

Solid Waste Management in Developing Countries^{*}

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Solid waste management includes all activities that seek to minimise the health, environmental and aesthetic impacts of solid wastes

1. Terminology

Solid waste is material, which is not in liquid form, and has no value to the person who is responsible for it. Although human or animal excreta often ends up in the solid waste stream, generally the term solid waste does not include such materials. Synonyms to solid waste are terms such as "garbage", "trash", "refuse" and "rubbish".

The term **municipal solid waste**, refers to solid wastes from houses, streets and public places, shops, offices, and hospitals, which are very often the responsibility of municipal or other governmental authorities. Solid waste from industrial processes are generally not considered "municipal" however they need to be taken into account when dealing with solid waste as they often end up in the municipal solid waste stream.

2. Introduction

Human activities create waste, and it is the way these wastes are handled, stored, collected and disposed of, which can pose risks to the environment and to public health. In urban areas, especially in the rapid urbanizing cities of the developing world, problems and issues of Municipal Solid Waste Management (MSWM) are of immediate importance. This has been acknowledged by most governments, however rapid population growth over-whelms the capacity of most municipal authorities to provide even the most basic services. Typically one to two thirds of the solid waste generated is not collected. As a result, the uncollected waste, which is often also mixed with human and animal excreta, is dumped indiscriminately in the streets and in

drains, so contributing to flooding, breeding of insect and rodent vectors and the spread of diseases. Furthermore, even collected waste is often disposed of in uncontrolled dumpsites and/or burnt, polluting water resources and air.

While urbanisation in developing countries has contributed to wealth accumulation, it has also been accompanied by an alarming growth in the incidence of poverty. Today, one out of four people in cities lives in "absolute poverty," while another one in four is classified as "relatively poor". Throughout the developing world it is these urban poor, often in the peri-urban areas, that suffer most from the life-threatening conditions deriving from deficient MSWM. Municipal authorities tend to allocate their limited financial resources to the richer areas of higher tax yields where citizens with more political pressure reside. Usually as income of the residents' increases, part of the wealth is used to avoid exposure to the environmental problems close to home, but as waste generation also increases with increasing wealth, the problems are simply shifted elsewhere. Thus even as environmental problems at the household or neighbourhood level may recede in higher income areas, city-wide and regional environmental degradation due to a deficient SWM remains or increases.

There are sometimes situations in which the difficulty experienced by urban managers in planning and directing concrete projects in a cost-effective way may overshadow the need for technical solutions to MSWM problems. In other cases, there is a tendency for MSWM decisions to be made without sufficient planning, to take into account only some aspects of a situation, to be based on a short-term view of the situation, or to be influenced by the interests of political elites. Adequate municipal solid waste management is much more than a technological issue -

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it always also involves institutional, social, legal, and financial aspects and involves coordinating and managing a large workforce and collaborating with many involved stakeholders as well as the general public. The preparation and management of a good solid waste management system needs inputs from a range of disciplines, and careful consideration of local conditions.

3. Challenges in Solid Waste Management

In Municipal Solid Waste Management (MSWM) of developing countries typical problem areas can be identified. These can be described as: 1) inadequate service coverage and operational inefficiencies of services, 2) limited utilization of recycling activities, 3) inadequate landfill disposal, and 4) inadequate management of hazardous and healthcare waste.

Service Coverage for Waste Collection

Municipal solid waste collection schemes of cities in the developing world generally serve only a limited part of the urban population. The people remaining without waste collection services are usually the low-income population living in peri-urban areas. One of the main reasons, is the lack of financial resources to cope with the increasing amount of generated waste produced by the rapid growing cities. Often inadequate fees charged and insufficient funds from a central municipal budget can not finance adequate levels of service. However not only financial problems affect the availability or sustainability of a waste collection service. Operational inefficiencies of SW services operated by municipalities can be due to inefficient institutional structures, inefficient organizational procedures, or deficient management capacity of the institutions involved as well as the use of inappropriate technologies.

With regard to the technical system, often the "conventional" collection approach, as developed and used in the industrialized countries, is applied in developing countries. The used vehicles are sophisticated, expensive and difficult to operate and maintain, thereby often inadequate for the conditions in developing countries. After a short time of operation usually only a small part of the vehicle fleet remains in operation.

In many countries there is currently great interest in involving private companies in solid waste management. Sometimes this is driven by the

failures of municipal systems to provide adequate services, and sometimes by pressure from national governments and international agencies. Arrangements with private companies have not all been successful, and as a result some opposition to private sector involvement is now in evidence. An important factor in the success of private sector participation is the ability of the client or grantor - usually a municipal administration - to write and enforce an effective contract. Many municipalities do not know what it has been costing them to provide a service, so they cannot judge if bids from the private sector are reasonable. The contract document must be well written to describe in quantitative terms what services are required and to specify penalties and other sanctions that will be applied in case of shortcomings. Monitoring and enforcement should be effective. It is also important that the rights of both parties are upheld by the courts. Three key components of successful arrangements are competition, transparency and accountability.

As an alternative to large (often international) companies that can provide most or all of the solid waste services in a city, microenterprises or small enterprises (MSEs) or Community-based Organisations (CBO) can be involved for services at the community level (neighbourhoods or the small city administrative zones). They often use simple equipment and labour-intensive methods, and therefore can collect waste in places where the conventional trucks of large companies cannot enter. The MSEs may be started as a business, to create income and employment, or they may be initiated by community members who wish to improve the immediate environment of their homes. A recurring problem with collection schemes that operate at the community level is that these systems generally collect and transport the waste a relatively short distance up to a transfer point, from where the waste should be collected by another organisation - often a municipality. Problems of coordination and payment often result in the waste being left at transfer points for a long time creating a hygienic unsatisfactory condition. Another approach is to recycle as much of the waste locally (decentralised) so that there is very little need for on-going transport of collected waste.

Resource Recovery and Recycling

Recycling inorganic materials from municipal solid waste is often well developed by the activities of the informal sector although such activities are seldom recognised, supported, or promoted by the municipal authorities. Some key

factors that affect the potential for resource recovery are the cost of the separated material, its purity, its quantity and its location. The costs of storage and transport are major factors that decide the economic potential for resource recovery. In many low-income countries, the fraction of material that is won for resource recovery is very high, because this work is done in a very labour-intensive way, and for very low incomes. In such situations the creation of employment is the main economic benefit of resource recovery. The situation in industrialised countries is very different, since resource recovery is undertaken by the formal sector, driven by law and a general public concern for the environment, and often at considerable expense.

Reuse of organic waste material, often contributing to more than 50% of the total waste amount, is still fairly limited but often has great recovery potential. It reduces costs of the disposal facilities, prolongs the sites life span, and also reduces the environmental impact of disposal sites as the organics are largely to blame for the polluting leachate and methane problems. This is one of the reasons why solid waste managers in many parts of the world are now exploring ways to reduce the flow of biodegradable materials to landfills. The feasibility of municipal solid waste composting as one step in the city-wide solid waste management system depends on the market for the compost product, as well as the technical and organisational set-up of the individual plants. Last but not least, a clear legislation, policy and municipal strategy versus the management of organic waste is an important prerequisite for the success of composting activities.

Disposal

Most of the municipal solid waste (MSW) in developing countries is dumped on land in a more or less uncontrolled manner. These dumps make very uneconomical use of the available space, allow free access to waste pickers, animals and flies and often produce unpleasant and hazardous smoke from slow-burning fires.

Financial and institutional constraints are the main reasons for inadequate disposal of waste especially where local governments are weak or underfinanced and rapid population growth continues. Financing of safe disposal of solid waste poses a difficult problem as most people are willing to pay for the removal of the refuse from their immediate environment but then "out of sight – out of mind" are generally not concerned with its ultimate disposal. The present disposal situation is expected to deteriorate even more as with rapid urbanization settlements and housing

estates now increasingly encircle the existing dumps and the environmental degradation associated with these dumps directly affect the population. Waste disposal sites are therefore also subject to growing opposition and it is becoming increasingly difficult to find new sites which find public approval and which are located at a reasonable distance from the collection area. Siting landfills at greater distances to the central collection areas implies higher transfer costs as well as additional investments in the infrastructure of roads hence intensifying the financial problems of the responsible authorities. In addition to all this, an increase in service coverage will even aggravate the disposal problem if the amount of waste cannot be reduced by waste recovery.

Other reasons for inadequate disposal are the mostly inappropriate guidelines for siting, design and operation of new landfills as well as missing recommendations for possible upgrading options of existing open dumps. Many of the municipal officials think that uncontrolled waste disposal is the best that is possible. Often the only guidelines for landfills available are those from high-income countries. These are based on technological standards and practices suited to the conditions and regulations of high-income countries and do not take into account for the different technical, economical, social and institutional aspects of developing countries.

The safe alternative, a sanitary landfill, is a site where solid wastes are disposed at a carefully selected location constructed and maintained by means of engineering techniques that minimise pollution of air, water and soil, and other risks to man and animals. Loans or grants to construct sanitary landfills do not necessarily result in sanitary landfill disposal. Equally important as site location and construction is well trained personnel and the provision of sufficient financial and physical resources to allow a reasonable standard of operation. If this is not given good sites can quickly degenerate into open dumps.

Healthcare Wastes from Hospitals and Hazardous Wastes

Healthcare wastes are generated as a result of activities related to the practice of medicine and sales of pharmaceuticals. Some of the healthcare wastes coming from any particular hospital or institution are similar in nature to domestic solid wastes, and may be called "general healthcare wastes". The remaining wastes pose serious health hazards because of their physical, chemical or biological nature, and so are known as "hazardous healthcare wastes". In many

cases the most dangerous items in healthcare wastes are needles from syringes and drips, because the needles shield the viruses from chemical disinfectants and a harsh external environment, and the sharp point allows easy access for the viruses into the blood stream of anyone who is pricked by the needle. For treatment of hazardous healthcare wastes many strategies rely solely on the provision of incinerators or other treatment technologies. Such a strategy has several weaknesses as often the hospitals and healthcare facilities are not able to afford the operating costs of the plant. Thus plants are left unused or not repaired when they break down. Further, many of the risks occur before the waste gets to this final stage, and therefore they are not reduced by the provision of treatment equipment. The key to improving healthcare waste management is to provide better methods of storage and to train the staff to adopt safer working practices and segregate as hazardous healthcare wastes from general healthcare wastes.

Some waste materials need special care and treatment because their properties make them more hazardous or problematic than general wastes. The management of hazardous chemicals is not only a matter of technology and legislation, but also of enforcement, funding and financial instruments. Changing processes to use less hazardous substitutes and minimising hazardous waste quantities that are discarded can be seen as the preferred options in dealing with any difficult waste. The Basel Convention seeks to control the movement of hazardous wastes across international boundaries. This instrument is necessary because the high cost of treating hazardous wastes in industrialised countries makes it financially attractive to ship the wastes to another country where no special requirements for their disposal will be applied.

4. Factors Influencing Solid Waste Management in Developing Countries

There are many factors that vary from place to place and that must be considered in the design of a solid waste management system. Amongst them are:

Waste amount and composition

Typically, domestic waste from industrialised countries has a high content of packaging made of paper, plastic, glass and metal, and so the waste has a low density. In many developing

countries wastes contain large amounts of inerts such as sand, ash, dust and stones and high moisture levels because of the high usage of fresh fruit and vegetables. These factors make the waste very dense (high weight per unit volume). The consequences of this high density are that vehicles and systems that operate well with low-density wastes in industrialised countries are not suitable or reliable when the wastes are heavy. The combination of the extra weight, the abrasiveness of the sand and the corrosiveness caused by the water content, can cause very rapid deterioration of equipment. If the waste contains a high proportion of moisture, or is mostly inert material, it is not suitable for incineration, and so this treatment option is ruled out. Recycling or salvaging operations often reduce the proportion of combustible paper and plastic in waste before it reaches the treatment stage.

Access to waste for collection

Many sources of waste might only be reached by roads or alleys which may be inaccessible to certain methods of transport because of their width, slope, congestion or surface. This is especially critical in unplanned settlements such as slums or low-income areas and thus largely affects the selection of equipment.

Awareness and attitudes

Public awareness and attitudes to waste can affect the whole solid waste management system. All steps in solid waste management starting from household waste storage, to waste segregation, recycling, collection frequency, the amount of littering, the willingness to pay for waste management services, the opposition to the siting of waste treatment and disposal facilities, all depend on public awareness and participation. Thus this is also a crucial issue which determines the success or failure of a solid waste management system.

Institutions and legislation

Institutional issues include the current and intended legislation and the extent to which it is enforced. Standards and restrictions may limit the technology options that can be considered. The policy of government regarding the role of the private sector (formal and informal) should also be taken into account. The strength and concerns of trade unions can also have an important influence on what can be done.

