-based society if they are to provide a clean, healthy and pleasant living environment to its citizens for current and future generations. Urban managers are therefore encouraged to pursue the paths of Integrated Solid Waste Management (ISWM) and Reduce, Reuse and Recycle (3Rs) that place highest priority on waste prevention, waste reduction, and waste recycling instead of just trying to cope with ever-increasing amounts of waste through treatment and disposal. Such efforts will help cities to reduce the financial burden on city authorities for waste management, as well as reduce the pressure on landfill requirements.

While facing the increased volumes and diverse characteristics of MSW that come with economic growth, cities responsible for urban waste management are struggling to handle the MSW produced in their jurisdictions. In developing countries, 20-50 per cent of the recurring budget of municipalities is often spent on solid waste management, although often only 50 per cent of the urban population is covered by these services. In low-income countries, collection alone drains 80-90 per cent of total waste management budgets. Open dumps and open burning continue to be the primary method of MSW disposal in most developing countries.

## III. OVERVIEW OF WASTE MANAGEMENT

Solid waste management is a growing problem in many urban cities in developing countries. The reason attributed to this is rapid urbanization due to the population growth rates from rural areas to urban cities in search of a better life (Medina, 1997). On average the generation rates in most developing countries are between 0.3 to 0.6 kg per person per day compared to the 0.9-2 kg per person per day in developed nations. Future projections estimate that the world's solid waste generation could reach up to 1.42 kg/capita. The limited waste collection in developing countries, including Uganda, is due to inadequate waste management budgets, poor management, weak legislation and equipment failures. In the developed world, legislation, regulations and action planning of sustainable waste management. Generally, there is a lack of organization and planning in waste management due to insufficient information about regulations and financial restrictions in many developing countries. The municipalities in these countries do not have the capacity to manage the increasing volume of waste, leading to about 35-40 % of the waste being collected and transported to a landfill. During waste transportation, the trucks overflow and on many occasions litter the city with the waste. The trucks used are also manufactured in the context of developed countries and designed to handle a different kind of waste. This leads to constant breakdowns of these trucks.

Electrical and electronic wastes (e-waste) are rapidly growing forms of waste that are generating much concern. In 2005, 20 to 50 million tons of e-waste were generated worldwide, and by 2020, e-waste from used computers in emerging economies like South Africa, China and India will have increased by 200-500 per cent over 2007 levels.9 E-wastes contain metals such as mercury, cadmium and lead that may leach into the environment and pose a health hazard to human beings, unless handled with care. Numerous cases have been reported where informal sector workers are engaged in dismantling used electrical and electronic equipment in order to recover metals, plastics and other materials for recycling, often without proper protection, exposing them to severe health risks.

Other types of waste streams of concern in the context of an urban lifestyle are construction and demolition waste and end-of-life vehicles. For example, about 10-15 per cent of waste generated in developed countries is due to construction and demolition activity.

Dependence on fossil fuel and inefficient use of energy supplies can expose cities to price and supply fluctuations. Cities can dampen their demand for oil, electricity and natural gas by implementing energy efficiency measures and thus insulate themselves from fossil fuel supply risks.

## IV. ENVIRONMAENTAL IMPACT DUE TO MUNICIPAL SOLID WASTE

When solid waste is disposed off on land in open dumps or in improperly designed landfills (e.g. in low lying areas), it causes the following impact on the environment.

1. Ground water contamination by the leachate generated by the waste.
2. Surface water contamination by the run-off from the waste dump.
3. Bad odor, pests, rodents and wind-blown litter in and around the waste dump.
4. Generation of inflammable gas (e.g.methane) within the waste dump.
5. Bird menace above the waste dump which affects flight of aircraft.
6. Fires within the waste dump.
7. Erosion and stability problems relating to slopes of the waste dump.
8. Epidemics through stray animals.
9. Release of Green House gas.

## V. OBJECTIVE OF SOLID WASTE MANAGEMENT

The objective of solid waste management is to reduce the quantity of solid waste disposed of on land by recovery of materials and energy from solid waste as depicted in. This in turn results in lesser requirement of raw material and energy as inputs for technological processes.

A simplified flow chart showing how waste reduction can be achieved for household waste is shown in. Such techniques and management programs have to be applied to each and every solid waste generating activity in a society to achieve overall minimization of solid waste.

## VI. FUNCTIONAL ELEMENTS OF MUNICIPAL SOLID WASTE MANAGEMENT

The activities associated with the management of municipal solid wastes from the point of generation to final disposal can be grouped into the six functional elements: (a) waste generation; (b) waste handling and sorting, storage, and processing at the source; (c) collection; (d) sorting, processing and transformation; (e) transfer and transport; and (f) disposal.

### 1. Waste Generation:

Waste generation encompasses activities in which materials are identified as no longer being of value (in their present form) and are either thrown away or gathered together for disposal. Waste generation is, at present, an activity that is not very controllable. In the future, however, more control is likely to be exercised over the generation of wastes. Reduction of waste at source, although not controlled by solid waste managers, is now included in system evaluations as a method of limiting the quantity of waste generated.

**2. Waste Handling, Sorting, Storage, and Processing at the Source:**

The second of the six functional elements in the solid waste management system is waste handling, sorting, storage, and processing at the source. Waste handling and sorting involves the activities associated with management of wastes until they are placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. Sorting of waste components is an important step in the handling and storage of solid waste at the source. For example, the best place to separate waste materials for reuse and recycling is at the source of generation. Households are becoming more aware of the importance of separating newspaper and cardboard, bottles/glass, kitchen wastes and ferrous and non-ferrous materials. On-site storage is of primary importance because of public health concerns and aesthetic consideration. Unsightly makeshift containers and even open ground storage, both of which are undesirable, are often seen at many residential and commercial sites. The cost of providing storage for solid wastes at the source is normally borne by the household in the case of individuals, or by the management of commercial and industrial properties. Processing at the source involves activities such as backyard waste composting.

**3. Collection:**

The functional element of collection, includes not only the gathering of solid wastes and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a materials processing facility, a transfer station, or a landfill disposal site.

**4. Sorting, Processing and Transformation of Solid Waste:**

The sorting, processing and transformation of solid waste materials is the fourth of the functional elements. The recovery of sorted materials, processing of solid waste and transformation of solid waste that occurs primarily in locations away from the source of waste generation are encompassed by this functional element. Sorting of commingled (mixed) wastes usually occurs at a materials recovery facility, transfer stations, combustion facilities, and disposal sites. Sorting often includes the separation of bulky items, separation of waste components by size using screens, manual separation of waste components, and separation of ferrous and non-ferrous metals. Waste processing is undertaken to recover conversion products and energy. The organic fraction of Municipal Solid Waste (MSW) can be transformed by a variety of biological and thermal processes. The most commonly used biological transformation process is aerobic composting. The most commonly used thermal transformation process is incineration. Waste transformation is undertaken to reduce the volume, weight, size or toxicity of waste without resource recovery. Transformation may be done by a variety of mechanical (eg shredding), thermal (e.g. incineration without energy recovery) or chemical (e.g. encapsulation) techniques.

**5. Transfer and Transport:**

The functional element of transfer and transport involves two steps: (i) the transfer of wastes from the smaller collection vehicle to the larger transport equipment and (ii) the subsequent transport of the wastes, usually over long distances, to a processing or disposal site. The transfer usually takes place at a transfer station.

**6. Disposal:**

The final functional element in the solid waste management system is disposal. Today the disposal of wastes by landfilling or uncontrolled dumping is the ultimate fate of all solid wastes, whether they are residential wastes collected and transported directly to a landfill site, residual materials from Materials Recovery Facilities (MRFs), residue from the combustion of solid waste, rejects of composting, or other substances from various solid waste-processing facilities. A municipal solid waste landfill plant is an engineered facility used for disposing of solid wastes on land or within the earth's mantle without creating nuisance or hazard to public health or safety, such as breeding of rodents and insects and contamination of groundwater.

## IV. CHARACTERISTICS OF REVERSED PRODUCTS

At the landfill, waste was characterized into the following waste streams: food waste, plastics, soft polyethylene, paper, textiles, metals, rock soil, vegetation and special waste. After analysis, food waste had a percentage of 39 %, vegetation 23 % and rock soil 21 %. There was no significant difference in generation between these three waste streams at the landfill, but there was a great variation with the other waste streams (Fig. 15). The variation of soft polyethylene at 5 % and plastics at 4 % was not significant, but it was slightly significant with paper (2 %), textiles (2 %), special waste (2 %) and metals and glass (1 %).

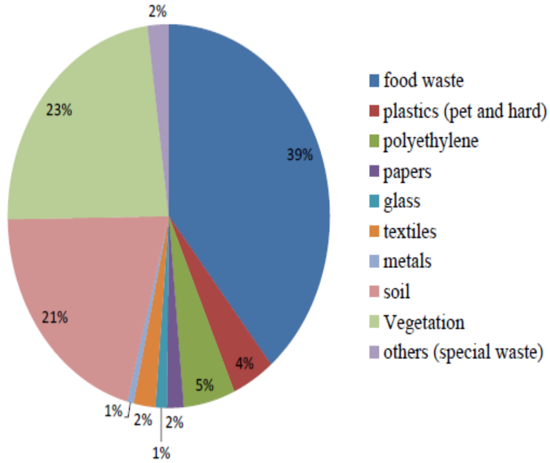


Figure 3. Selected waste stream categories at landfill.

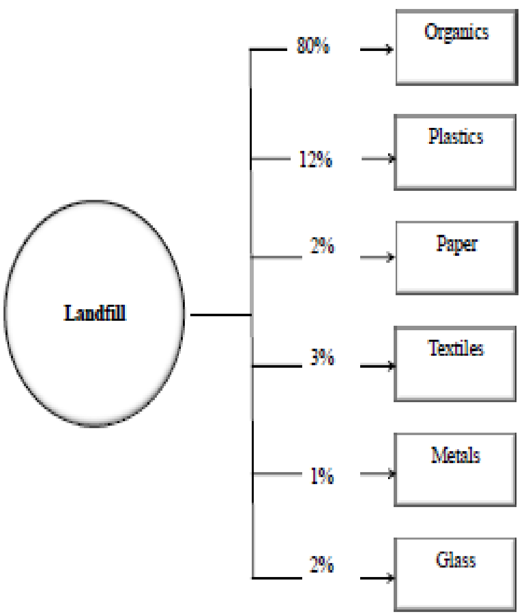


Figure 4. Average percentages of the different product that can be recovered from the laandfill


Figure 5. Reversed product at the landfill(a) Aluminum can,(b) Hard plastic,(c) Food waste,(d) Soft plastic (Polyethylene).

## VIII. CLASSIFICATION OF SOLID WASTES

| TYPES OF SOLID | WASTE DESCRIPTION | SOURCES |
|---|---|---|
| **Food waste (garbage)** | Wastes from the preparation, cooking, and serving of food. Market refuse, waste from the handling, storage, and sale of produce and meats and vegetable | Households, institutions and commercial such as hotels, stores, restaurants, markets, etc. |
| **Rubbish** | **Combustible** (primary organic) paper, cardboard, cartons wood, boxes, plastics, rags, cloth, bedding, leather, rubber, grass, leaves, yard trimmings **Noncombustible** (primary inorganic) metals, tin cans, metal foils dirt, stones, bricks, ceramics, crockery, glass bottles, other mineral refuse | |
| **Ashes and** | Residue from fires | |

| | | |
|---|---|---|
| **Residues** | used for cooking and for heating buildings, cinders, clinkers, thermal power plants. | Streets, sidewalks, alleys, vacant lots, etc. |
| **Bulky waste** | Large auto parts, tyres, stoves refrigerators, others large appliances, furniture, large crates, trees, branches, palm fronts, stumps, footage | |
| **Street waste** | Street sweepings, Dirt, leaves, catch basin dirt, animal droppings, contents of litter receptacles dead animals | |
| **Dead animals** | Small animals: cats, dogs, poultry etc. Large animals: horses, cows etc. | |
| **Construction & demolition waste** | Lumber, roofing, and sheathing scraps, crop residues, rubble, broken concrete, plaster, conduit pipe, wire, insulation etc. | Construction and demolition sites, remodeling, repairing sites |
| **Industrial waste & sludges** | Solid wastes resulting from industry processes and manufacturing operations, such as food processing wastes, boiler house cinders, wood, plastic and metal scraps and shaving, etc. Effluent treatment plant sludge of industries and sewage treatment plant sledges, coarse screening, grit & septic tank | Factories, power plants, treatment plants, etc. |
| **Hazardous wastes** | Hazardous wastes: pathological waste, explosives, radioactive material, toxic waste etc. | Households, hospitals, institution, stores, industry, etc. |
| **Horticulture Wastes** | Tree-trimmings, leaves, waste from parks and gardens, etc. | Parks, gardens, roadside trees, etc. |

## IX. VARIOUS METHODS FOR THE REVERSED LOGISTIC PRODUCT REUSE OF MUNICIPAL SOLID WASTE

The use of these materials basically depends on their separation and condition of the separated material. A majority of these materials are durable and therefore, have a high potential of reuse. It would, however, be desirable to have quality standards for the recycled materials. Construction and demolition waste can be used in the following manner.

- Reuse (at site) of bricks, stone slabs, timber, conduits, piping railings etc. to the extent possible and depending upon their condition.
- Plastics, broken glass, scrap metal etc. can be used by recycling industries.
- Rubble, brick bats, broken plaster/concrete pieces etc. can be used for building activity, such as, leveling,under coat of lanes where the traffic does not constitute of heavy moving loads.
- Larger unusable pieces can be sent for filling up low-lying areas.
- Fine material, such as, sand, dust etc. can be used as cover material over sanitary landfill

Most municipal authorities are unable to provide efficient waste collection. Waste management budgets are normally less than other municipal services because the service is not perceived as

deserving a high priority. As a result, unsatisfactory management means public complaints are the order of the day. Research and development activities in solid waste management are often given low priority. This is because there are other pressing issues that need to be tackled by governments, such as poverty eradication, war and AIDS. This is compounded by the limited budgets directed to the solid waste management sector. Limited available resources provided by developing countries have made it impossible to hire highly skilled labor for

An increase in the economic development in developing countries means better income levels for most urban people, leading to higher purchasing power. This in turn has increased the waste being generated in the cities of developing countries. Per capita waste generation in developing countries is currently estimated to be 0.3to0.6kg/day

## X. CONCLUSION

No rational decisions on municipal solid wastes system are possible until data of composition and quantity of solid waste are available. The method and capacity of storage, the correct type of collection vehicle, the optimum size of crew and the frequency of collection depend mainly on volume and density of wastes.

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