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MUNICIPAL SOLID WASTE MANAGEMENT IN MIDDLE- AND LOWER-INCOME COUNTRIES

Report

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WASTE MANAGEMENT AND SOIL POLLUTION

By the year 2000, public health risks caused by solid and hazardous wastes and soil pollution should be effectively controlled in all Member States.

ABSTRACT

Most major cities in middle and lower-income countries face increasing difficulties in solid waste management. Energetic change stems from a strong public desire for improvements in social and economic wellbeing and in public health protection.

While uncollected waste presents the greater hazard, a poor history of waste disposal provides the simpler focal political issue. The acquisition of new disposal sites is becoming as protracted in many middle- and lower-income countries as it is in many prosperous nations.

Waste service and improvements are linked to national prosperity. Affordability, or the upper limit of public willingness to pay for an adequate waste service, in cities in a wide range of prosperity appears to be similar at around 0.5% of the prevailing annual gross national product (GNP) per capita. This "0.5% GNP" criterion will be examined and discussed further in this report.

The 0.5% GNP value, together with projected growth of prosperity, a locally suitable legal framework and accountable management, can form the basis of a business-like waste service improvement plan. Such a plan, executed in the medium term of, say, 20 years, can yield an economically sustainable public benefit.

This report has been prepared to stimulate international debate on the ways to promote political will to improve solid waste management, in a financially sustainable manner, in many cities around the world.

Keywords

REFUSE DISPOSAL
WASTE MANAGEMENT
SUSTAINABILITY
HEALTH POLICY
FINANCING, GOVERNMENT
DEVELOPING COUNTRIES

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1. THE PUBLIC AND POLITICAL SITUATIONS

1.1 Waste policy

Successful urban solid waste management meets three interlocking criteria. It must:

- enhance neighbourhood amenity and quality of life;
- protect public health; and
- be affordable and consistent with the growth of prosperity.

Meeting these conditions presents difficulties in almost all major cities, but they are most acute in large cities of middle- and lower-income nations. They are clearly apparent in burgeoning and populous cities in low- and middle-income Asian economies. Evidence from several Asian cities will be cited in this report. The work reported is highly applicable to some CCEE and NIS countries.

In the 1980s, the Government of Pakistan (1987), reported the daily generation of 5880 tonnes of solid waste in Karachi and the transportation to disposal of only one third of this amount. In 1985, Lahore, Pakistan, with a population of approximately 3.2 million, lacked a designated disposal site and discarded the collected fraction of waste, thought to be less than 40%, on a river flood plain to await removal in flood waters.

In 1994-1995, Kathmandu, Nepal, also disposed its urban waste along local river banks to await removal on flood waters. The use of a designated disposal site, provided by German aid funds, had to be abandoned following protests made by a neighbouring community.

In 1996, Manila, Philippines, with a population of approximately 8.5 million, had outstripped its small remaining waste disposal capacity and now lacks an approved plan for the future. The Presidential Task Force on Waste Management (1994) estimated that waste is generated at a daily rate of approximately 5440 tonnes. Collection is reported to be approximately three quarters of this amount. The remainder is burned in small heaps, or dumped illegally on river banks, vacant land or in storm drains. By the year 2014, it is estimated that Manila's population will reach 13 million and the daily waste generation rate will be 11 700 tonnes.

Difficulties with urban solid wastes are commonly found throughout Asia. Examples of cities with serious problems of waste collection or disposal or both are Bombay, Madras, Jakarta, Istanbul and Bangkok.

1.2 Historical parallels

There is a striking similarity between the results of the recent growth rates of many Asian cities and those experienced in cities affected by the Industrial Revolution in Europe in the late 18th and early 19th centuries. For example, Briggs (1971) notes that the city of Manchester, UK grew in population from approximately 40 000 in the late 1780s to 142 000 in 1831. In that period it had deteriorated from a 'large and superb town' noted by a French visitor in 1784, to a 'town (that) is abominably filthy' in 1808. Thereafter, it became renowned both for its increasing wealth and its worsening squalor. The growth of Karachi, a city with modest beginnings, illustrates its modern-day Asian equivalent. Census data quoted by Kureshy (1986) show a population of 3.5 million in 1972 and 5.1 million in 1981, an increase of 45%. This explosive growth rate has far outstripped

physical and financial resources to provide adequate environmental, transportation and other basic urban services.

The response to the squalor of largely unplanned industrializing British municipalities of the early 19th century provides some insight into the lapse of time that can readily occur in achieving the reform of social ills. The first Public Health Act was passed in 1848, in response to an outbreak of cholera and to the publication of accounts of grossly unhygienic conditions existing in many British cities. The Act was largely an empty gesture because it permitted rather than compelled cities to clean up. Compulsion at that period of British history was widely held to be an unwelcome intrusion on individuals' rights in a laissez-faire society, and financially unsustainable in most cities. By 1875, the public's mood had softened and another Public Health Act was passed compelling improved urban sanitation. However, a combination of several events was needed to persuade the public and political leaders that the time was ripe for change. In 1858, the foul smell of the heavily polluted river Thames led to a proposal to move the British Parliament to a more agreeable site; in 1861, Prince Albert, Queen Victoria's consort, died of typhoid caused by contaminated water at Windsor Castle; in the mid-1860s there was a further outbreak of cholera in London; and in 1871, the Prince of Wales, the future King Edward VII, nearly died of typhoid. Epidemics alone were clearly not sufficient to produce strong legislation. It took additional politically significant events to convince politicians that cleaner cities provided a substantial, sustained and financially worthwhile public benefit.

1.3 Law and politics

Strong and enforced legislation and regulation are fundamental to urban waste management and other environmental services. Unfortunately, like the British Public Health Act of 1848, there still exists in many countries a great deal of national environmental legislation that imparts a sense but no depth of commitment to reform. It usually lacks any accompanying policies, programmes, human or financial resources to confirm intentions and strengthen enforcement. Clarity of accountability for action is complicated by the present tendency for senior government, that usually provides the legislation, to devolve more and more authority upon municipalities that execute local services, such as water, wastewater and solid waste. This transfer of power is not always accompanied by transfer payments adequate to sustain legislated municipal service improvements. If, as is often the case, local revenue cannot be readily increased and the legislation is untimely, there is a high probability that reforms will go unenforced and unheeded. This is at the heart of the difficulties in waste management in many cities in middle and lower-income countries.

The high incidence of diseases associated with squalor occurring in most Asian cities may not be a sufficient incentive to recruit the strength of public opinion required to demand and pay for a rapid improvement of urban environmental services. Additional incentives for reforms, such as those that preceded the British Public Health Act of 1875 may be lacking and public support may be only lukewarm.

In the case of many cities, the required weight of added incentives may lie elsewhere, such as in the enhancement of property values associated with improved water, sewage and waste collection services. It may also lie in the encouragement of investment provided by a clean and orderly city, following the example set by, say, Singapore.

It is always a matter of good political judgement to identify where urban services can be most advantageously improved. Improvements in any public service are usually made with considerable reluctance because the competition for revenue funds, inadequate to meet all demands even in the

most prosperous cities, is always fierce. Municipal politicians are also keenly aware of public resistance to increased taxation. Therefore, it is usually in their best interest to wait as long as possible to identify the strength and continuity of the public mood, and to recognize and discard mere whim. This helps to establish a robust order of priorities in needs and expenditure. This occurs even in the more prosperous countries where much of the urban environmental infrastructure is of recent vintage. It is worth recalling that most of Tokyo's domestic solid waste was disposed in Tokyo Bay in the 1960s; Montreal, Canada, and major German cities along the Rhine lacked effective sewage treatment until the 1960s and 1970s; and Hall (1967) points out that the 1954 French census showed that more than 20% of dwellings in Paris lacked interior water supplies. The present keen public interest in urban waste in northwestern Europe, Canada and the United States started in the 1970s and arose only after revelations of mismanagement of industrial waste. Prior to that time interest was sparse and largely confined to neighbours in the immediate vicinity of older disposal sites frequently associated with characteristic malodours, noise and unsightliness.

1.4 Urban industries

Possibly the cause of the greatest uneasiness in the environmental management of many cities is the failure to deal with industrial wastes. The operating licences issued by environmental regulatory agencies, usually lodged in senior government, often require industries in general terms to dispose of their wastes without causing detriment to the environment. However, enforcement is rare, for many reasons. For example, cities may lack adequate disposal facilities, or disposal facilities may not be suited to the types of industrial waste generated, or industries may be unwilling to pay cities for the disposal of wastes. The dilemma is often that while cities and senior government may want to enforce good industrial waste management, they also feel an obligation but lack the resources to provide service to industries that are important to urban and national prosperity. This is an important issue that causes considerable political difficulty in many cities and governments. Some impression of the importance of industries to national economies can be gained in the examples of Nepal and the Philippines.

In Nepal, one of the world's least prosperous countries, a recent assessment made in this study of national productivity showed that the average annual value of output in 1992 per manufacturing worker was approximately US \$870; the corresponding value per agricultural worker was approximately only US \$220. In the Philippines, a lower-middle income economy and considerably more industrialized than Nepal, the average annual value of output in 1991 per manufacturing worker was approximately US \$5870 and the corresponding value per agricultural worker was approximately only US \$1270. The relatively high contribution made by the manufacturing sector to national prosperity provides a strong argument for national and urban governments to pay attention to the needs of industries in the management of their wastes.

This may become even more compelling in the future when international trade competitiveness is likely to make national performance in environmental protection, occupational health and child labour important to the acceptability in foreign markets of export goods. Recent dramatic declines of sales in western Europe of carpets from Pakistan and Nepal where child labour was employed, indicate that consumers can express effective trade sanctions based on social issues without the imposition of tariffs. The lack of environmental control of industries offers a ripe target for further trade sanctions.

2. PRIORITIES, PERCEPTIONS AND PROPRIETIES

2.1 Human values

Public health and environmental laws are usually devised by senior, often national, governments. Cities are obliged to comply. It is only rarely that these laws are accompanied by explanatory policies and work programmes that might convey a sense of priorities relative to other public service commitments such as education and transportation. It is usually left to the judgment of regulatory staff and municipal leaders to devise environmental services improvement programmes that they consider to be appropriate.

Regulatory environmental agencies in many higher-income countries originated in departments of health. Therefore, their earlier work tended to stress public health protection, particularly from diarrhoeal diseases associated with microbial contamination of water and waste, respiratory diseases caused by urban smog, and nuisances of malodours and smoke. By the mid-1970s, diseases from microbial contamination of urban water, uncollected waste and winter smog were largely controlled and no longer issues demanding great urgency of abatement. It is, however, a very different story in most other countries, including many in Asia. For example, in 1987 a report of the Government of Pakistan (1987) quotes an estimate that 30% of all reported illness and 40% of deaths in the country were attributable to waterborne diseases.

By the mid-1970s public interest in northwestern Europe, Canada and the United States had changed sharply to take a much broader view of environmental management. This was rooted in a reaction against rapid changes in lifestyle following the end of the Second World War. Attention focused on the chemical industries which had provided a large number of new products. Most, like the new antibacterial pharmaceuticals were welcome. Others, like some of the long-lived pesticides and the hard detergents that left an unsightly foam in rivers and lakes, have had a mixed reception. However, several cases of mismanaged industrial waste, spills and fires in chemical plants brought matters to a head and stirred the public conscience and interest as few other issues have done. Attention in the most prosperous countries broadened from classical public health illnesses to embrace a wider interest in the protection of the natural environment, and to arouse a fear of the risk of cancers and genetic imperfections accused of being induced by the newly available chemicals.

Unfortunately, toxicologists and epidemiologists were unable to define the health risks in a timely manner or to mollify the public's uneasiness. Consequently, to restore public confidence in their health and environmental regulatory systems, governments were obliged to rely on the passage of much stricter regulatory controls over the introduction and use of chemicals, and the management of industrial wastes. This process is still in progress and is not likely to cease until a sceptical public assures itself of a high quality of personal and environmental wellbeing for which it is able and prepared to pay.

While it is becoming rare to encounter identifiable mortality in the human population of prosperous countries caused by winter smog, contaminated urban water supplies, wastewater or waste, this is no longer the main point of their environmental management. The important political issue is not the acceptability of risk to public health, but the degree of indignation caused by environmental risk as it is perceived and measured in the public's mind. Humans are far less tolerant of hazards that are new, imposed by others or of wide and frightening consequence, than they are of hazards that are familiar, self-inflicted, restricted in scope or less daunting in health effects. However, humans are also very sensitive to conditions that may impair prevailing social proprieties, living standards or

self-esteem. These social aspects of acceptability have become at least as persuasive as those used to measure the quality of human health. They have become the essence of acceptable management of urban waste in prosperous economies.

The public of each country and even of each community develops its own evaluation of its environment. This is based only partially on health. Other cogent factors are bad smells, squalor, infestation by flies and rodents that can detract from the quality of life and reduce the value of property.

Property value, with its close relationship with a tidy neighbourhood resulting from effective waste collection, is a very powerful force for improved waste services in many communities with widely differing economies. Unfortunately, this motivation, which is driven by high urban land costs, often seems to be overlooked both by governments and by development aid agencies investing in environmental improvement.

2.2 Conflict in priorities

Many cities remain beset with endemic public health diseases, but the order of priorities of action to improve the environment perceived by the public is not solely dictated by the reduction of disease. Other social influences are strong and must be accommodated by political leaders if they are to satisfy the electorate. Fig. 1 gives an example of the marked differences that arise in establishing an order of environmental priorities. In Fig. 1(a) priorities are selected on the basis of cost-effectiveness of investments made to reduce the incidence of acute illnesses. In Fig. 1(b) the priorities are arranged in a sequence of effectiveness to reduce public indignation and satisfy social proprieties. The two distinct sets of priorities were selected by the author to reflect the conditions and opinions that appeared to prevail in Nepal in 1994–1995 while normal seasonal cholera, dysentery and other diseases associated with squalor were occurring. However, the strongest public indignation and demand for improvement were reserved for traffic smog, industrial discharges and uncollected waste in the capital city, Kathmandu.

Fig. 1(a) portrays a derived order of precedence of investment priorities in environmental remedial tasks designed to reduce the incidence of acute public health diseases in the most cost-effective manner. The highest priorities are assigned to the improved cleanliness, quantity and management of water supplies and of food. The waste service also deserves its high ranking because, as quoted by Fedorak and Rogers (1991), the bacterial contamination of uncollected waste, which is widespread in Kathmandu, is comparable to bacterial populations in undigested sewage sludge. This presents a potent source of hazard from disease vectors and hand-to-mouth transmission of pathogens, particularly for children playing near waste piles. The rehabilitation of failed sewage collection and treatment facilities in Kathmandu and attention to winter smog, particularly indoor air pollution, would be beneficial. The calculated probability of mortality due to cancers in the general public exposed to vehicle diesel exhaust gases in the heavy urban traffic smog indicates that the risk is comparatively small. The health effects caused by industrial pollution are also likely to be modest compared with those associated with contaminated water, food and waste. This is because the scale of industrialization in the country is still small and limited to simpler industries such as wool carpets, textiles, bricks, sugar and small tanneries.

On the other hand, the order of priorities perceived to be important by the public and their political leaders appeared to follow the pattern shown in Fig. 1(b). The greatest expressed concern was reserved for the malodours, smarting eyes, dirt and discomfort caused by smoky diesel vehicle engines. The second priority appeared to be directed at industrial pollution causing

Poor water quality and the failure of a new wastewater management system seemed to arouse little public indignation. This is echoed in many communities in Asia partly, it is thought, because these services flow unseen in buried pipes and do not intrude on the public conscience or offend the eye and nose like piles of uncollected waste.

Most cities in Asia suffer, to some extent, the same environmental problems as Kathmandu. However, the order of remediation priorities, both for the improvement of health and to enhance social and economic conditions, varies to suit local circumstances and perceptions of importance. Some understanding of the prevailing human valuation underlying the differences between orders of priority is basic to achieving public satisfaction.

One notable feature in middle- and lower-income cities, such as those in Asia, is the consistently high rank of waste management in environmental priorities to serve both health needs and social satisfaction. A major benefit of better waste services lies in the prospect of increased urban land values, which in some cases are comparable with values in major European and North American cities. This provides an added strong incentive to seek improvements of service.

3. URBAN WASTE MANAGEMENT

3.1 Waste generation

Cities produce waste from dwellings, commerce, industries, schools, parks, health-care institutions, roads and other infrastructure such as water and wastewater treatment. While this waste is mostly solid, many Asian cities that lack adequate wastewater collection and treatment usually have substantial additions of human body waste as well as industrial, health-care and household waste liquids and sludges. All requires collection and disposal to prevent squalor, reduce the risks of serious diseases and permit the social and economic advancement of cities.

Middle- and low-income cities characteristically generate daily wastes totalling one half to two thirds of a kilogram per inhabitant. Typically, one third to one half is household waste; between one quarter and one third arises in commerce and industry, and the remainder is generated in schools, parks, hospitals, roads and other parts of the urban infrastructure. Highly efficient or total collection is rare. Many cities lack well chosen disposal sites adequate for their needs; some lack any designated disposal area and rely on haphazard and often ill chosen temporary dumping grounds.

In contrast, high-income cities (such as Toronto, Canada) provide an example of waste generation rates in a prosperous city. In 1994, from data provided by Toronto (1995) residential waste collected and disposed of amounted to approximately 1 kg per inhabitant daily, while a further quarter of a kilogram of residential waste was diverted for recuperation of materials, composting and a hazardous household waste disposal programme. In 1990, the total daily wastes disposed of from all urban sources averaged approximately 3.8 kg per inhabitant. Owing in part to the economic recession and in part to the imposition of high disposal fees levied on private companies to encourage waste reduction, by 1994 the combined daily rate had declined to approximately 1.9 kg per inhabitant. Wastes are disposed of in well organized sanitary landfill sites. For largely social reasons, waste incineration in Toronto was abandoned, though it is favoured in some similar cities.

3.2 Collection and disposal

There are only two fundamental urban waste management tasks. The first, and usually the more crucial, is the effective collection of wastes from inhabited areas. This removes easy access to a potent source of health hazards, reduces squalor caused by accumulated waste, and enhances the social status of neighbourhoods together with property values and the self-esteem of the inhabitants. In prosperous cities, where collection is essentially complete, most of these benefits are realized, but civic reputations are still made or marred by the control of litter. In this respect, Singapore is held in high international regard. However, for most cities, waste collection is far from complete. This gives an impression of urban decay.

The second crucial waste management task is disposal. This is often the subject of much attention because proposed new waste disposal sites provide an easily identified focal issue that arouses great controversy in almost all major cities, prosperous and otherwise. This has become one of the most intractable political problems for civic leaders. In contrast, uncollected waste is more diffuse geographically, especially in poorer suburbs, and often lacks the necessary focus to become a political issue. Public reluctance to accept new sites is rooted in the history of the poorly chosen locations, noise, malodours and unsightliness that often accompanied disposal sites until recent times. While prospective neighbours express fears of health hazards from disease vectors or contaminated water supplies, the more potent underlying concerns are usually social in character. Added to the nuisances of noise, smell and poor appearance is the loss of neighbourhood self-esteem associated with accepting waste from other communities, especially richer communities, and the fear of an accompanying loss of property values.

3.3 Lapse of time

Rejection of a proposed site by neighbours can be particularly vehement in the case of industrial waste. For example, the province of Ontario, Canada, spent 14 years and approximately US \$100 million conducting a search and public hearings into a proposed new industrial waste disposal site. The proposal, reported in the *Toronto Star* newspaper (1994), was rejected following strong local opposition. In the intervening years, the value of the required capital for treatment equipment had risen from approximately US \$50 million to US \$185 million. Even for less controversial urban wastes, it is not uncommon for more than 10 years to pass in major Canadian communities between the preliminary identification of required new disposal sites and the commissioning of those sites that survive technical, economic, political and environmental assessment. It is probably fair to assume that comparable lapses of time and community reluctance will occur in Asian cities.

Urban waste management has assumed an intensely political character and its difficulties are resolved in a time-frame set by politics and economics and not by technology. Lack of technology has never been a very serious deterrent to environmental improvements.

Much of the delay stems from the often hesitant and lengthy processes required to reach agreement on issues first between local municipal leaders and later with leaders of senior government with jurisdiction over environment, land-use and economics. Metropolitan Manila, for example, comprises a substantial number of local municipalities and communities, each with its own set of traditions, social values, priorities, needs and rivalries. The most likely sources of conflict are inter-community equality of service, affordability and cost-allocation of waste collection and the location of shared disposal sites.

Such issues take much discussion, compromise and concessions before they can be resolved. Unless the political climate is suitable and public opinion compels change, it is likely that civic leaders will postpone the decision as long as possible. Alternatively, they may seek to widen the responsibility for the decision by recruiting the help and financial assistance of regional or central government with less parochial interests. Although this may incur delay, it may also provide a considerable advantage. This is because it can improve access to prospective disposal sites beyond city boundaries, where a better selection, compatible land-use and more favourable land costs are likely to be found. For many cities, this course of action should be cautiously encouraged in the interests of economy. However, the tendency in some countries is towards decentralization and the devolution of power over local issues from senior government to local government. While this works well in many urban services such as waste collection, it has some distinct drawbacks in waste disposal if it is applied too rigorously.

3.4 Management

As a general rule, the technical knowledge and capability of senior officials in many middle- and lower-income cities are of a high order. Their problems arise partly from urban administrative inexperience, but more from a lack of sufficient depth of management and sound organizational structure, clarity of accountability of staff and, of course, sufficient funds. Difficulties tend to be made more acute by the desire to replace simple waste management systems with capital-intensive systems that have evolved over many decades in more prosperous economies. However, even if the most advanced technologies were immediately affordable and made available, they are unlikely to prove satisfactory without substantial changes in management style and structure. In addition, it is rare that city waste managers have much understanding of the specialized needs of industries whose wastes must be disposed of safely and economically, and upon whose success urban prosperity often heavily depends.

The need for excellence of management of urban waste lies more in collection than in disposal. There are two essential features in efficient collection.

The first is the choice of collection equipment. This is a fairly straightforward matter for household wastes in prosperous cities offering a regular door-to-door pick-up service provided along wide paved access roads. The vehicles are selected to suit wastes of well-established density and composition which are deposited at predetermined times and places in standardized containers. The second essential feature is the strict management of vehicle movement. This depends on a well paid trained collection team following a well defined route at a predetermined rate that makes vehicle location closely predictable at any time in a working day. It also includes efficient maintenance in well stocked garages that ensure the most cost-effective performance of collection vehicles, coupled with the timely planning of procurement of replacement parts and capital equipment. At its best, collection is a highly organized business conducted and managed like a commercial enterprise, with budgets, accounts and measured performance.

3.5 Planning

This sense of organization is not clearly evident in most middle- and lower-income cities, despite the fact that waste management usually requires a substantial proportion of local government expenditure. Some city governments take the view that a prime task of waste collection, road sweeping and debris removal is to provide jobs for unskilled rural immigrants that must find food and shelter. While this has obvious merit, it does not lessen the need for good organization and productivity management to maximize waste collection. Lack of strong management often seems to

stem partly from a lack of trained and enthusiastic field managers, and partly from urban leaders who fail to stress the need for planning and efficiency in performing urban services.

At the core of the matter is the need to devise a plan that provides waste collection for all or a large part of a city, provides a reasonable quality of disposal, and can be afforded within municipal budgets without causing loss of other vital urban services. The main constraint in most cities is municipal revenue and the amount that can comfortably be devoted to waste services.

The plan for operating a sustainable waste service must be compatible with a sustainable level of municipal budget allocation. Some of the main considerations are the choice of vehicles, crew sizes and salaries, collection frequencies and methods (ranging in service quality from centralized waste containers to door-to-door collection), access and routes to disposal sites, and fee systems for commercial and industrial wastes. The selection of appropriate vehicles may be one of the more difficult tasks, because it is often assumed that compaction-type collection equipment designed for low-density household wastes encountered in prosperous countries are appropriate in all cities. Such vehicles with their high capital and maintenance costs are often ill suited to the high density wastes and difficult access conditions encountered in most cities in middle- and lower-income countries. In many cases, a better and more affordable service in some densely populated districts is by carts drawn by hand, draught-animal or farm tractor. Operating costs and simplicity of vehicle design and maintenance are always important. No matter how simple or complex the equipment, close supervision of staff and equipment is also always important to maximizing service.

The same holds true of equipment used for the transfer and disposal of wastes. All cities are confronted with choosing preferred disposal systems for wastes. Long and fierce debates argue the respective technical merits of incineration, composting and landfill. Advocates for each are never hard to find.

3.6 Incineration

Buekens and Patrick (1985) observe that the combustion of solid waste can proceed without supplementary fuel when the heat value exceeds approximately 1200 kilocalories per kg, and under certain limiting conditions of carbon, ash and moisture content. Due to the vagaries of waste composition and incinerator operations, some engineers feel more comfortable with a threshold heat value in excess of 1500 kilocalories per kg. Typical of many middle- and lower-income cities, the waste of both Istanbul, Turkey and Surabaya, Indonesia have heat values less than 1200 kilocalories per kg, making incineration at least questionable. From discussions with municipal engineers, similar conditions are believed to prevail in most major cities in India and Pakistan. Unfortunately, combustion management problems increase where supplementary fuel is required, and it is sometimes doubtful if the added complication is worthwhile. Buekens and Patrick (1985) also reported that western European municipal waste typically exhibited a gross heat value of approximately 2150 kilocalories per kg. This is in the range where engineers would not only be comfortable with the prospect of incineration, but also with the economics of electrical generation, at least from the bigger municipal incinerators. In 1978, municipal waste, largely from dwellings in one Canadian city exhibited a gross heat value of approximately 2900 kilocalories per kg.

A major constraint for less prosperous cities is likely to be the capital cost of modern incinerators that are not only efficient but also meet the air quality emission standards now found internationally acceptable. For a unit capable of incinerating 1000 tonnes of waste daily, the capital cost is likely to lie in the range of US \$110–150 million, with an average of US \$130 million. Estimates of the

costs of incineration, including capital and operations but exclusive of any sales of heat or electricity, that seem to be current in, for example, Asia, lie in the range of US \$80–120 per tonne of waste.

3.7 Composting

Due to the high organic content of urban wastes commonly found in middle- and lower-income countries, the manufacture of compost is relatively simple. The product finds many advocates due to its strong social appeal. Unfortunately, the history of compost plants outside high-income countries has not been encouraging. This is because the fundamentals of good business, such as a business plan, pre-manufacture market surveys, product valuation, uniformity of quality and seasonality of sales were rarely applied before construction and operation commenced. Often, market development, transportation and product delivery to customers were left to municipalities or companies that lacked experience or the incentive of profit to make the system work economically. Also, there is often misunderstanding of the nature and qualities of compost. It is characteristically an excellent soil conditioner to help retain moisture in the soil, but unless fortified with suitable manufactured chemicals, animal waste or sewage sludge, its qualities as a fertilizer are modest. Good quality compost requires the removal of larger fragments of plastic, metal, broken glass and other materials that may detract from safety or product acceptability. In Europe, compost seems to be favoured for use on inadequate or depleted humus areas specializing in high-value crops such as fruit and market-garden vegetables. The product can only be applied when crops cannot be damaged by vehicles delivering compost to fields. This means that sufficient space must be reserved in cities to store compost while awaiting the appropriate season for application to farmland. The needs for storage and good access to transport routes are sometimes overlooked.

Early composting systems in India were simple and relied heavily on labour to turn over and aerate alternating layers of straw and human and animal body waste. This method was suited to a rural village economy but it is not as well suited to large cities. In the latter case, a substantial degree of mechanization may be necessary to remove metals, glass and objects that resist pulverization or shredding before the composting process. These rejects must be dispatched to landfill or recycled. Depending on the customers' needs, the compost may have to be screened to reject oversized products. Estimates of costs of production vary widely. Brunt et al (1985) suggest a cost before revenue of US \$150 per tonne of product in a western European city of 100 000 population. Costs in larger Asian cities seem to range from US \$5 to \$40 per tonne, but the basis of the costs, the degree of mechanization, quality of product, revenue and production rates are not clear.

3.8 Landfilling

By far the most common method of urban waste disposal is by landfill. The least socially acceptable is unplanned open dumps that were familiar in Europe and North America until the second half of the twentieth century and remain the norm in most middle- and lower-income cities. Except where they have been very poorly located and operated, they have performed surprisingly well in confining the health hazards associated with wastes. This has been due partly to the reluctance of rodents, flies and other disease vectors to abandon or migrate far from the plentiful food source found in waste, and partly to thermal and chemical conditions unfavourable to the survival of a range of pathogens in leachate escaping from waste. Even more surprising is the rarity of fires and explosions due to methane accumulated in dwellings built on or near operating and abandoned disposal sites.

The high degree of control now commonly exercised in prosperous cities' sanitary landfill sites over the leachate and methane produced is provided more to satisfy social pressures and the minimization of perceived risk, rather than to curb observed hazards to public health. This matter is of considerable importance in less prosperous cities that are obliged to make careful choices in public service expenditure. For example, site development and final cover costs for a sanitary landfill site of 100 hectares in Asia is likely to range from US \$25 million to US \$40 million, depending largely on the design of the bottom liner. Assuming a simple bottom liner of clay from local sources; the use of a minimum of well chosen and well maintained heavy equipment; but exclusive of costs of land and waste transfer operations, disposal costs in well-managed sanitary landfill sites in middle- and lower-income cities may range from US \$8 to \$10 per tonne. At present, it seems doubtful if these conditions are likely to be found, or the costs to be comfortably accommodated in the budgets of most major cities.

3.9 Salvage

By 1970, waste scavenging as a private business had largely disappeared in northwestern Europe, Canada and the United States. This was due to increased prosperity and the consequent social pressures that made the work seem repugnant to human dignity. This stage has not yet arrived in many other cities, and scavenging before, during and after collection is widely practised. It provides a livelihood for many families, though it is increasingly being viewed as undignified and an embarrassment to local and national governments. On the other hand, its great virtues are its role in the reduction of urban waste and the recuperation of materials to suit market needs, to which it responds in a very agile manner. Its major defects are the health hazards associated with working, and often living, at disposal sites in heavily contaminated wastes, together with the danger of fire and explosion caused by the presence of methane. There is a less obvious defect which arises when collection crews are scavenging. This can involve not only loss of production and reduced collection efficiency, but it also incurs increased operational costs, especially if expensive packer-type collection vehicles are idle while crews search for salvage items.

The strong tendency in prosperous countries is for the encouragement of waste reduction and recuperation as a matter of social policy. Governments, often with strong public support, have replaced the former private scavengers with organized separation and collection of selected, marketable wastes such as paper, glass, aluminum and plastics. The presence of government, which is rarely adept in its dealings with a market economy, has sometimes had the effect of causing wide fluctuations in salvaged materials prices while industries adjust to the availability of recovered wastes. Metropolitan Toronto (1992) reported that in 1991, the cost of collecting and handling materials separated for recuperation by householders, amounting to approximately 85 000 tonnes, was approximately US \$150 per tonne, while revenue from the sale of this material was only approximately US \$9 per tonne.

At least for the present, the perceived social benefits of domestic waste recuperation outweigh the high financial costs and tolerate the continued presence of government in the highly volatile waste recuperation market.

The health of scavengers and their families living in waste disposal areas appears to be receiving more attention from some governments in lower-income countries as well as increasing international sympathy. While this area of concern lies beyond the scope of this discussion, it is likely to have a substantial effect on the future organization of scavenging and waste markets in these countries.

4. AFFORDABILITY

4.1 Total environmental expenditure

Cities, like people, can purchase only those goods and services that they can afford. Cities that spend beyond the limits of affordability will, sooner or later, reach a state of fiscal discomfort leading to unpopular tax increases or painful austerity measures.

The affordability of urban services is intimately tied to urban revenues which are also linked to national prosperity. For example, Karachi's capacity to deliver a waste management service is greatly influenced by the prevailing state of prosperity in Pakistan. It cannot equal the capacity of cities like Seoul, Singapore or Tokyo in more prosperous countries.

A commonly used measurement of comparative national prosperity is the annual gross national product per capita, expressed in US dollars (GNP per capita), and regularly published by the World Bank. This measurement will be adopted here because it is well suited to urban waste management with its characteristic high cost dependence on imported collection vehicles and disposal equipment purchased with international currency.

The Organisation for Economic Co-operation and Development (1990) reported on the environmental expenditure of its prosperous member countries in the period 1972–1987, including expenditure on water, wastewater and waste services, vehicle emissions and air pollution control, pesticides control, groundwater management, conservation of natural resources, and noise abatement in the public sector, industries and commerce, households and agriculture. The data lead to the conclusion that total expenditure lay fairly consistently in the range of 1% to 2% of GNP per capita for OECD countries. The major exception is the United States, where it increased to approximately 2.5%, or US \$550, of a GNP per capita of US \$22 240 in the early 1990s.

These OECD values reflect a measurement of the public's willingness to pay for environmental protection in prosperous countries. The allocations made by less prosperous countries are not nearly as well defined. This is partly because it is often difficult to obtain figures for household expenditure on acquiring water through private vendors and disposing of human and domestic waste and wastewater. However, from necessarily crude estimates obtained in this study, such expenditure is unlikely to exceed 3% of GNP per capita in most cases, although it is possibly more where irrigation is common and the resulting saturation and salination of soil require extensive agricultural drainage. This is consistent with a World Bank (1992) estimate of expected expenditure of 2% to 3% of GNP per capita by the end of the 1990s.

Assuming an upper limit of 3%, Pakistan, which in 1991 had a GNP per capita of US \$400, would not be likely to devote more than an annual average of US \$12 per capita to environmental management, and Turkey, with a 1991 GNP per capita of US \$1780, would not be likely to devote more than an annual average of US \$53 per capita for its environmental programme. This is clearly far short of the US \$550 per capita expended in the early 1990s in the United States, or even the average of approximately US \$140 per capita reported by the OECD (1990) to be expended in France in 1986.

It is reasonable to assume that environmental policies, programmes, technologies and expenditure must conform to the prevailing state of prosperity and a nation's available resources that can be comfortably allocated. Urban waste management is only one of the many environmental elements that must be accommodated within this total allocation.

4.2 Comparisons of health and environmental expenditure

Further insight into affordability and resource allocation in national environmental management is provided by a review of expenditures on human health. In 1990, the World Bank (1993) reported that the average total expenditure on human health in the United States was US \$2763 per capita. In France the sum was US \$1869 per capita, in the Philippines it was US \$14 per capita and in Pakistan it was US \$12 per capita. These values express both a level of willingness and an ability to pay to preserve human health. In France, the United States and other prosperous countries expenditure on the environment is modest compared with that on health. Therefore, it can be concluded that their citizens are likely to view the health benefits accompanying environmental programmes as well worth the relatively modest cost. In Pakistan, the Philippines and other less prosperous countries, where expenditure on health and on the environment is roughly comparable, health benefits by themselves are not likely to be sufficient to persuade people to invest in improved urban environmental services. It is much more likely that improvements must also provide substantially better neighbourhood amenity and increased local land values if they are to be perceived as worthwhile.

4.3 Urban expenditure on waste services

Urban waste management is only one element of environmental management. However, it is often the element most strongly influenced by municipal revenue. For most cities, it remains a service directly provided by local government employees and not, as is increasingly common with water and wastewater services, by a separately-funded public or private authority. Inadequate urban revenue is almost always a major impediment to the quality and affordability of waste services in middle- and lower-income countries. There are often additional underlying fiscal constraints. One is that the portion of revenue provided to most cities by transfer payments from central or federal governments is always subject to changes that make long-term planning difficult. Also, the locally provided portion cannot be increased quickly to improve service without arousing public opposition against increased taxation.

The contrasts in the fiscal capacities of prosperous and less-prosperous cities can be illustrated in the following manner. The Ontario Government (1993) reported that in 1991, Toronto, Canada, with a population of 2.13 million and associated with a GNP per capita of US \$20 440, expended slightly less than US \$2000 per capita on urban services. Of this, approximately US \$67 per capita, on average, was devoted to waste services. This represents 0.33% of the overall GNP per capita and is a modest fraction of total local government expenditure on urban services. Water and wastewater services consumed a further US \$156 per capita.

Data from the US Department of Commerce (1993) show that in 1990–1991, New York City, with a population of 7.32 million, expended a total of approximately US \$5570 per capita on urban services. Of this amount, approximately US \$106 per capita, on average, was expended on waste services. This represents 0.48% of the prevailing GNP per capita of US \$22 240. In the same period, United States cities with populations exceeding one million expended on average a total of US \$3006 per capita on urban services. Of this amount, approximately US \$70 per capita was expended on urban waste services. This represents 0.31% of the prevailing GNP per capita.

In 1985, Lahore, Pakistan, with a population of approximately 3.2 million and an associated GNP per capita of US \$390, expended approximately US \$9.70 per capita on urban services. Of this amount, approximately US \$1.75 per capita was devoted to waste services. This represents 0.45% of the overall GNP per capita, and is a substantial fraction of total local government

expenditure on urban services. Water and wastewater services consumed a further US \$3.90 per capita and constituted the largest single item of urban expenditure.

In London, United Kingdom, waste services cost an annual average of approximately US \$46 per capita in 1991, when the associated GNP per capita amounted to US \$16 550. This is approximately 0.28% of the overall GNP per capita.

In 1995 in the Philippines, during the preparation of this report, it was estimated that on average the cost of the waste service in Manila (population approximately 8.5 million) was about US \$4 per capita while the overall 1994 GNP per capita was reported to be US \$838. This expenditure on waste represents approximately 0.5% of GNP per capita.

Bartone et al. (1991) described the costs of urban waste services in five South American cities. Buenos Aires, Caracas and Santiago incurred expenditure substantially less than 0.5% of GNP per capita. The Brazilian cities of Rio de Janeiro and Sao Paulo incurred expenditure greater than 0.5% of GNP per capita. However, the authors warned of the distortion of reported costs, caused by runaway inflation prevailing in 1989 in Argentina, Brazil and Venezuela, and the consequent dangers of making intercity comparisons. Recent data contained in a personal communication to Canadian consultants (1996) from Bogota, Colombia – which has undergone substantial privatization of waste services – suggested that the annual average expenditure is US \$7.75 per capita. This is slightly less than 0.5% of the 1994 GNP per capita of US \$1620.

4.4 Limit on municipal waste service expenditure

The sum of the observations, impressions and data reported suggests that there presently exists an upper limit of expenditure on urban waste services beyond which major cities are reluctant to proceed. Although the evidence is still fairly sparse, this limit of affordability appears to be 0.5% of GNP per capita. It seems to denote an upper boundary of resource allocation at which the municipal leaders (as elected representatives of the general public) perceive that a balance between affordable cost and social benefits exists.

The 0.5% GNP value can be used by other middle- and lower-income cities as a reasonable guide for the preparation of urban waste management budgets and for waste planning purposes. It does not preclude the separation of costs for private collection and disposal of commercial and industrial city wastes, or for the imposition of additional charges for private service disposal. It is always prudent to maintain a reasonable balance of resources devoted to urban waste services within the broader national allocation of funds to environmental management and health.

Cities in prosperous economies that presently commit less than 0.5% of GNP per capita to waste services, such as London and Toronto, are not likely to increase their expenditure quickly. They are more likely first to try to contain expenditure by such means as moving towards privatization of collection, greater management efficiency and the sale of heat and electricity recovered from landfill gas or incinerators.

For large cities in other countries the question is how best to allocate the 0.5% of GNP per capita to gain the most satisfactory social and health benefits for the citizens.

5. ADMINISTRATION AND EXECUTION

5.1 Policy and programme of work

The quality of urban waste management is largely dependent on public support and willingness to pay for service. Even in the most prosperous countries where a high level of urban waste collection and disposal should exist, lack of public interest is often evident in details such as ineffective control of litter and domestic animal faeces in public areas. In less prosperous economies, lack of public support for waste management improvements may mean postponement until a crisis or until a more favourable political climate prevails.

On the other hand, if the public recognizes a social or economic need for change, it is prudent for civic leaders to embark on a public information programme that encourages sustained support to assure a continued willingness to pay for service. In most cases, urban waste management also needs the support of central or federal government to provide a necessary legislative and regulatory base; technical advice; links to public, private and support funding; and easier access to prospective disposal sites lying outside city boundaries.

At this stage, civic leaders are well advised to formulate an action (or improvement) plan and policy to be executed in a reasonable programme period, such as 20 years. This allows substantial progress in a time frame that is neither too long to sustain interest nor impossibly short. The policy should be clear and deal with such interrelated matters as costs, service efficiency, management, employment and the role of privatization of services.

Industrial and health-care waste management matters, which usually affect economic and regulatory policy at both urban and senior government levels, need special attention. The main concerns are to understand both the real hazards to the public and the hazards as they are perceived by the public. A management programme can then be devised that provides graduated and timely abatement measures that are safe, affordable, practical and protect both society and the security of health-care institutions and the industrial economy.

A useful starting point for an urban waste management plan is the determination of the kind of service that is affordable both at the beginning and at the end of the 20-year programme period. For example, a major city in a country with a GNP per capita of US \$1000 can be presently expected to afford, on average, approximately US \$5 (0.5% of GNP per capita) annually per inhabitant on waste management. A range of prosperity growth rates can then be applied to predict an approximation of the GNP per capita in 20 years' time. If, for example, strong national growth at an average annual rate of 5% is assumed, the GNP per capita may reach approximately US \$2700 at the end of 20 years. It therefore suggests that the state of urban waste management in the city described above could be expected in 20 years' time and can be roughly compared to that which existed in the early 1990s in a city like Kuala Lumpur. That is, the city should appear clean and its waste collection services well organized. However, the quality of disposal operations is likely to be of an intermediate standard compared to that found in, for example, London or Singapore.

An improvement plan is best based on a graduated programme of defined intermediate and final goals together with their compliance dates, interspersed in the 20-year planning period. The final aims may, for example, be essentially complete waste collection; the installation of professionally designed, well managed and controlled landfill sites with periodic soil cover; and the establishment of an enforced interim disposal system for the most hazardous wastes. The

intermediate goals may include the identification, assessment, approval and procurement of interim disposal sites; identification and procurement of collection equipment and vehicles; the improvement of management and reliability of collection practices and vehicle maintenance; and the minimization of industrial production wastes.

5.2 Law and enforcement

The legislative base for urban waste management usually exists in various enactments of national and local governments dealing with municipal affairs, public health, industry, transport, the environment and other parts of public service. Existing laws are often neither fully consistent with each other nor enforced uniformly by those government departments with jurisdiction.

Most laws dealing with urban waste express in general terms the obligations placed on municipal governments to collect and dispose of waste in a competent manner; to obey prohibitions against negligence; to make environmental assessments, hold hearings and apply for approval of new waste systems or modifications to existing systems; and to follow a prescribed formula in making an appeal against a ruling of the central or federal government departments with jurisdiction. To these are added penalties for infractions of the law. These are usually supplemented with regulations that define the standards of acceptability that should be enforced by the appropriate regulators and the authority of the courts. Most environmental law works on the principle of the implied threat of court action when all other practices of businesslike negotiations have failed.

There are a number of impediments in this legal system when it is applied to urban waste management. Not the least is the great reluctance of national governments to prosecute municipalities on issues of municipal services. Court actions are usually reserved for deeper matters of policy. Cities are well aware of this reluctance. Pressure to improve urban services is usually met with a request for financial contributions from central or federal government to defray any additional costs that cities may incur. Unless a municipality has been thoroughly negligent or careless in its waste management, prosecution by national government can adversely affect negotiations to encourage improvements in waste services.

Another impediment frequently arises when a city seeks approval for a new disposal site. Applications are usually scrutinized by central or federal government technical staff who are often inclined to reject proposals that fail to meet the high landfill or incineration standards now required in prosperous economies. While this is a technically safe position to adopt, the associated costs may be beyond the prevailing limit of affordability. Delays in finding a resolution of this question of sustainable technology are often substantial. It is an oddity of national government approvals functions that the efficiency of waste collection is seldom scrutinized. However, failures in waste collection are more likely to expose the public to health hazards and diminished social quality than shortcomings in the design of disposal sites.

A major underlying difficulty is the inability to express concisely in legal language what constitutes acceptable standards of waste management. Except for the disposal of a limited range of defined industrial and health-care wastes, the required conditions for the storage, collection, transfer and disposal of most wastes elude the terse and precise description required by the courts. This difficulty is greatly diminished, but far from completely absent, in court actions dealing with air and water pollution where maximum permissible emissions of defined forms of contamination tend to simplify the presentation of evidence.

Law courts are not particularly well suited to remedying or improving environmental management. Only rarely does legal action adequately repay enforcement agencies for the long delays, the labour of preparing court cases and the risk of failure. Reliance on the courts is usually best reserved for circumstances where breaches of environmental law are due to negligence or carelessness of a degree that scandalizes the public, or where failure to prosecute would embarrass the government agency having jurisdiction.

It is almost always far preferable, more businesslike and more likely to succeed for a city to commit itself to a waste service improvement programme jointly devised with the senior government having jurisdiction. The programme can be based on an affordable city action plan. This can specify a series of intermediate activities with compliance dates, by which a city's graduated performance of its commitments can be observed and measured.

A programme to remedy the waste services has additional advantages. It not only permits the public, national government and the courts to measure progress by the timely completion of intermediate tasks, but it does so as a public commitment readily understood by all. Meeting target dates avoids the risk of prosecution. On the other hand, the terms and compliance dates of the programme can be renegotiated with government departments if the expected growth of prosperity changes, or some unexpected event interferes with the planned rate of progress.

5.3 Industrial wastes

The drafting of regulations for industrial waste management can be particularly difficult because it is tempting to adopt rules devised and applied by prosperous countries. These rarely work in less prosperous economies. This is partly because the rules usually require waste tracking systems that are too costly and onerous for many environmental regulatory agencies to sustain, but mostly because the highly complex facilities for the storage, transport and disposal of waste that are required do not exist. It is better that the regulations are drafted to be compatible with making best use of existing resources in the middle or lower-income country. Until prosperity permits the construction of waste treatment facilities to higher complex standards, reliance has to be placed on simpler disposal methods. These may include techniques such as depositing inorganic waste solids, liquids and sludges in coal-fired power station fly ash disposal sites or in municipal disposal sites, preferably in areas from which scavengers and the public are excluded. Examination of the prospects for the disposal of combustible waste liquids and sludges in cement kilns is always worthwhile, not only because of the advantages of the incineration conditions available, but also because it may offer some fuel cost savings for cement manufacturers.

In addition, manufacturers' associations and chambers of commerce can be strongly encouraged to collaborate with civic leaders and environmental regulatory agencies. Together, they can devise and embark on programmes to minimize the use of raw materials, energy and process wastes and to establish waste exchanges whereby wastes discarded by one industry may find beneficial use in another. These steps are not only likely to provide savings in waste disposal and manufacturing costs, but also help to improve the social stature of industries in their communities.

The management of industrial and health-care wastes can follow a graduated improvement programme akin to programmes for other urban wastes. In many countries it is reasonably certain that increasing pressure to enforce improved management of wastes will be exerted by the need for international compatibility of basic occupational health and environmental management as a prerequisite of the export trade, as well as a local need to act as a good neighbour. To respond, it

is necessary to devise regulations that are compatible with local conditions and the growth of prosperity, export markets, and the capabilities of enforcement agencies.

5.4 Health care wastes

Though health-care waste makes up only a small proportion of urban waste, it can often arouse public sensitivities and therefore requires special consideration. Most waste from larger institutions, such as hospitals, is discarded food, paper and debris and is no more hazardous than most domestic waste. However, there is a small proportion that includes discarded needles, pharmaceuticals, and anatomical and isolation ward waste that requires care to avoid misuse or exposure to unusual risk. Based on a report by Vos (1993), it can be concluded that the annual amount of health-care waste in the Netherlands is approximately 8.6 kg per capita of population. However, only 0.5 kg per capita require special care in handling, transport and disposal.

Vos (1993) adds that although the cost of incineration of this latter fraction was approximately US \$440 per tonne, the total cost of management lay in the range US \$900–2450 per tonne. Even in high-income countries these costs are causing concern, and attention is turning to alternative treatment methods. The United States Congress Office of Technology Assessment (1990) has provided an account of many treatment systems and their associated costs.

However, as with all urban waste, it is likely that a graduated programme of improvements is required. Burial of anatomical waste within chosen fenced sites, and the fixation of discarded sharp instruments and pharmaceuticals in cement or asphalt to prevent misuse, may be appropriate early measures. Fortunately, hospitals can usually rely on the advice of professional staff that are experienced in public health risk management as well as public sensitivity.

5.5 Privatization of urban waste services

Large, well organized and specialized private waste management companies arose in prosperous countries several years after the Second World War. They have now supplanted waste services formerly provided by municipal forces in many cities not only in high-income countries, but increasingly in middle-income economies. In many cities where public service labour unions are strong, the replacement of municipal forces by the private sector is often resisted. However, the provision of a reliable service and cost savings through labour and vehicle efficiencies offered by private companies are very tempting to municipalities that are always in need of revenue to meet public demands to improve services.

For many years the role of the private sector in most countries was largely confined to the recovery of selected waste such as paper, metals and textiles. To this were later added the collection and disposal of an increasingly wide range of industrial waste such as lubricants, solvents, acids and alkalis. This trade was normally conducted by smaller companies, often with experience in transport or construction. The diversity of wastes and associated management techniques, coupled with the growth of public interest in the social aspects of all forms of urban waste, led to the formation of private waste companies capable of providing the management, capital and technical skill needed in large diverse cities. To stay in business they must be both competitive and profitable. The strength of the successful companies lies in the close supervision of the movement of waste collection vehicles, a well motivated staff and a mechanical maintenance regime that maximizes the cost-effective performance of vehicles and mobile equipment.

Most large middle- and lower-income cities rely primarily on municipal forces to collect and dispose of domestic and infrastructural wastes. Many rely on the private sector for the scavenging of recoverable wastes and for supplementing the collection of waste with rented or leased vehicles. The advantages and cost-efficiencies experienced in prosperous economies have encouraged some cities to investigate a broader role for privatization. Understandably, this is a matter of very considerable importance because urban expenditure on waste management characteristically commands a substantial proportion of the budgets of middle- and lower-income cities. Furthermore, privatization introduces the prospect of a good deal of fiscal flexibility. At one end of the range of possibilities, a private company can be recompensed by a municipality under a contract that defines the scope of waste management tasks to be provided. At the other extreme, a private company may seek a concession to provide waste services for an area of a city and, in return, receive payment directly from tenants of premises. There are many possible variations. The choice and success depend on clarity of the contract and strict enforcement of its terms by both the city and the private company. Apart from the relative newness of the trend in privatization of urban waste management, the hesitant response of the private sector in many cities suggests the existence of other practical impediments. Not the least of these is the reluctance of civic leaders to lose the political power that accompanies the appointment by patronage of city workers in some countries. This practice runs counter to work efficiency that is basic to successful privatization.

It is also obvious that public service managers and workers will be reluctant to give up authority and jobs without a fight. In response, civic leaders will tend to seek a compromise or to postpone privatization. While the division of responsibilities for waste collection on the basis of urban geography has frequently been used to apportion tasks between the private contractor and public employees, the division of work at waste transfer stations and disposal sites is not likely to be as simple. However, subcontracting the supply and maintenance of heavy disposal equipment to municipalities has been successful in some prosperous communities.

A recurring concern is the duration of contracts. The tendency in many cities is to prefer short contract periods to guard against the risk of poor performance by private contractors. However, companies offering large scale privatized collection or disposal tend to seek contract periods commensurate with the economic working lifespan of high-cost vehicles and equipment. This is usually in the range of six to eight years. To reduce the risk of the contract not being renewed after a shorter contract period, the private company may amortize vehicles and equipment over this shorter period. The effect is to raise the cost of service. In most middle- and lower-income cities where labour costs are modest and motorized equipment costs are relatively high, the matter of contract periods takes on a special importance.

A further matter requiring consideration is the ownership of disposal sites. Experience, particularly in the United States, has shown that some sites which were once privately owned and were filled or later abandoned, have subsequently caused a hazard to the neighbouring public. If, as is sometimes the case, the former owners have gone out of business or cannot be held accountable, the cost of remediation is likely to be borne by the public. However, it is unlikely that many middle- and lower-income cities can afford in the near future the costly highly-protective sites that, in the last 20 years, have become the standard in northwestern Europe, the United States and Canada. Therefore, for some time public protection may have to rely on a careful selection of sites, with emphasis on suitable separation distances from dwellings, natural low permeability geologies, civil engineering and management skills, and on ownership at some level of government to assure the public of long-term protection and accountability.

It seems likely that the private sector can be particularly useful in the management of industrial and health-care wastes. This is due to its flexibility to respond to a wide range of types and conditions of the materials to be handled. However, it is very unlikely that the necessary skilled and reputable private companies will enter this business sector unless the government department with jurisdiction undertakes measures to enforce regulations strenuously and thereby ensure continuity of service, defines acceptable disposal methods and sites, and underwrites the possibility of public health-care institutions not paying their waste disposal charges to the private contractor.

The private sector is not always enthusiastic about entry in the urban waste market. This seems to be mainly because it fears that city government processes often lack the clear definition and transparency of commercial contracts. Until it gains experience, it is likely to wait until prosperity reaches a threshold where the profit margin is sufficient to compensate for the commercial risks perceived. There does not appear to be any established rule to identify this threshold of interest.

6. CONCLUSIONS

Most major cities in middle- and lower-income countries face increasingly serious waste management problems that produce both squalor and public health hazards. The improvement of waste services is becoming a matter of urgency in many cases.

Energetic improvement programmes are typically preceded by expressions of public indignation aroused by a combination of unacceptable loss of neighbourhood amenity and economic values and of threats to public health. The strength of public opinion is gauged by political leaders who then decide on the priority of response and the resources to be allocated from strained budgets. Only strong and sustained public demand for improved waste service is likely to produce strenuous remedial action. The incentives for change may be more due to relief from neighbourhood squalor and the expectation of consequent enhanced social conditions and land values, than to relief from health hazards.

The resolution of both social and health problems lies predominantly in the improved collection of waste, rather than improvements in its disposal. However, the latter provides the clearer focus for public and political attention, and is now becoming an almost intractable municipal issue in many major cities, prosperous or otherwise.

In addition, many middle- and lower-income cities lack facilities for the accommodation of industrial urban wastes. This exposes the important manufacturing segment of national economies to the risk of formal or informal international trade sanctions against countries with poor records of environmental protection. It also seems probable that local public indignation against the mismanagement of industrial waste will arouse a demand for rapid improvements, as it did in high-income countries in the 1970s.

The rate of urban waste service remediation is linked to the state of national prosperity and the financial resources that countries can allocate without damaging other essential services. It appears that for the full range of public and private environmental services and protection, the allocation in less prosperous countries is typically less than 3% of GNP per capita. While expenditure on water and wastewater predominates, urban waste management must share the remaining allocated resources with other environmental demands. Available statistical data suggest that large cities seem reluctant to expend more than 0.5% of GNP per capita on waste services. It is suggested that this is adopted as an upper limit to the public willingness to pay for

the benefits of urban waste services. This amount provides both a measure of affordability and a useful guide with which to establish urban waste management budgets.

It also provides a basis for planning improvements in waste service based on the expected growth of prosperity in a reasonable planning period of, say, 20 years. Such a reasonably firm financial base for urban waste remedial programmes not only permits government to predict the attainable future results of planned investments with some confidence, but also elicits the important administrative elements required to make the plan successful.

It quickly leads to questions of the selection of affordable collection and disposal methods and vehicles and the related matters of management, efficiency, organization, training, accountability and, of course, possible revenue sources.

It will also suggest the need to define the respective roles of city and central or federal governments in legislation, regulation, waste system approvals for industrial, health-care and all other forms of urban waste, environmental assessments, public involvement, sources of finance and, not least, access to disposal sites lying outside urban boundaries. It is very likely that cooperation between these levels of government will be most helpful to smoothe progress. It will also define the introduction and growth of the private sector's role.

In most cases the rate of progress will be determined by the twin constraints of affordability and the lapse of time required by administrative processes of government, public debate and technical evaluation. Both the executive and administrative elements can be meshed together to provide a coherent urban waste management development programme.

Such a medium-term development plan provides a transparent and businesslike base. It is particularly well suited to urban waste management with its heavy reliance on the maintenance and frequent replacement of expensive collection and disposal equipment. This makes it especially appropriate in middle- and lower-income countries with their enhanced need for careful budgetary control.

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