Economics of Solid Waste Management

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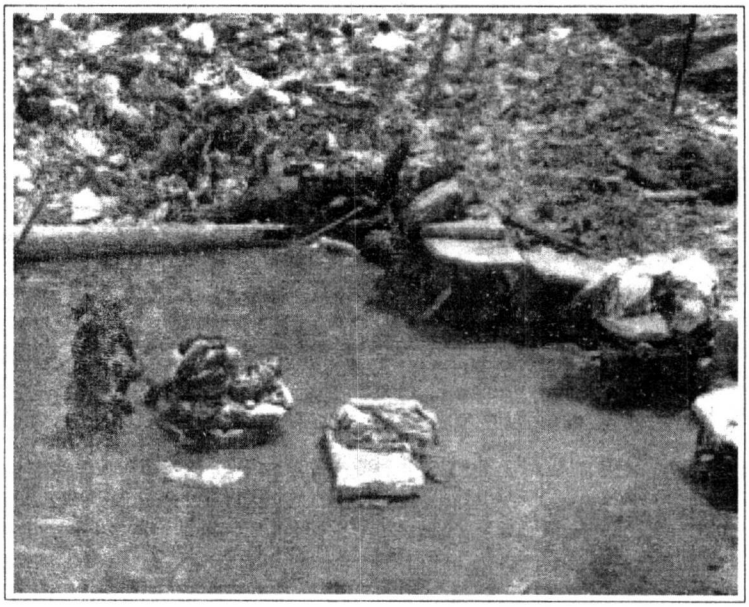
Relationship between man and environment has been evolving from the ancient time, and that mutual relationship has been continuing up to present and it will not change in the future too. However, with the initiation of the development process, problems related to environmental quality have been gradually increasing and today it has become a prominent discussion. Sustainable development is one of the main concepts today in the world and quality of the environment plays a major role in this concept. Therefore, steps have to be taken to maintain the economic growth and development process with the minimum effects to the environment and to utilize the natural resources with the formal management.

Solid waste is a growing problem in the world aggravated in the absence of proper management systems. Development and implementation of a national strategy for solid waste management is essential in order to reduce environmental, solid and economic problems associated with the present disposal practices. In the past, more attention had been given to waste disposal systems with little attention to solid waste management. However, rate of generation of solid waste is also increasing with the increase of population, technological development and the change of life styles of the people.



According to previous studies the global burden of solid waste amounted 113 billion metric tons in 1990 or two thirds of a kilogram of waste per person per day. Industrial countries account for a disproportionately high share of the world's waste relative to their share of the world income. Analysis across countries and overtime reveal that the generation of solid waste is positively related to variation in per capita income and that the generation of solid waste per capita does not vary with population size among countries with comparable with per capita income.

However, today solid waste has come to mainstream of discussion, because of the following four reasons:

1. Huge quantities of solid waste are being generated around the world. Although, much of it is collected and disposed of through controlled incineration or burial in sanitary landfills a good deal of the rest continued to be burned in the open or dumped haphazardly, especially in developing countries. Such practices are putting increasing pressure on land. Air and water quality and posing threats to human health that will be exacerbated by projected increase in total waste generation. Some studies suggest that some improvements in the handling of hazardous wastes now would be less expensive than undoing in the future the damages to the environment and to human health cased by current handling practices.
2. Solid waste has resource value. Some of it is captured through scavenging and recycling practiced in the informal sector throughout the developing world and some through community-sponsored recycling systems and the conversion of waste in to energy, compost or both. Many studies are under way throughout the world to determine whether future value can be economically captured from solid waste.
3. Because the benefits of solid waste disposal extend beyond households and firms that incur the cost, community intervention may promote the social good.
4. Most of the countries in the world have spent a huge amount of money to dispose solid waste, because most people think that it is part of government duty. To reduce the government cost burden as well as the amount of gathered solid waste, it is necessary to take action to change this view.

In recent years problem of waste disposal have become critical in all industrialized nations as well as developing nations. Nations have been extremely active in the production of more and newer chemicals with never and difficult waste resulting from there from. It must, however, be remembered that no nation, no industry, no man will discover or produce these new chemicals and their mixtures unless they are required by the consumers. The consumer requires these chemicals as they perform for him in better, more efficient and beneficial ways than the existing materials. Several examples of chemicals, particularly those used for agricultural purposes could be given to prove that without these the production of food, in quality and quantity could not be achieved. It is not unreasonable to visualize that without these chemicals many peoples could have died of starvation. The problem of waste disposal that any nation face is, therefore, complicated. No nation wants, which are difficult to dispose of, should be completely banned. Such an action would have extremely serious implications.

The choice, therefore, is in ensuring that the disposal of all waste, and particularly hazardous waste, take place in a well regulated and controlled methods, using not the cheapest tolerable methods but the best environmentally friendly methods. It is unfortunately not realized that during the last 10 years appreciable advance has been made in improving the image

of the waste disposal industry. Most regulatory authorities are employing scientific staff to deal with waste disposal in environmentally safe way. Controls and operational techniques have improved considerably.

Difference between Solid Waste and Municipal Waste

Solid waste can be defend as non-liquid waste material arising from domestic trade, commercial, industrials and agricultural activities as well as waste arising from public sectors. Solid waste comprises of various different materials such as food waste, discarded clothing, garden waste, construction waste, factory off cuts and process waste and packaging in the from of paper, metals, plastic or glass, etc.

But, if we consider the meaning of municipal solid waste, we can say all solid wastes generated in a community except for industrial and agricultural wastes. Generally it includes discarded durable and non durable goods, containers and packaging, food scraps, yard trimmings and miscellaneous inorganic debris, including house hold hazardous wastes and often construction and demolition debris and sludge's and ashes generated by sewage treatment plants. Sources of municipal solid waste include households, commercial enterprises such as food markets and offices and institutions such as schools, transportation terminals, and hospitals.

Practices for collecting, processing, and disposing of municipal solid waste vary widely across countries generally in accord with the nature of the waste stream and the key environmental and economic features. The least efficient practices tend to be found in developing countries, creating serious threats to local environmental quality and public health. Although considerable evidence points out that the generation and management of waste is sensitive to income and price variables, Natural incentives to over-use common property and the presence of intergenerational externalities both suggest that private economic behaviour will not yield socially optimal outcomes in that area. Community intervention may need to promote the social good with evidence accumulating in support of arrangement involving the participation of private firms.

Municipal solid waste increase at an annual rate of 2.7 percent and increased levels of solid waste may not have the catastrophic potential of either global warming or stratospheric Ozone depletion, but they have long posed the treats to environmental quality and human health, that are reasonably well understood and typically of great local and immediate concern.

Types of Municipal Solid Waste

Wastes are divided into four main groups depending on their physical form. They are -

1. Solid waste
2. Liquid waste
3. Dust or particulate material
4. Gaseous waste

Out of above categories our attention is focused on the municipal solid waste and municipal solid waste can be divided into two classes -

1. Recycled materials
2. Non-recycled materials

Recycled materials can be used by transforming as an input. Where as it is not the case of non- Recycled materials. Examples of Recycled materials are discarded Aluminium soft-drink cans, melted down to create new cans, food and yard waste composted and used to enhance soil fertility and old newspapers and plastic bottles burned to produce electricity. The non-recycled portion of municipal solid waste consists of by products that must generally be removed from the site lest they interfere with production and consumption by attracting vermin and files, obstructing passage, clogging drains, emitting unpleasant odours and so on. Weather or not materials are recycled depends on the nature and cost of available production, consumption, Recycling and disposal technologies, as well as on government regulation. These can very widely across economic settings.

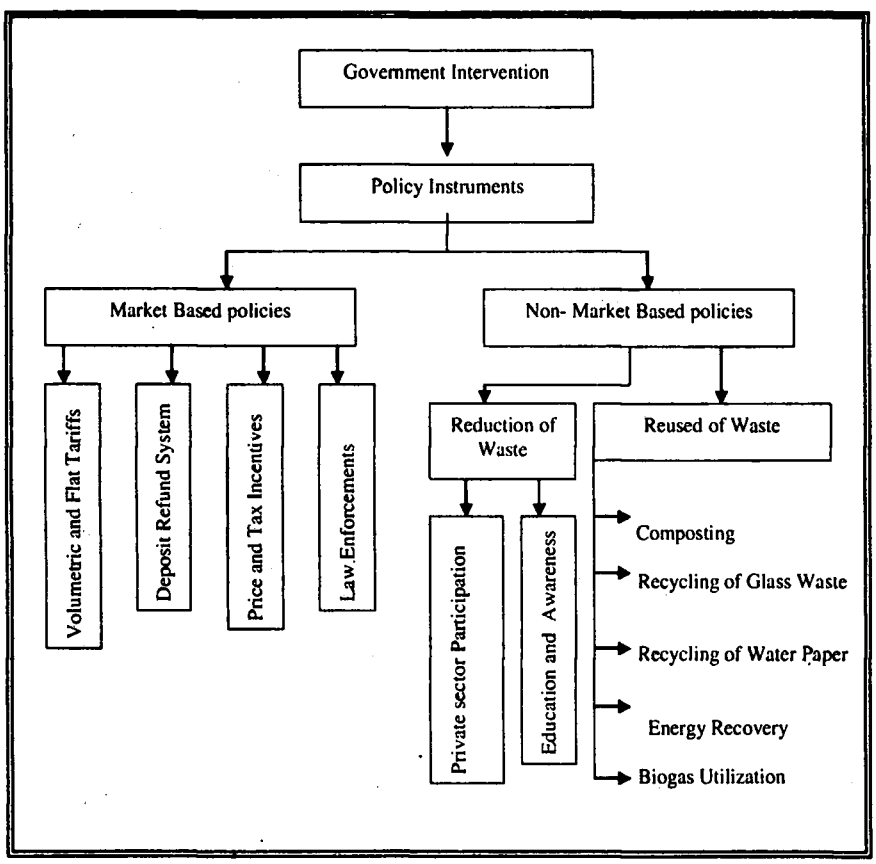
In developing countries, municipal solid waste management is often disposed of with ash where sewage systems don't reach substantial portions of the population, medical waste and industrial waste. For this reason, municipal solid waste in developing countries is sometimes more harmful to human and ecological health that it is in industrial countries.

The quality characteristics and composition of refuse vary mainly according to socioeconomic states, food habit, local customs, geographical location, occupation and climatic conditions. Further seasonal generation determine the future of the waste. The quantity and quality of waste depend on climate of the season. The characteristic of the waste reflects the consumption and the production activity of the country, because it determines physical, biological characteristics of waste.

In developing countries, it is evident that the rate of production of municipal solid waste is

Box 1

Economic policy instruments



about 30 percent of that developed countries. However, developing countries sever crisis with waste, due to lack of adequate treatment and disposal measures.

Solid Waste Management Systems

Most systems for managing municipal solid waste management have three basic components -

1. Collecting and transport
2. Processing
3. Disposal

The purpose of collection and transport is to gather and remove municipal solid waste management from its point of generation to safeguard public health, limit congestion and preclude unpleasant odours and aesthetically offence sights. The purpose of processing is transform the physical characteristics of municipal solid waste management by recycling composting, burning or compacting, in order to reduce the threat it poses to human health and eco-systems, improve its disposability and possible capture value from the waste. The purpose of disposal is to isolate and contain the residual waste that is left after processing. Some municipal solid waste management systems ignore or incompletely implement one or more of these key components.

Mismanagement solid waste and its improper disposal lead to health and environmental problems. Most obvious environmental problem that has more public concern is damages to aesthetic view. However, more serious visible, invisible, and some times irreversible environmental damages occur due to surface and ground water pollution by the emanate from uncontrolled open dumping of solid waste.

Air pollution can also be caused from the inefficient burning of waste either in an open air or in plants with inadequate emission control systems.

Solid waste management incorporates management activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid waste in an environmentally sound manner. It encompasses planning, organization, administration, financial, legal and engineering aspects of involving interdisciplinary relationships.

There are few types of solid waste management systems in the world as follows:

1. Direct dumping on approved sites
2. Sanitary land filling
3. Dumping in deep sea
4. Elimination by incineration
5. Direct and indirect recycling

An effective integrated solid waste management system examines waste reduction source, resource recovery through separation and recycling, resource recovery through waste processing, waste transformation and environmentally sustainable disposal with the accelerated generation of waste caused by increased population, urbanization and industrialization. Developed countries are now in a position to solve the problem of solid waste through well- organized, and well-planned solid waste management programmes. Developing countries, on the other hand, are fighting with problems associated with food, shelter and clean drinking water. Poor economic condition is a major barrier for developing countries to promote and implement effective waste management technology as practiced in developed counties. Proper care has to be taken for planning and implementation of various components of solid waste management programmes in developing countries, each country has its own way of problem solving.

Common property resources and intergenerational externalities provide incentives for household and firms to under consumer services in the private market for municipal solid waste management. Because the benefits of some kinds of municipal solid waste management to households and firms fall short of the benefits to society, the optimal government interventions are those that align the private and social incentives for municipal solid waste disposal as closely as possible. The government has access to a number of policy instruments. These can be described as follows:

1. Market based policy instrument
2. Non- market based policy instrument

Market Based Policy Instruments are as follows:

1. Volumetric and flat tariff
2. Deposit refund system
3. Price and tax incentives
4. Law enforcement

Volumetric and flat tariff

Government can undertake one or more of the tasks of municipal solid waste collection, transport, processing and disposal, charging either a volumetric tariff or a benefit tax (a flat amount per household). A volumetric tariff gives households and firms an incentive to reduce residual waste either by charging the way they produce and consume, by recycling or by illicitly dumping or burning waste.

A flat benefit tax charged to all household as part of their utility or property tax bill may be the most effective way for cities of developing countries to pay for municipal solid waste management, reduce the incentive to dump municipal solid waste illegally and possibly subsidize municipal solid waste management services for poor neighbourhoods.

Although benefit taxes do not provide an incentive to reduce municipal solid waste discards, in developing countries, it is likely that most of the recyclable or reusable materials have been recovered by the time municipal solid waste is put out for collection.

Deposits Refund system

This is a method that is placed at national level. Fullerton and Kinnamon (1993) present a theoretical model where illicit burning or dumping are option for municipal solid waste disposal and the resulting environmental damage is grater than from sanitary land filling or incineration. In such circumstances, a deposit refundable scheme for recycling waste may be a more efficient policy than levying curbside charges. The clear advantage is that it encourages households and firms not to dump or burn municipal solid waste illegally. Moreover, it may be cheaper to manage deposit refundable scheme than to monitor the disposal behaviour of many small-scale illegal dumpers. Cyprus, Egypt, India and Lebanon have deposit refundable system for carbonate beverage containers made of glass. Australia, Canada. France, Germany, Switzerland and the United States have deposit refund system for various types of beverage containers and the Scandinavian countries are considering deposit refund system for certain products such as batteries.

Deposit refund system for returnable glass bottles is traditionally adopted. In most countries, due to the predominance of the beverage and beer packaging systems, Refund payment for Aluminium cans due to the high vale added from recycling and the expanding use of such countries are now increasing considerably in Brazil and Venezuela.

Deposit refund system could also be used as a successful method to reduce the quantity of garbage collection in city/town and this could be carried out to unit each town or municipal council. For example, several private garbage collecting centres can be established to collect disposal of bottles and plastic collections and allows the market to decide the price to be paid. But to overcome the problem, the municipal council have the right to all garbage collected in the city limit and can get this collection to make a payment to the municipal council based on the amount collected or a specific cube. This process can be implemented at different stages.

These waste can be collected and sorted out and create a marker in such a way that they are sold to the respective producing factory. This will encourage to reduce the disposal of waste when people observe the creating such a new market in the private tender or even if they are disposed. This will create another set of people who will collect these items and make it a source of income. Thereby this will minimize the amount of waste collected in the environment. Such activities will reduce the amount of garbage to be collected by the municipal council.

Price and Tax Incentives

Incentive policies that indirectly affect prices are also an option fees can be imposed on goods at the retail level to reflect expected disposal costs. This policy is less precise than curbside charges because it does not directly influence disposal decisions. It may affect consumption decisions, however, and hence the composition of municipal solid waste. If a system of curbside charges is too costly to operate as would probably be the case in developing countries packaging taxes may be a second best policy. A related policy would be to tax the virgin materials content of goods at the point of production to reflect their disposal costs. The policy may be easier to administer than retail charges and would give producers and ultimately consumers a clear incentive to favour recycled over virgin materials.

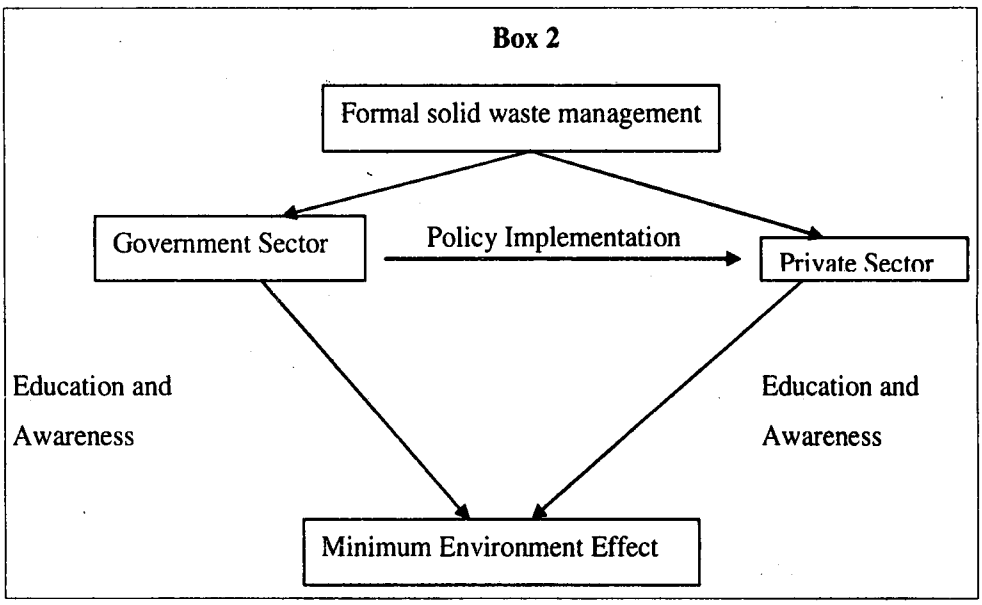
A problem with these policies is that any variation on disposal costs within the products geographic market will mean that the tax will inaccurately reflect local disposal costs. Some evidences at least for the United States, indicate that low income households are more likely to purchase small sizes packaged goods that to buy in bulk perhaps because they lack storage space or can't afford to tie up their limited funds in stored foods. Thus, low-income households may purchase more packaging per unit of product than high-income households, which suggest that retail and virgin material taxes would be regressive.

Well-intentioned government policies that influence prices may have unintended and undesirable consequences on the quality and scope of municipal solid waste management. In India, Indonesia and other developing countries, for example, governments subsidize the production of chemical fertilizers, there by stifling the development of agricultural markets for compost. Yet compost not only cuts down on fertilizer use, but also reduces runoff pollution by enhancing the ability of soil to prevent fertilizer from leaching out after rainfall.

Law Enforcement

The power available at present, in most of the developing countries to the local authorities are not adequate to implement efficient solid waste management strategies and also the local authorities should be given sufficient incentives in the from of capital, land, and technical assistance in order to develop and implement solid waste management strategies in sustainable manner. Law enforcement should be coupled with these incentives in order to ensure compliance; a reasonable percentage of the total budget should be allocated by the local authorities annually for further implementation of efficient solid waste management strategies. Especially government authorities should have enough power to implement policies to dispose the solid waste, and policy markers can create incentives that indirectly affect municipal solid waste disposal behaviour. For example, policy markers in industrial countries frequently face local resistance to the sitting of municipal solid waste disposal facilities. So-called NIBY (Not In my Back Yard) activism may also arise in developing countries.

Box 2



Non-Market Based Policy Instruments

Non-market based policy instruments can be divided into two categories.

Reduce the quantity of solid waste that is to take measures to minimize the amount of garbage collected in the city. Following instruments can be used for that purpose:

1. Private Sector Participation
2. Education and Awareness

Private Sector Participation

Private sector participation in solid waste management is an essential component to encourage. The existing recycling industries should be encouraged to participate more in the development of infrastructure facilities in collection and transportation on waste. Contribution of the private sector can be summarized as follows:

(a) Involvement in recycling activities
(b) Provide infrastructure facilities
(c) Participation in the development of infrastructure facilities
(d) General awareness creation

Education and Awareness

Education and awareness creation at national, Provincial and local authority level is an essential component to ensure the implementation of national strategy for solid waste management. Education and awareness programmes should be launched through school, community, organizations, universities, women's societies to encourage, reuse and recycling of waste, sorting of waste at household level and disposing of waste in an environmentally sound manner. Education and awareness creation should be a continuous activity for the sustainable solid waste management in the country.

Cooperation and the participation of the community by education and awareness programme in solid waste management are essential to implement any solid waste management strategy. Solid waste is generated by each and every individual. On the other hand, the public displays strong emotion on the environ-

mental and health impacts of mismanagement of solid waste. In general, the public looks at solid waste management as a function of local authorities without considering the important role that can be played by them to ensure solid waste management in an environmentally sound manner, which in turn reduces their health costs. Reduce, reuse and recycling of waste cannot be performed without active participation of the community. Therefore, community participation should be encouraged through education and awareness creation as much as possible. Positive cooperation of the community in solid waste management will help the community itself to live in a healthy environment, which is the most important factor in our lives.

Using the collected waste to produce certain goods and earn an income by reusing them. Under this, following instruments can be used for that purpose:

- Composting
- Recycling of glass waste
- Recycling of waste paper
- Energy recovery
- Biogas utilization

Composting

Analysis of data in most countries reveals that, most of the solid wastes contain biodegradable waste and suitable for composting. The high moisture content of the waste makes incineration not economically viable. Therefore, composting of organic waste as much as possible will be an option, which should be given serious attention of the local authorities. In lieu of the high prices of the chemical fertilizers and also the health problems associated with overuse of chemical fertilizers aiming at increasing the harvest. The farmers should be encouraged to compost produced by organic waste as a soil conditioner. However, it should be noted that the quality of the compost will depend mostly on the degree of contamination type of the organic waste. In order to increase the market for composting, arrangements shall be made through the proper authorities to encourage agricultural sector to use compost as a soil conditioner.

Table 1

The amount of solid waste accumulation per day in provincial/ vice

Province	Amount of waste Tons/per day
Western	1,448
Southern	144
Central	223
Sabaragamuwa	81
Wayamba	89
Uva	170
North Central	33
Northern	223
Eastern	258
Total	**2,669**

Source: *National Strategies for solid waste management.*

Recycling of Glass Waste

Recycling of waste also helps to reduce and reuse the amount of waste at a considerable extent making final disposal manageable. Use of broken glass helps glass industry to reduce the production cost, as it requires lower temperature in its production process when waste glass is used. The amount of raw materials required for glass production also will be reduced facilitating to save of natural resource. *eg.* At present In Sri Lanka, Ceylon Glass Company uses 40% of (waste glass) in its process of production. The company has facilities to go up to 60% if waste glass is available.

Recycling of Waste Paper

At present technology exists for the use of waste papered in the world. In the process of paper production equipment are available in the world market to use various types of paper wastes for this purpose. The policies should be developed to encourage the use of waste in the process of paper production.

Biogas Utilization

Highly organic wastes have a potential for produce biogas as a source of energy while producing compost after digestion in anaerobic condition. Therefore, utilization of biogas technology for the disposal of highly organic waste can also be considered as a strategy for the disposal of highly organic waste.

Energy Recovery

After removal of recyclable components, there may be a considerable amount of garbage left behind which could be utilized for the generation of electrical and thermal energy. The utilization of combustible materials for energy recovery would be a better option prior to land filling if economically feasible. Special attention should be paid to control air pollution when incineration is used for waste disposal. A large sanitary landfill has the potential for landfill gas recovery as a source of energy.

According to the above analysis, it is clear that the solid waste management should not be a responsibility of the government alone. It is the responsibility and obligation of all sectors including the government, public, private sector and community groups at various stage. The cooperation of all sectors in solid waste management shall be obtained by promoting all concerned through education and awareness creation countrywide.

Current Situation in Sri Lanka

Solid waste has been becoming a major problem in Sri Lanka as a developing country, new industries will be developed and relatively low technologies are used to manage solid waste. Open damping is the commonest method practiced in Sri Lanka to manage solid waste. Dumping is the commonest way of disposal of municipal solid waste in cities and municipalities in the third world generally the are found on the outskirts of the urban areas, turning into source of contamination due to the incubaration and proliferation of flies, mosquitoes and rodents. That in turn is disease transmitters consequently.

Dumping sites have very high economic and social cost to the public health services, which is yet to be estimated by the governments. In addition to these sanitary problems, open dumping also has caused following negative impacts.

- Air pollution
- Surface water pollution and ground water pollution
- Sub soil pollution

In the past, there were many lands that have not been used for any special purpose. In Sri Lanka, the people and government also use those lands to dump waste but now, especially in urban areas, land has become very valuable and limited resource and it is difficult to find land for open dumping.

Main features that is involving efficient and effective solid waste management are investment, operational cost and technologies. However, as most of the developing countries, Sri Lanka is also suffering from the barrier of technology as well as high operational cost. Therefore, it is high time to implement a formal solid waste management system by both considering, reduce and reuse of the solid waste.

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