CHAPTER III

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Solid wastes are being produced since the beginning of civilisation. During early period, solid waste was conveniently disposed off as the population was very low with large open land space. However, with the advent of industrialisation followed by urbanisation, the problem of waste disposal increased. It is true that all wastes are not necessarily pollutants. The natural system is capable of diluting, dispersing and decomposing many wastes so that their level of concentration is no threat to the biosphere in general, and humans in particular. However, if the volumes of wastes are very large, the systems into which they are dumped will be overwhelmed and consequently the wastes can not be diluted, dispersed or decomposed which results into pollution. The field of solid waste management is a large one and the changes in this field have been widespread. Therefore, reviewing the available literature, helps in understanding the subject. So, in the following pages a number of studies have been reviewed, in order that predictions for future developments can be made.

NATURE AND CHARACTERISTICS OF SOLID WASTE

While classifying the sources of solid waste, Bhide and Sunderesan,1 Flintoff,2 Mishra and Mani,3 Somashekar and Iyengar,4 and the High Power Committee5 and

2 Frank Flintoff, Management of Solid Waste in Developing Countries, (NEW Delhi: WHO Regional Publication, 1976) p. 4-5.
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also others have classified it from different angles. However, because of heterogeneous nature of solid waste, no single method of classification is entirely satisfactory. In some cases, it is more important for solid waste specialists to know sources of waste, so that classifying wastes as domestic, institutional and commercial, becomes easier. For other situations, the type of wastes: garbage, rubbish, ashes, street wastes and the like, is of greater significance because it gives a better indication of the physical and chemical characteristics of the waste. Further, it is important to know that the contents of solid waste of different types varies from country to country. The waste constituents of developed countries are different from that of the developing countries. Solid waste specialists of developed countries claim that soft drinks, beer cans, bullets and electronic goods etc., are common in their urban solid waste. However, these things are rarely found in the waste of developing countries. Therefore, in this background, the authorities of developing countries have to be very conscious while buying any machine from developed countries to manage their waste, because, such machines are designed to manage the solid waste generated in developed countries, so it is very difficult to adopt such machines in our system which, in many ways, are different from developed ones. This results damage of machines—which consumes huge investments for purchasing and maintenance.

No doubt the contents of solid waste differ from country-to-country and from city-to-city and within a city it may also vary from place-to-place. Not only that, it may differ, in cases, from season-to-season.
PROPERTIES OF SOLID WASTE

Materials discarded across our globe range from items that easily dissolve and decompose and soon disappear, to those essentially inert and long-lasting. There is some overlap between the solid and liquid wastes and the boundary between the two is not sharp. For example, organic sludge from sewage is solid, although initially it is waterborne, from household plumbing to septic tanks or sewage plants. Conversely, solid wastes buried in a dump may be leached down into groundwater and produces contaminants in groundwater and other surface water formations or streams that become liquid wastes. Solid waste production in the home, public and private institutions, and commercial enterprises accounts for only six per cent of our annual solid waste, writes Laporte.7 Despite this relatively small fraction of the total, most discussions on solid waste emphasise residential, institutional and commercial aspects of the problem. Laporte8 gives several reasons for this pre-occupation. The reasons according to him are, firstly, this waste category has shown the fastest annual growth, i.e., around four per cent per year. A two per cent per capita per year increase was compounded, until recently, by a two per cent per year rise in total population. Secondly, solid waste is concentrated in highly populated areas and for public health reasons, requires rapid and efficient removal.

While discussing the nature of solid wastes, Laporte further classifies9 solid wastes according to their degree of chemical stability; for example, organic wastes are all byproducts of animals and plants, whether living (as with excrement) or dead (as with wastes from tanneries or wood pulp mills). These wastes generate a

8 Ibid, p. 41.
9 Ibid, p. 36.
high 'biological oxygen demand (BOD)' when micro-organism decomposes them. Furthermore, the chemical oxidation of organic wastes without the intervention of organisms creates a 'chemical oxygen demand (COD)', which, like BOD, uses oxygen dissolved in water. Secondly, paper, wood and natural fibres i.e., waste material from fibres like linen and cotton is also organic, but it is largely composed of cellulose, a starchy, chemically resistant compound that forms the membrane of plant cells. Thirdly, leather and rubber products are also solid wastes composed of natural or man-made organic substances. They are physically and chemically resistant and consequently endure a long time. These solid wastes have no special harmful impact on the environment other than visual one. Fourthly, ash type of solid waste is produced by burning wood, coal and paper products in homes, apartment's house incinerators, power plants and open dumps. When these materials burn, carbon, hydrogen, and sulphur in the organic matter are converted to carbon dioxide, sulphur dioxide, and water vapour that diffuse into the atmosphere. The incombustible residue or ash is rich in mineral substances like potassium, nitrogen, phosphorus, and iron and can easily leach into surface water and groundwater.

While explaining the sources of solid waste, Wilson\(^{10}\) opines that solid wastes arise in association with almost every activity of man. The composition and properties of these wastes reflect the full diversity of man's actions. For convenience, however, waste characterisations are usually associated with broad description of the sources of the waste. According to him, domestic sources of wastes include wastes generated by individual family dwellings, apartment houses etc. And wastes from institutional sources include wastes from schools, offices,

hospitals etc. The commercial sources include wastes produced by retail stores, offices, service stations, warehouse etc. Industrial sources include wastes from consumer sources and industrial goods, and lastly, municipal sources mean construction and demolition debris, street and alley cleaning, tree and landscaping activity, park and beach operation, and sewage treatment solids. Wilson further observes\textsuperscript{11} that the weight per cent of two refuse categories are highly dependent on local conditions. For example ‘yard waste’ is very sensitive to both geographical location and the season of the year when the sample is taken.

In developed countries, parks, homes and commercial enterprises, generate substantial quantities of solid wastes which are too large in characteristic dimension to be burned in conventional incinerators and that occupies more and more of landfill space. Wastes falling into this category include furniture, appliances, pallets, tree trimmings and logs, pilings, construction and demolition debris. Since these wastes are often too large for typical collection vehicles or disposal systems, they are usually collected separately from the domestic/commercial refuse described above. These oversized wastes, usually called ‘bulky waste’, vary widely in composition, depending upon their source.

The commercial and institutional solid wastes (those generated in stores, offices buildings, hospitals and schools) are important contributors to the waste handled by municipal governments. Since commercial and institutional wastes are often collected and processed with domestic refuse by municipal agencies, such information would require special sampling and analysis efforts. Such tests should be conducted extensively. Further, when compared with mixed municipal refuse, it can be seen that the amount of paper in commercial waste is significantly greater. This is expected as the largest fraction of waste from commercial establishment

\textsuperscript{11} Ibid, p. 12.
that consists of packaging materials which are predominantly paper-based. The high fraction of plastics observed in the commercial waste studied in Kentucky further suggests the important contributions of packaging materials. Switzger\textsuperscript{12} observes that the Kentucky data are in agreement with data from New Orleans which showed 84 per cent combustible materials mixed commercial wastes. Baffo and Bartilucci\textsuperscript{13} have studied the bulky wastes generated by commercial establishments in the New York City. They observed that these wastes had about 65 per cent of combustible matter, most of which was shreddable. The remaining 35 per cent non-combustible material was noted to be almost entirely unshreddable.

It is also evident from various studies that the municipal solid waste contains not only valuable and often reusable materials with a high nutrient content, but it also contains an ever-increasing amount of hazardous waste. Cunningham and Saigo,\textsuperscript{14} and Rich\textsuperscript{15} have listed few of the such wastes like, mercury from batteries, cadmium from fluorescent tubes, pesticides, bleaches, printed circuit boards (PCBs) in old TV sets and a wide range of toxic chemicals which occur in solvents, paints, disinfectants and wood preservatives. After studying the data of various cities across the world, Rich says that, the per capita production of solid waste does not vary much with the state of development of countries concerned. Listing the data of various cities, some are highly industrialised while others are still developing, yet they have comparable rates of generation of solid waste.

However, Rich's argument has been rejected by Boyes.\textsuperscript{16} According to Boyes, the per capita generation of solid waste varies from city-to-city and from country-to-country.

It has been reported that, the composition of street sweepings, consists of a variety of components depending upon the area and season concerned. It was noted by APWA\textsuperscript{17} that the quantity of vegetation in Western and cold countries was highest during the fall (October and November) when it (primarily leaves) comprised 53 per cent of the total waste. During March–September, vegetation comprised only 10 per cent of the street cleaning material and almost none in the winter months. However, the case is very different in tropical countries where the quantity of dry leaves is more during the month of December.\textsuperscript{18}

Further, the biggest proportion of solid waste (in USA) comes from agriculture; virtually, all of it is organic. Harvesting and processing crops, along with raising livestock for food, generates two billion metric tonnes of waste annually. But this is not the case with the Gulf and Third World countries, where inorganic material is found more. In country like the USA, electric power generation alone produces about 30 million tonnes\textsuperscript{19} of ash from burning of coal. Greater demands for electricity accompanied by gas and oil shortage means that more and more coal will be used for power generation yielding greater amounts of ash. The American experience can be a good lesson to the Third World countries, (especially, cities like Delhi where fly ash has become a big nuisance-whose

\textsuperscript{17} 'Water Pollution Aspects of Urban Runoff', \textit{Report by the American Public Works Association} (APWA) to the FWPCA, January 1969.
\textsuperscript{18} These are the countries with hot climates such as India, Sri Lanka, etc. Those countries which fall geometrically between two imaginary lines (Tropic of Cancer and Tropic of Capricorn) running round the earth, parallel to the equator, and about 23°27' north or south of the equator, are known as tropical countries.
\textsuperscript{19} Laporte, op. cit., p. 39.
effluence in the air is some metric tonnes per day\(^{20}\) which are not only posing solid waste problem but also creating environmental problems since it adds to the problem of global warming.

The studies done by Anon\(^{21}\), Miller\(^{22}\) and Matoumoto\(^{23}\) provide the comparison between USA and other countries in refuse composition estimates. In case of US refuse data, the great decline in the use of coal for home heating is shown in the change in ash content between 1939 and 1970. However, use of coal continued in European countries like Norway and Czechoslovakia, significantly affecting refuse composition and thus heat content. The effect of the socio-economic strata of the waste generator on domestic waste composition is studied in Berkeley city, California city in 1967; Cincinnati city, Ohio and Jefferson country city, Kentucky city, in 1970–71; and Boston city, Massachusetts city in 1969–70 by Anon (1972)\(^{24}\), Davison\(^{25}\), Portridge and Harrington\(^{26}\) respectively. Govan\(^{27}\) argues that, the data of these studies are too limited to support definitive conclusions; it would appear that refuse from low-income domestic sources

\(^{20}\) In fact Delhi’s thermal power plants release both types of ash; one is fly-ash and the other one is common thermal ash which is dumped separately.


contains more glass, metal and food waste than average refuse: and it contains less paper, textiles, plastics, leather and rubber than average refuse. These conclusions are consistent with qualitative estimates that low-income apartment house refuse contained 50 per cent rubbish and 50 per cent garbage whereas middle-range to luxury apartment house refuse contained 80 per cent rubbish and 20 per cent garbage. The conclusions are consistent with lesser use of heavily packaged prepared goods; enhanced use of canned versus frozen foods; and the consumption of less clothing and shoes by individuals of lower income.

In the late 1970s, Americans produced almost five billion metric tonnes of solid wastes; substantial rise came from residential wastes. Out of the total solid wastes in US, six per cent originates in the home and includes garbage, glass, metal containers, plastics, and paper. In this connection a significant factor determining how solid wastes are disposed off, is the disproportionate cost of their collection. In US in 1970s it cost 14$ to collect one metric ton of residential, commercial and institutional wastes, and only 4$ was spent on their disposal. As the drawbacks of improper solid waste disposal became better known as cheap resources became scarce, the cost of collecting and properly disposing off solid wastes seemed more reasonable.

Characteristics of solid wastes in Istanbul City are unusual in the extremes of composition for different seasons. Patrick observed that during the summer, waste is very high in organic and moisture content; while in winter ash content predominates. In Turkey, domestic heating is mainly done by burning of a low-grade coal, cost of oil which is to be imported is higher. Low grade coal yields to

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more ash-content in the domestic wastes. This situation is a good example of the influence of national economic factors on waste characteristics.

Indian cities have a strikingly similarity when it comes to heaps of garbage and overflowing bins—a sign of the inefficiency of the municipalities in managing wastes in most of the towns and cities. Further, with the country’s population crossing one billion mark, coupled with unplanned development and rapid urbanisation, an enormous amount of waste generation is going to be a nuisance in Indian towns and cities. The situation is no better at present, says, Iqbal Malik. 29

The urban population was 217 million in 1991 and the total quantity of solid waste generated in urban areas was estimated at 20.71 million tonnes per year. This is expected to cross 56 million tonnes by 2011. He further claims that, in the 1980s a family’s weekly garbage production used to be about 7 kg and now it is 20–30 kg.

Therefore, the per capita waste generation in urban areas with a population less than 0.1 million people, is 0.21 kg. per day, while in areas with a population of more than 5 million people, it goes up to 0.5 kg. per day, says a study by Ahmed and Jamwal. 30

Thus, growing population and rising per capita consumption of goods and services are multiplying the generation of solid wastes, ranging from biologically and chemically active animal refuse and garbage to virtually inert glass and plastics. So, the first step in solving waste management problems is to discard the belief that ‘waste’ is so heterogeneous in its composition and so variable in its properties that problems cannot be defined, let alone solved. To be sure, waste streams exhibit great variability. The design of waste management systems must, therefore, provide for more operating flexibility, reserve capacity and materials

29 Director, Vatavaran, a Delhi-based NGO involved in waste management.
‘stamina’ than conventional processes and equipments. Nonetheless, characterisations of the average composition and properties of waste streams provide the starting point for design, it will be appropriate to alert the waste manager to process the constraints and use the opportunities to manage the safety hazards. And also knowledge of the factors influencing the generation rate and composition of solid waste can be of great assistance in predicting waste characteristics within homogeneous generation zones.

URBANISATION AND SOLID WASTE

Sivaramakrishnan, Dasgupta and Buch31 have pointed out urbanisation as one of the major causes of massive generation of solid waste. They say that, in developing countries, urbanisation takes place as a natural consequence of economic changes, which encourages immigration into cities. Increasing pressure of population in large cities accounts for deterioration of infrastructural services and amenities. The worst sufferers are the poor people, whose access to basic services like water, sanitation, education and health services is shrinking. According to Sandhya Venkateswaran32 on an average, 30 per cent of solid waste of Indian cities is unattended by municipal authorities which is mainly generated in slum localities and other squatter settlements every day.

With the rapid urbanisation, the problem of solid waste came to be considered as a responsibility of the municipal authorities. Further, the municipal practices with respect to solid waste vary widely across the world. In some areas,

almost all wastes are collected by the municipality. In others, industries and communities manage the disposal of their own wastes. Disposal problems become difficult with increase of population density. Simultaneously, there is a greater production of waste per unit area; therefore, the history of solid waste is largely connected with the histories of largest cities. Further, the history of solid waste, in general, has not been written. Till recently, there is no tradition of scholarly research into solid waste management. What the review have given have been extracts from occasional articles, which have provided no more than reference points.

PLIGHT OF SLUMS

The term ‘slum’ is used to indicate housing which falls below a certain level which is necessary to contribute to human development. The term ‘squatter settlement’ is used to indicate a house that is either the result of illegal occupation or has developed in an unauthorised fashion. United Nations Urban Land Policies define slum as a building, a group of buildings or areas characterised by overcrowding, deterioration, unsanitary conditions or absence of facilities or amenities which, because of these conditions or any of them, endanger the health, safety or morals of its inhabitants or the community. Deccan Herald, defines slum as a habitat having small tenements, narrow lanes and a lack of sanitation with no thought for the quality of life. Birdi observed that slums are, physically, areas of the city with inadequate housing, deficient facilities, overcrowding and

35 Deccan Herald, 21 July 1987, Bangalore.
congestion, and socially, slum is a way of life, having a special character with its own set of norms and values as reflected in poor sanitation, health values, health practices, deviant behaviour and social isolation.

A number of studies have examined the causes behind the emergence of slums. Rao\(^\text{37}\) observed that slums are created mainly because of poverty, social backwardness and unemployment of people living in the countryside, who subsequently move to urban areas as a last resort. The rapid industrialisation in the towns and cities provides more opportunities, and thus attract a large number of people from the surrounding areas. Rao and Rao\(^\text{38}\) mentioned three conditions under which slums emerge, namely, squatting of poor migrants; deterioration of group of buildings in the old part of city; and conversion of the villages and peripheral areas into slums due to city expansion.

Hardoy and Satterthwaite,\(^\text{39}\) in their study of slum conditions in developing countries, note that slums are developed on most unhealthy and polluted land sites. They also develop near sites of high noise levels, close to major highways or airports. Poor groups choose such sites because these sites meet their more immediate and pressing needs even though they are aware of the dangers involved. Polluted sites are cheap because they are dangerous and commercially unsuitable. Rao and Rao (1984)\(^\text{40}\) observed that slums emerge at the vacant piece of land near the workplace.

\(^\text{40}\) K.R. Rao, and M.S.A. Rao, op. cit., p. 3.
With few exceptions, most studies on slums are based on individual cities. A study of slums in Delhi\(^{41}\) concluded that the slum areas required prevention of future congestion, planned decentralisation of population, economic betterment and clearance programmes. De Souza\(^ {42}\) analysed the geographic distribution of the poor people who live in slum conditions. In Chandigarh, such people were shifted to labour colonies in the fringe sector. Each dweller was allotted on nominal rent a small plot, measuring 9 ft.$\times$ 6 ft., but the plots were not evenly distributed among the dwellers. The study points out the limitations of state-sponsored planning, towards the rehabilitation of homeless in Chandigarh city. It has provided a shelter to many, but it could not prevent the 'structurally located inequality' within the slum dwellers. Only a few of them have taken a lead by constructing attached pucca houses to the original one.

Ghosh and others\(^{43}\) have made a detailed survey of Calcutta with special reference to the land-use pattern, the utility services, housing condition and traffic arrangement of the major metropolitan city. They, have found that the major concentration of squatter settlements occurs near the railway crossing, local bus depots and in the low-lying areas in the heart of the city. Thus the organic growth of the city is linked with the degeneration of old slum areas and their benefit to the new areas which once again termed to the overall growth of the city. While analysing the morphology of residential areas in Indian cities, Tanuja\(^{44}\) has discussed the nature and characteristics of slums. Citing the examples of Kanpur

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and Delhi, she claims that slum development in India indicates that it is the result of overcrowding and haphazard growth of cities. Immigrants lured by job opportunities in industrial units also take up other occupations, such as petty shop keeping, domestic servants, milkmen, rickshaw and cart pullers, even beggars. The study, however, did not cover the aspects of market employment–manpower utility syndrome and thereby ends up with a presentation on the facts and related theory. Bose\textsuperscript{45} has made a comprehensive study of the trend of urbanisation in India. He has also analysed the nature and spatial characteristics of Indian slums. Sinha\textsuperscript{46} studied the cost aspect of slums in Patna and suggested measures to eradicate this problem from the city. The study however, could not provide a contemporary analysis about the preparedness and the commitment of the executives responsible for the implementation of the development programmes.

Khatu\textsuperscript{47} has examined the nature and characteristics of slums of Baroda and has identified two distinct categories i.e., inherited and satellite slums. The former includes villages which were incorporated into the city during its expansion, while the latter includes the blighted areas that grew around the former on illegally occupied areas. De Souza (1978)\textsuperscript{48} has observed that unplanned and haphazard growth of the metropolitan cities in India was a factor for the rapid development of the blighted areas. He estimated that one-fifth of the total urban population (22 million) lived in slums or squatter settlements. In Ahmedabad, nearly 45 per cent


of the total urban population lived in slums, and this number is estimated at 2.5 million in Calcutta. He also studied the nature of urban problems of India; ignore the extraneous factor like nature of policy, mechanism of market economy and manoeuvring of the industrial class over the very growth of urbanisation.

Lahiri\(^49\) has discussed the urban problems of Calcutta, particularly those arising out of population growth, mass migration, employment situation and transport. He has correlated them with the squatter problem which showed a tendency to grow in the heart of the city. Further, Singh\(^50\) has made an extensive socio-ecological study of Shillong and its environment. He has studied the land-use pattern and suggested a model pattern for future developments. Sahani\(^51\) has also discussed the spatial character of the chawls or squatter settlements in Bombay and has stressed the need for public utility service, and their availability to the urban poor.

Further, degraded living environment in the slums leads to poor health conditions of their dwellers. The crowded, cramped conditions transmitted diseases like tuberculosis, influenza and meningitis easily. The spread of disease was often aided by low resistance among the malnourished individuals. In Kanpur, one of India’s major industrial centres, the development authority estimated that 60 per cent of the children in slums had tuberculosis, says CSE.\(^52\) In a study, Basta\(^53\)


\(^{50}\) J.P. Singh, Urban Land Use Planning Hill Areas: A Case Study of Shillong, (Delhi: Inter-India Publications, 1979).


\(^{52}\) The State of India’s Environment: A Citizen’s Report, Delhi, Centre for Science and Environment, 1983.

observed that in the slums of Delhi, infant mortality rate was 221 per 1000 live births. Among the lowest castes, infant mortality rate was more that double.

PLANNING AND MANAGEMENT OF SOLID WASTE

In the earliest days of man, the problems of solid waste management were dealt with at the lowest political level—each man took care of his own waste, usually with a dump at the back of his cave. Subsequent centuries saw increases in the quantity and diversity of waste; and with increasing urbanisation, the problem came to be considered as a responsibility of the municipal governments. Further, municipal practices with respect to solid wastes vary widely across the world. In some areas, almost all wastes are collected by the municipality. In others, industrial and community must provide for the disposal of their own wastes, either partially, or fully. Because of this diversity in the responsibility of municipal solid waste management agencies and because of the different levels of on-site disposal or salvage activity, 'municipal solid waste' appears to be inherently an ambiguous concept. From the earliest civilisations, burial of wastes has always been comparatively easy in rural areas. But, the solid waste treatment has necessarily always been more advanced in the largest cities.

In designing waste-processing systems, it will often be found that desired data are lacking. Many municipal waste studies have demonstrated the large errors, possibly from armchair estimates of the generation rate composition or properties of waste. It is strongly recommended, therefore, that the results of especially commissioned waste surveys analysis be incorporated in the definition of problems phase of the design effort for waste management systems. For systems disposing of municipal waste, for example, the local unit of waste generator types, climate, level of construction and demolition activity and existing
waste management practices and expectations can greatly affect the characteristics of the wastes which are collected.

Adrian Coad\textsuperscript{54} has observed large variations in solid waste quantities and its contents in different cities across the world. These variations are linked to differences in prosperity, climate, industrialisation, community size and consumption habits. He says, that the design of an efficient solid waste collection and disposal service requires data on refuse weights, composition and volumes and an understanding of local customs and so it is necessary to obtain information from the area concerned; global values cannot be assumed everywhere equally. While supporting Coad's views American Public Works Association\textsuperscript{55} and Flintoff\textsuperscript{56} have advocated that Western countries have often been able to provide developing countries with technical guidance in environmental matters, but solid waste may prove to be an exception; there are too many climatic, economic and social differences for systems to be successfully transplanted. Flintoff goes one step further and says that even the technical literature of the West may be of little value for either training or operational guidance. Therefore, it is important to gather the information from the area concerned.

Further, although transfer of technology is an important aspect of aid to developing countries, it is essential to propose measures which are within the economic and technological abilities of the country concerned, even if they do not measure up to hygienic and environmental standards expected in developing countries. The adage 'best is the enemy of the good' is particularly relevant to

\textsuperscript{54} Adrian Coad, 'A Case Study in Solid Waste Generation and Characteristics in Iran', in Holmes, R. John R. \textit{Practical Waste Management} (Avon: John Wiley and Sons Ltd., 1983) p. 503.


\textsuperscript{56} Frank Flintoff, op. cit, pp. 2-3.
attitudes to waste management projects in developing countries. Again, one of the
difficulties of 'master plans', aimed at some speculative and undeterminable
future, is to make assumptions on long-term conditions in countries where the
political and economic development is full of uncertainty. For example, it might
seem advantageous to propose a plant or equipment of high capital cost because
the investment cost will be financed by a long-term low-interest loan provided by
one of the international funding agencies. However, the key question is, whether
the municipality or other operating authority will have the financial and technical
resources to operate and maintain the facility through its lifetime. Great
metropolitan authorities, more often tend to want and expect modern technological
solutions to their problems. These hopes and expectations are not always feasible
within the realities of economic constraints.

The established social customs are a further important consideration. In
Istanbul City, for example, there is a well-organised system of salvaging (i.e.,
collecting of solid waste by rag pickers in the morning before the arrival of
municipality men) where the very large quantities of material are recovered and
sold to salvage industry or recovery shops. The system operates through a number
of entrepreneur activities. At the base level, scavengers clean the waste put out in
bin and boxes for collection. These men and women go round the streets early in
the morning before the collection vehicles arrive. Material thus collected is sold to
merchants, who carry out some preliminary sorting before selling it to other
merchants, who do further sorting and cleaning, prior to sale to industry. The
whole range of activity, though deficient in many aspects of hygiene and public
amenity, gives employment and a living for hundreds of people, provides industry
with low cost secondary raw material, and saves the national economy
considerable amount of foreign currency for imported materials. It is easy enough
to say that the practice of salvaging (tooting) and manual sorting in open yards is undesirable and should be stopped, but what is the substitute? A mechanised sorting plant under municipal control would be a tidier and more environmentally acceptable alternative, but the consequential reduction in employment and higher costs to industry must be weighed in the balance.

Further, among various methods of solid waste disposal, Spaan\(^57\) discusses about 'ocean incineration'. It's a method of destruction of solid waste by burning at sea. This concept was pioneered by a German Engineer, D. Sobinger who owned and operated a coastal tanker (ship), which had been converted to a sea-going incinerator. Although incineration at sea is seen as technically sound, it continues to attract political debate and opposition is now appearing in Europe. Some environmentalists consider the sea to be even more sacred than mother earth.

Compared to different methods of waste disposal like: incineration, composting etc., the 'landfill method' was and still remains, by and far the most common method for waste disposal. It may well be the quickest and the cheapest way to get rid of waste, but it is not necessarily a sound solution to the problem of waste disposal. More often than not, it simply postpones the problem by taking the waste 'out of sight' and leaving it for some future generations to deal with. Indeed, at times, it has led to major disasters. In this background, the Policy Review Committee\(^58\) of U.K. (through Department of Environment) has conducted five years of intensive research work on 19 existing landfill sites and has provided some very useful guidelines in relation to waste disposal by landfill. In this

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research, a great deal of valuable information was gained with respect to the behaviour of landfill operation in general. The 19 sites were carefully selected from amongst the hundreds of sites. To ensure that they represent the main geological conditions encountered in the U.K., this research involved drilling of boreholes into and around the landfill sites and removing samples of waste materials and the underlying strata, to study the condition of the waste and the quality of groundwater.

Thus, solid waste management is nothing but the purposeful, systematic control of the generation, storage, collection, transport, separation, processing recycling, recovery and disposal of solid wastes. In developing countries, it is often found that institutional factors give rise to more difficulties than technical problems. Success in solving the latter can only be achieved by devising systems acceptable to the population at large and within the political will and the ability of the government to implement recommended measures. Master plans are often prepared more in a spirit of hope than of expectation and long range economic forecasting. Priority in solid waste management projects may be given to measures which bring about environmental and health improvements to population sorely in need of both.

Long-term solution to solid waste disposal problems can be foreseen, but their implementation would require a strong engineering and organisational capacity, which is lacking at present. In planning and implementation of solid waste collection system for any particular area, design and operation parameters of the collection system need to be carefully considered. Once implemented cost effectiveness can be realised. Moreover, proper maintenance of the collection equipment reduces annual operating costs of the system. Using inefficient equipment, past its useful life, should be avoided. Further, solid wastes
management services should be self-financing by means of direct charges for waste collection and disposal. Various methods of collecting the charges can be discussed and put forward for the government's consideration.

LEGAL ASPECTS AND GENDER ISSUES IN SOLID WASTE MANAGEMENT

Studies like that of Freeman, Divan and Rosencranz, Jain, and Hall and others deal with legal aspects of hazardous waste handling, since the authors also happen to be lawyers. In view of the growing consciousness and recognition of public concern in this area, the legal aspects are indeed crucial. These books help the readers to gain a working knowledge of legal aspects of solid and hazardous waste management programmes. But compared to USA, the teeth in India's legal system to tackle Indian urban waste is not sufficient.

Another interesting study by was taken up Scheinberg and Muller, in which they focused on the issue of gender and waste. It has studied the real gender implications of waste activities and the ways in which gender and waste are related. It studies whether women and men have different perceptions of waste management in the communities? How their roles and tasks in household and community related waste activities. How have gender differences affected the

63 Anne Scheinberg and Maria Muller, Gender and Waste: Integrating Gender into Community Waste Management, UWEP Working Document-12, WASTE, CW. Gouda, Netherlands, September 1999, p. 5.
sustainability and effectiveness of waste management and what is their roles and tasks in community and household wastes? They have also tried to come out with strategies and methods that can be applied to enhance the contribution of both women and men.

HEALTH ASPECTS AND SOLID WASTE

The ever-increasing degradation of the urban environment is seriously affecting health and well being, especially, in the developing countries where urban populations are growing rapidly, with shrinking civic amenities to the urban poor living in the slums or in the shanty towns and squatter settlements that surround many urban conglomerations. In many cities in developing countries, administrations lack the resources to meet existing needs for basic water supply and sanitation systems and health services, let alone those of the future.

Further, rising urban population growth, dwindling municipal resources and the complexity of municipal solid waste management, in both industrialised and developing countries, have complicated the relationship between environmental management and urban and occupational health. The combined effects of uncollected wastes, poor handling, and inadequate disposal safeguards for municipal wastes have always had implications for public health. Among these are the direct transmission of diseases and the spread of epidemics, loss of healthy urban and amenable environment, and most importantly, the social reinforcement of poor hygienic habits and practices, all of which contribute to a vicious cycle. The inclusion of hazardous wastes and excreta (although in small quantities) in the urban waste stream complicates the search for practical responses to the problem. The potential threat of spread of AIDS and other infectious diseases through the discharge of healthcare wastes in general urban waste streams is a growing threat.
The implications for public health of inadequate solid waste management can no longer be ignored.

With hundreds of articles that have appeared in scores of journals, and books published worldwide, much of the attention has been directed towards the handling, treatment and management of hazardous waste and its effect on the environment. However, there are very few articles, studies and books on municipal waste and its impact on public health. Among them, the ones that can be cited are: Khanna and Saraswat, Esha Shah, Nath, UNEP-BMFT, UNEP and Last. While discussing health aspects, Last argues that, the garbage component of solid wastes provides the maternity wards and free lunch counters for flies and rats. This holds true from storage of waste at home (before disposing to community bins). He says, in warm climates, exposed garbage has been found to produce as many as 70,000 flies per 0.03 m$^3$ (1 ft.$^3$) of garbage in a week. Home refuse bins with accumulated residues and loose garbage can produce over 1000 fly larvae per week, with one champion can produced over 20,000 larvae in one week. These larvae seed the dumps and complete their cycle there. Some leave the bins through

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corroded bottoms or faulty cracks at the seams. Thus, the inadequate disposal of solid wastes is a major factor in the spread of gastro-intestinal and parasitic diseases and leptospirosis, primarily as a result of the proliferation of insects and rodent vectors.

Laporte\(^{70}\), in his study, argues that the solid wastes may be intentionally discarded or simply allowed to accumulate where produced. For example, household garbage and trash may be collected and buried or burnt at local dumps. When solid wastes are burnt, gaseous byproducts enter the atmosphere and disperse widely; small ash particles eventually settle down and affects the function of the incinerator. When solid wastes are left on the ground surface or buried, natural surface and underground water may be contaminated by substances leached from the refuse. Because overwhelming burdens of solid wastes are generated every year and because air and water pollution are associated with these wastes, more attention is now being paid to their disposal in soils and sediments that will safely contain them.

Further, over the past decades, researchers\(^{71}\) have reported a dramatic increase in the number of overweight Americans with reproductive deformities. The number of youth reaching puberty at early ages has also increased. In the past, these findings have been attributed to nutrition, lifestyle and genetics. However, researchers note that a chemical estrogen that is used to make plastics could be a contribution factor to this health deterioration. The reason behind, including this finding, is that the percentage of plastics in garbage is increasing rapidly. Further, researchers have found that Bishphenol A (BPA)\(^{72}\) is used as a ‘building block’ for

\(^{70}\) Laporte, op. cit., 35.

\(^{71}\) ‘Plastics Cause Health Problems’, \textit{The Hindu}, (Delhi), 2 December 1999.

\(^{72}\) BPA is a compound that was originally made as a chemical estrogen.
the production of polycarbonate plastic products such as baby bottles, tin can linings, certain toys and certain types of food storage containers.

While discussing about commonly-encountered health risks associated with solid waste Khanna and Saraswat\textsuperscript{73} have summarised the health risks in three groups: (i) health risks caused by solid form of waste (ii) health risks caused by liquid waste, and (iii) health risks caused by various gases produced from waste. In the study of \textit{UNEP}\textsuperscript{74}, the health aspects of solid waste management has been discussed in detail. They found, public as well as waste handling workers to be risk-prone. Further, they have classified the occupational health hazards into three types: accidental injuries, infectious diseases, and chronic diseases.

Compared to the impact of solid waste on public health, numerous studies and researches have been done on impact of solid waste on occupational health. The International Labour Organisation (ILO)\textsuperscript{75} and WHO in 1950 defined occupational health as 'the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations'. According to Park,\textsuperscript{76} the aim of occupational health is 'prevention of disease and maintenance of the highest degree of physical, mental and social being' of workers in all occupations. Ever since the ILO was set up in 1919, it has been concerned with problems affecting the workers’ safety and health; in fact, the ILO was established largely to deal with those problems. In the last century, concern with regard to the health of the worker has evolved from the identification of industrial disease to the much broader concept of the promotion of occupational health.

\textsuperscript{73} Khanna and Saraswat, op. cit., p. 6.
\textsuperscript{74} UNEP, op. cit., p. 398
According to WHO’s\textsuperscript{77} estimation, based on the current occupational injury rates in a number of countries, all over the world there are 32.7 million occupational injuries per year apart from 146000 deaths. Every year to be more specific, according to Gupta,\textsuperscript{78} the comparative accident rate per 1000 workers in municipalities in India was 0.30 in 1957 and 0.90 per 1000 in 1958. Further, workers handling waste are exposed to the impact of wastes. According to a study conducted by NEERI, cited by Venkateswaran,\textsuperscript{79} it is found that workers suffered from skin and eye infection, respiratory diseases, jaundice etc. Another study conducted in Ahmedabad\textsuperscript{80} found that more than 15 per cent of sweepers suffered from ‘Tuberculosis’ and that prevalence of Tuberculosis among sweepers was three times higher than the national average. The other studies which throw light on the impact of solid waste on workers’ health are Hunt,\textsuperscript{81} Hobson \textsuperscript{82} and WASTE\textsuperscript{83} can be mentioned. Thus, by going through these studies, one can assess to what extent the aims of occupational health are safeguarding the health of the waste handling workers.

Apart from the occupational health hazards of municipal workers, the plight of the rag pickers is very vulnerable. Because of their constant and direct contact with waste for long time municipal workers are more prone to serious health

\textsuperscript{78} M.N. Gupta, \textit{Swasth Hindh}, reproduced in Park, K., op cit, p. 4461
\textsuperscript{79} Sandhya Venkateswaran, op cit. p. 2909.
\textsuperscript{80} Ibid, p. 2909.
hazards. Rag pickers may be protected in the same manner as municipal workers, but in developing countries, occupational health and safety services are most often deficient for municipal workers, and rag pickers can expect none of those facilities and services at all. Another outstanding work done by Baud and Schenk\textsuperscript{84} throws light on complete socio-economic profile of rag pickers, but this work has not covered health aspects of rag pickers living in Bangalore City.

Further, the utility of garbage in energy generation has been overlooked by authorities. The result is that landfill sites are tossing up poisonous gases in air, which accelerates the pollution level. At least 2m\textsuperscript{3} of poisonous methane\textsuperscript{85} is generated by one metric ton of garbage.\textsuperscript{86} This gas emission creates a green house effect. Gases such as methane, carbon dioxide, and carbon monoxide create a screen in the air and prevent radiation. The layer of gases hangs in the air, posing a health hazard for the citizens.

Thus, it has become very clear that adverse health impacts can and do result along the cycle of solid waste management process, which needs a lot of attention. A proper understanding by municipal waste managers and health workers is necessary to study the impacts and the conditions of transmission for confronting these problems. Overall, there are three types of waste-linked health impacts and their conditions of transmission are: firstly, injuries and exposure to chronic diseases; secondly, bacterial, viral, or parasitic infections; and thirdly, indirect creation of endemic conditions for specific tropical water-borne diseases. Therefore, the safe handling and appropriate disposal of all municipal waste


\textsuperscript{85} It contains 55 per cent methane and 40 per cent of carbon dioxide.

\textsuperscript{86} Prabhat Shunglu, ‘Garbage’s Potential Overlooked’, \textit{Times of India}, New Delhi, 3 November 1993.
streams will go a long way in ensuring a healthy living environment. This is easier said than done. Given the poor state of the economies of most of the developing countries and the sheer magnitude of the waste management problems, only strategies based on incremental improvements on the existing situation are practicable in most cases. So, the first priority for minimising the public health impacts of solid waste management should be to ensure, at the community level, hygienic and safe management of domestic waste; and at the city level, complete coverage of the population by an efficient but appropriate municipal waste collection services.