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Partnerships Towards Responsive Solid Waste Management

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EDITORIAL INTRODUCTION

PARTNERSHIP TOWARDS RESPONSIVE SOLID WASTE MANAGEMENT

E. A. R. OUANO AND HISASHI OGAWA

Solid waste management (SWM) is a major problem in most metropolitan cities of Asia, in spite of the financial and human resources committed and priority given by the public and private sectors. With an increasing standard of living, rapid urbanization, and wide variety of consumer goods, the problems of SWM in urban areas have become more complex today than they were thirty years ago. In fact, in most metropolitan cities, the standard and level of SWM services have deteriorated over the years although the resources committed to this sector have increased at a faster rate than other urban services, such as education, roads, sewerage, and water supply. Although innovations and improvements in solid waste collection, transport, and disposal technologies have contributed significantly to solving the solid waste problems, it has been a common experience that they alone would not lead to the most effective management system. It was found that appropriate technologies with multisectoral support from waste generators, industries, government, nongovernmental organizations (NGOs), and the general public would be required. Development of a partnership among them has become the key element of a successful SWM system in the metropolitan cities of Asia.

Past trends and experiences have shown that solutions to solid waste problems after the waste is generated are not only expensive and a waste of vital resources, but they also impose a serious burden on public health and the environment. A multisectoral and comprehensive approach to SWM must consider the factors affecting the quantity and characteristics of solid waste generated and its spatial distribution. A comprehensive analysis of the solid waste problems must examine the production and use of the material before it becomes waste, the possibility of more durable substitutes, and the feasibility of reuse, recovery, and recycling of the material after it becomes waste. In essence, the SWM authority must assess and understand the mechanism of the increasing quantity of solid waste and complexity of its problems, rather than accepting them as a phenomenon related to the growth and development of the metropolis.

The SWM authority needs to interact with, and affect the programmes and plans of industrialists and manufacturers, product distributors, advertising agencies, politicians, the mass media, consumer groups, the general public, NGOs, and the informal sector to implement effective programmes for solid waste minimization, recycling and resource recovery, and avoidance of toxic and hazardous substances. Unlike implementing solid waste collection, transportation, and disposal in which the SWM authority plays a major role, waste minimization, resource recovery and recycling, and avoidance of toxic and

hazardous substances require development of programmes by the other sectors. In most instances, the SWM authority's role in these areas is limited to guidance, facilitation, and coordination. A multisectoral approach and cooperation among the various actors or stakeholders in solving solid waste problems in Asian metropolises are considered to be essential. This has been realized by a number of cities and countries which have developed and implemented schemes and programmes with varying degrees of commitment and success.

The success factors in multisectoral partnership are often intangible and nonquantifiable. Case studies and narrative descriptions of approaches and techniques are often more useful and of practical value than a comparison of various socioeconomic indicators with evaluation criteria. Multisectoral partnership is a process whose maturation and impact vary from place to place, depending on a wide range of nonquantifiable factors. The transfer of techniques and methodology for multisectoral partnership in SWM will have to rely greatly on the intuition, appreciation of the local conditions, and commitment of the partners to a common goal.

While Southeast Asian countries have a diverse economic and industrial base which is reflected in the variation in solid waste generation rates and characteristics, they still share a set of common social and cultural patterns which may not be noticed by the casual observer. This diversity will provide planners with a deeper insight and wider perspective in forming an appropriate partnership agreement in their locality. Diversity should not be considered a constraint on the usefulness and applicability of the methods and techniques developed in other areas.

The United Nations Centre for Regional Development (UNCRD) held a Seminar-Workshop on Partnerships towards Responsive Solid Waste Management in Southeast Asia, 18-22 January 1993, in Penang, Malaysia. A total of fourteen resource papers and case studies were presented during the seminar-workshop. The papers covered a broad spectrum of SWM topics, from community participation and institutional development to the management of toxic and hazardous wastes. Twelve papers are presented as articles in this issue of the *Regional Development Dialogue (RDD)*. As in the seminar-workshop, these articles are organized into three parts: partnerships in solid waste collection and recycling; partnerships in hazardous waste management; and partnerships in solid waste disposal.

Antonio L. Fernandez, Associate Researcher of UNCRD's Environmental Planning and Management Unit (EPMU) and coordinator of the seminar-workshop, provides in the first part, an overview of public- and private-sector partnerships in SWM. His discussion focuses on the roles of actors or stakeholders in the various stages of SWM. He elaborates on the financial/economic instruments, institutional arrangements, and organizational mechanisms for developing and strengthening public-private partnerships for sustainable SWM.

E. A. R. Ouano presents an in-depth analysis of the potential for, and constraints in promoting recycling and resource recovery activities in Southeast Asia. He examines the solid waste characteristics and potential for recycling and recovery, and discusses the benefits of using recycled materials. However, he points out that the favourable pricing of raw materials against recycled ones, the poor quality of recycled materials from mixed solid waste, and the small quantity and unreliable supply of recycled materials have

rendered past recycling and resource recovery attempts less viable. He concludes with various measures that could be taken to eliminate or reduce these constraints at the local, national, and international levels.

Following these two resource articles on partnerships in solid waste collection and recycling, three case studies are presented. First, Kazal Sinha discusses the privatization of SWM services, particularly the collection and transportation of solid waste in Malaysia. Referring to the national policy of privatization of the public-sector services, he highlights the positive experience in terms of the cost-effectiveness of contracting out solid waste collection services to the private sector. However, he points out that successful privatization must ensure a reasonable work contract and period, a competitive environment for the contract bidders, and the effective supervision, monitoring, and enforcement of the contractor's performance and contract conditions.

Eddy Indrayana and Johan Silas present a case study on the involvement of communities and the informal sector in SWM in Surabaya, Indonesia. They review the historical development of the city and its SWM, highlighting the important roles played by waste pickers, street sweepers, and collection workers in improving and maintaining the cleanliness of the city. A change in government policies on dealing with the informal sector and mobilizing community resources in SWM is regarded as a key to the success of SWM in Surabaya.

Ksemsan Suwarnarat and Watana Luanratana present a case study on SWM in Bangkok. The article stresses the increasing cost of the SWM sector and the need to encourage waste generators to separate their waste and incorporate waste pickers more effectively into the present SWM system in the city.

The second part of this RDD issue covers the experiences in hazardous and hospital waste management in the region.

Joo-Hwa Tay describes the generation, characteristics, collection, disposal, reuse, and avoidance of toxic and hazardous wastes. He first discusses the general principles and techniques, and then presents a case study of the toxic waste management programme in Singapore. He also discusses the modifications and adaptations that Singapore authorities have made to suit the management techniques to local conditions. Tay concludes with a presentation of methods and techniques that the countries in the region could use to adapt the programmes in Singapore to their own localities.

Hisashi Ogawa of the World Health Organization's Western Pacific Regional Environmental Health Centre (WHO/EHC) in Kuala Lumpur, reviews the programmes, activities, and regulations in the region on the storage, collection, and disposal of hospital wastes. Hospital wastes consist of toxic and hazardous wastes generated even in remote areas and small islands where proper management has been ignored in the past. The occurrence of exotic contagious diseases in recent years has brought attention to this neglected problem area. The management of hospital wastes is complicated by diverse characteristics and wide distribution in small quantities, which makes storage and collection difficult.

Maria Victoria Fernandez-Ricaña presents an ongoing programme in Cebu City, Philippines, for the management of toxic and hazardous wastes. The programme is sponsored by the German Agency for Technical Cooperation (GTZ). Unlike Singapore, where a comprehensive data base is available on the sources, quantity, and characteristics

of toxic and hazardous wastes, no such data base is available on Cebu City. The programme tackles the various aspects of hazardous waste management, including monitoring, data base development, demonstration projects, personnel development in industry and government, and public information campaigns.

Reiji Hitsumoto discusses the strategies and concepts adopted in Japan in the minimization, collection, transport, and disposal of toxic and hazardous wastes. The Japanese experience provides a comprehensive programme involving various sectors of society, although most of the toxic and hazardous wastes are discharged by industries. The case study shows that even in a well developed and established economy, the problems related to monitoring and compliance are similar to those in emerging economies in the region.

The last part of this *RDD* issue focuses on problems and approaches associated with the final disposal of solid waste. Three case studies are included in this part, describing the experience in Malaysia and the Philippines.

Noor Hisham bin Ramly describes a leachate control programme adopted in Malaysia. The leachate was recirculated into the landfill through vent pipes. The process reduces the organic matter concentration in the leachate and at the same time improves the aeration of the decaying organic matter inside the cells of the landfill, thereby hastening stabilization of the solid waste. While considerable reduction in the organic matter (expressed as BOD and COD) takes place, the final effluent is still stronger than that prescribed by effluent standards. Pilot studies for filtering the leachate prior to discharge have been carried out successfully.

In relation to the collection and disposal of domestic solid wastes, Zaman Huri bin Zulkifli describes the pragmatic programmes adopted by the Government of Malaysia in the development of sanitary landfills. While a sanitary landfill is the cheapest acceptable method for disposal of solid waste under current environmental standards, the disposal cost is often ten to fifteen times higher than an open dump. Hence, while most cities in the region have formulated plans for closing open dumps and developing sanitary landfills, they are not yet implemented. The Malaysian programme calls for an evolutionary approach to converting open dumps to sanitary landfills. Instead of closing an open dump, the operation and expansion of the open dump were improved, so that with available resources a sanitary landfill could be attained within a five- to ten-year period. Demonstration projects have shown that the cost of converting open dumps to sanitary landfills is reduced by using the stabilized solid waste in the open dump for embankment, cover, and initial site development.

J. Salvador T. Passe, Jr. reviews the existing SWM system in Metropolitan Manila, identifying problems and issues pertinent to the development of an effective SWM system in the metropolitan area. In particular, he delineates problems associated with the siting and development of final disposal facilities in megacities such as Metro Manila, using the experience in the ongoing development of two sanitary landfill sites in the area.

The twelve articles included here provide a comprehensive coverage of the present practices, ongoing efforts, and future plans for more responsive SWM in the cities and countries of the Southeast Asian region. The guest editors of this issue, feel that the exchange of information and experience in developing and implementing SWM programmes in different cities and countries needs to be further enhanced and, therefore,

invite the readers to share their experience in innovative SWM, through this journal or UNCRD's SWM network.

PART I:

PARTNERSHIPS IN SOLID WASTE COLLECTION AND RECYCLING

PUBLIC-PRIVATE PARTNERSHIPS IN SOLID WASTE MANAGEMENT

ANTONIO L. FERNANDEZ

INTRODUCTION

This article attempts to assemble fairly standard rules, emerging lessons, and some strategies related to the financial, institutional, and organizational aspects of solid waste management (SWM). There are many stakeholders or interest groups who have a stake on the success or failure of the SWM system. These aspects of SWM lend themselves well to strategic planning and management.[1] Partnerships among the stakeholders are inevitable.

There is a whole range of alternatives for SWM strategies, which can be classified into the following categories: economic instruments; legal-*cum*-economic instruments; financial management; institutional arrangements; organizational instruments; integration; and public outreach and participation.

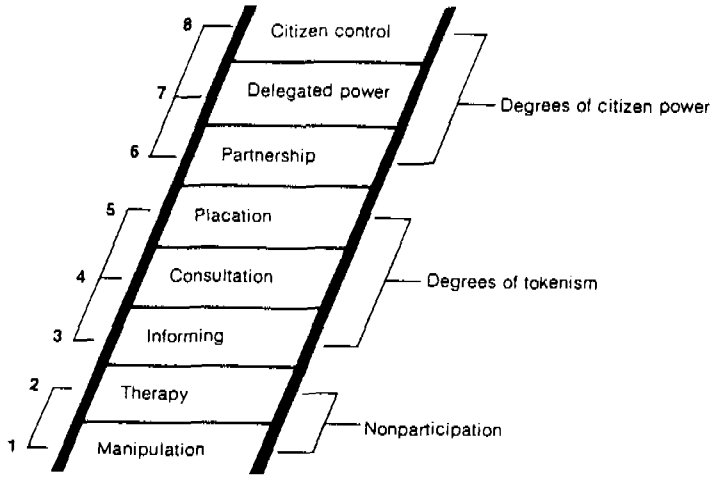
The article first defines the terms and concepts used to guide the reader. The subject of the potential usefulness of the different stakeholders' involvement is briefly dealt with. The discussion on opportunities for participation of private entities (business enterprises and communities) with public or government agencies leads to the elaboration of selected strategies in financial management, institutional measures, and organizational instruments.

DEFINITION OF TERMS

Partnership. Partnership is a word in vogue these days, that denotes a certain level of participation. In S. R. Arnstein's framework for analysing citizen participation, referred to as "the ladder of citizen participation," partnership enables some degree of citizen power (figure 1).[2]

Responsiveness. The term "responsiveness" stresses acceptability by the people concerned and appropriateness to given conditions. A service cannot be responsive if it is done inefficiently and inequitably. Therefore, responsive SWM policies and strategies should basically address the needs of the target group ("acceptable" to actors in the political process; "appropriate" in the sense of whether policy objectives mesh with the values of the community or society).[3]

Figure 1. Arnstein's Ladder of Citizen Participation



Source: Sherry R. Arnstein, "A Ladder of Citizen Participation," *Journal of the American Institute of Planners* 35 (July 1969):216-44, reprinted in Frank S. So *et al.*, eds., *The Practice of Local Goverment Planning* (Washington, DC: Published by the International City Management Association in cooperation with the American Planning Association (APA), 1979), p. 559.

Allocation of Service. Goods and services can be classified according to the willingness of producers to supply them and that of consumers to pay for them. When characterizing, for example, solid waste collection in economic terms, the service lies between private and toll service. The service is enjoyed by users jointly. It is practically impossible to prevent anyone from access to the service. Users who pay can expect the service, but those who do not pay can still have service to some extent. It is a kind of service which is not a collective good. It is socially acceptable to be charged for the service, unlike police protection, national defense, or vaccinations against communicable diseases for which people are not coerced to pay. In turn, people can be expected to be willing to pay more for solid waste collection for an improved level of service. Since solid waste collection is not a collective good, the government itself must determine how to allocate the goods.

OPPORTUNITIES FOR PUBLIC-PRIVATE PARTNERSHIPS IN SWM

Stakeholders are already involved in one or more stages of SWM and have certain potential roles (figure 2). Some of these involvements are formalized by creating institutions through agreements and programmes. The role of some stakeholders may also receive formal recognition by the leader of the city or the whole nation. Policies are laid out clearly to delineate tasks and ascertain responsibilities. Ideally, these involvements must result in the reduction of SWM costs.

Figure 2. Stakeholder Involvement in Solid Waste Policy and Action

Stakeholder	Generation	Storage	Separation for recycling and processing	Collection	Transportation	Intermediate treatment	Disposal
Central government	*		*		+	+	*
Municipal government		*	*	****	****	****	****
Private solid waste business	♦	♦	♦	*	*	*	*
Private industry (glass, paper, etc.)	♦	♦	♦				
Community organization	* ♦	**	**	**	♦	♦	♦
NGOs (national scope)	♦	♦	*	*		♦	♦
Waste pickers at dump site						♦	*
Itinerant waste pickers		**	♦				
Household	**	**	**	♦			
Collectors (Individual)	**	**	**	**	♦	♦	♦
Schools	*	*	*				

Notes:
+ indicates subsidies/external intervention from foreign loans.
♦ indicates supportive role.
* indicates responsibility for policy.
** indicates responsibility for action.

Experience in Canada, UK, and US shows that the private contracting of solid waste collection service is 20 to 48 per cent less costly than publicly provided collection. Some comparative data on vehicle and labour efficiency also indicate the advantage of the private-sector collection service in Asia and South America, as will be shown later. Many authors have lauded the benefits of the private-sector engagement in the SWM business. However, privatization is not a panacea, as S. J. Cointreau states.[4/]

Figure 3 further identifies current and potential involvement of private enterprises in the various stages of SWM. In advanced countries, some disposal sites are prepared and operated by private businesses. This is also the case with the transport of hazardous and hospital wastes.

Figure 3. Opportunities for Public-Private Partnerships in Developing Countries

	Private	Public
Collection	☆	☆
Transfer	☆	☆
Intermediate Treatment		
Composting	♦	☆
Incineration	♦	☆
Crushing	♦	☆
Baling/Compacting	♦	☆
Recycling	☆	♦
Disposal		
Open dump	♦	☆
Landfill	♦	☆

Notes: ☆ indicates current involvement.
♦ indicates potential involvement.

In cases where an industrial factory does not generate a sufficient amount of waste to justify its own treatment and disposal facility, then facilities to treat or dispose of the waste collected from a number of industries are required. Such facilities can be provided either by an independent company which may need government incentives; producer companies in a cooperative arrangement; directly by government; or a combination of the above, perhaps with the participation of an international or foreign agency to provide technology, training, or financing.

Public authorities may be involved either directly, for example, as partners in a joint venture with producing industries; or indirectly, for example, by providing low-interest finance for capital investment.

Financial management is crucial to SWM, especially in cities where costs attributable to SWM comprise a large portion (e.g., as much as 70 per cent) of the municipal budget.

FINANCIAL MANAGEMENT

Some strategies are enumerated below. Of these, user charge and privatization will be discussed.

SWM Strategies: Financial management	
User charge	Implement a service-charge type of user charges as nontax revenue.
Administrative charge	Levy licensing fees, registration/control fees, or fees to monitor in order to raise revenues (i.e., to partly finance authorized activities).
Privatization	Institutional arrangements combined with pricing policies.
Accounting	Separate accounting system or full cost accounting to enable cost-effectiveness analysis.

User Charge

The work done in Bandung funded by a loan from the Asian Development Bank (ADB) to provide new systems for achieving full cost-recovery is notable. Full cost-recovery was included as a covenant of two other ADB loans which funded capital works to upgrade the system. SWM is handled by a public cleansing authority called *Perusahan Daerah Kebersihan (PDK)*, an independent public enterprise headed by a director appointed by the mayor.

A tariff structure was initially prepared by consultants in 1982, and consequently approved. With an assumed level of noncollectables at 10 per cent (on the conservative end), the unit tariff rate per month was computed. An average service cost of approximately Rp1,000 per month was assessed for each household; the consultants noted that cross-subsidy by the affluent citizens to the poor served by the system was inevitable.

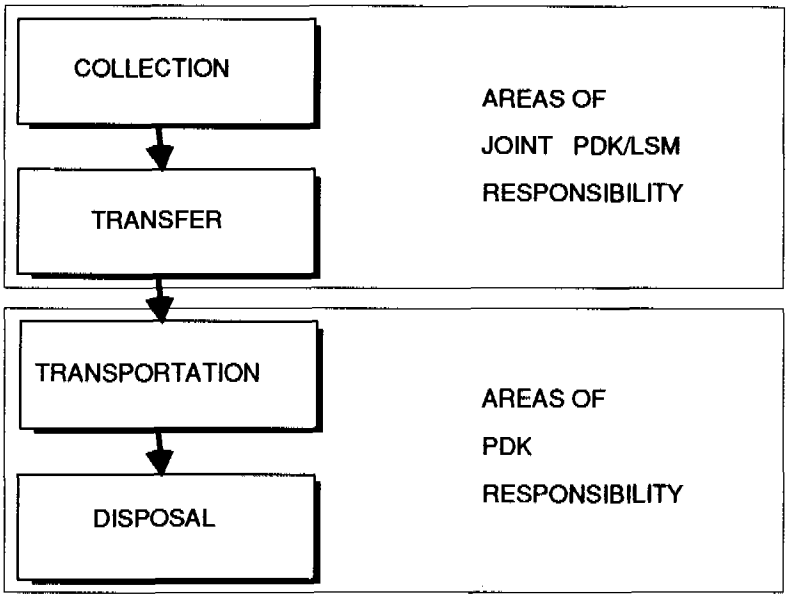
The Bandung system has not achieved full cost-recovery as of 1990. At present, user fees are billed together with the electric bill in the form of "payment points". The payment point system does not censure those who are unable to pay. A simple request is made to the customer who pays the electric bill to also pay for the solid waste service. The computerized electric billing system lists 255,000 customers against *PDK*'s list of 40,000.

The city has had a communal system of solid waste collection which is reinforced by the *Lembaga Swadaya Masyarakat* (*LSMs*) (local community organizations) (figure 4). Funds are provided to the *LSMs* by the city. As of now, *LSMs* levy a fee for the following: solid waste collection in the community and transfer service; provision of a community security service; maintenance of community facilities; and installation of community facilities.

The Directorate-General of Human Settlements of the Government of Indonesia has issued a directive that payments for solid waste collection should be from 0.7 per cent to 1.0 per cent of household income. With this as a barometer, some degree of success to recover costs is possible.

A conclusion of this case study is that user charges should be set on recovering operating and maintenance costs, plus depreciation, rather than loan repayments due to the relative short life span of solid waste equipment. Better still, economic costing is done to reflect the true cost of the SWM option to the national economy.

Figure 4. Responsibilities for Domestic Waste Collection, Bandung, Indonesia



Source: Djembar Wiradisastra and Gerald McManus, "Financial Aspects of Solid Waste Management in the Context of Metropolitan Management in Bandung" (Paper presented at the International Expert Group Seminar on Policy Responses towards Improving Solid Waste Management in Asian Metropolises, Bandung, 4-8 February 1991).

Garbage Collection Fees

User charge usually refers to a garbage collection fee. The fee schedule may be structured on the basis of any of the following:

(1) Volume of waste in litres per day, such as in Bangkok, or weight of waste in kg/day;

(2) Floor area for houses and commercial establishments;

(3) By type of business, for commercial, trade, manufacturing, service, banks, insurance companies, and other establishments; and

(4) Property tax value.

Billing may be done in any of the following ways:

(1) Paid separately as user charges to collectors employed by the municipality or solid waste authority;

(2) Paid to the community organizations, as in some *kampungs* in Indonesia, notably in Surabaya and Bandung;

(3) Attached to monthly utility bills for electricity or piped water supply; or

(4) Together with the property tax.

Privatization

The rationale for privatization is mainly economic. Public provision is more costly, as evidence seems to show. Often, public provision is unsatisfactory due to the inefficiency and rigidity of public bodies.

In his training manual on urban financial management, J. McMaster[5] enumerates the main reasons for delegating responsibilities to private-sector operations and nongovernmental organizations (NGOs) in the provision of urban services as well as the objectives to be achieved with such a shift in responsibilities. These reasons are summarized in table 1, with comments on the characteristics of government and private sectors. These are enumerated as follows:

(1) Reducing the cost of public services to consumers;
(2) Relieving the government's financial and administrative burden;
(3) Satisfying unmet needs;
(4) Increasing productivity and raising efficiency by promoting competition;
(5) Encouraging entrepreneurship;
(6) Innovation and adoption of new technology;
(7) Decision making;
(8) Condition of equipment;
(9) Interruption of service; and
(10) Responsiveness to cost control.

Understandably, individuals whose interests are threatened, such as government employees whose jobs may be at risk, are against privatizing. The negative effects on society need to be anticipated. There are ways to reduce these costs to a minimum. Among the arguments, as McMaster continues, are: the impact on employment; the impact on prices of public services; servicing remote or unprofitable areas; the impact on wage levels; the opportunities for corruption; control over the service quality; the impact on disadvantaged groups; the concentration of economic power; and the conversion of public monopolies into private monopolies.

Privatization basically involves the transfer of ownership and control from the public to the private sector. The transfer may be complete, partial, or selective. To guide the analysis of the impacts of privatization, McMaster offers table 2, as a guide for discussion on the subject. Criteria by government and consumers are suggested. Among the prerequisites for privatizing are:

- An analysis of the distribution of any cost savings that result from privatization as part of the macroeconomic impact assessment.
- Provisions and countermeasures (monitoring and control systems) must be devised to guard against the awarding of lucrative government contracts for political favours, bribery, or politicians using privatization for their own benefit, and other forms of corruption.

Complete privatization involves transferring ownership of a government enterprise to the private sector;

Partial privatization involves transferring the portion of the ownership of a government enterprise to the private sector; control **may or may not** (author's emphasis) be retained by the government, depending on the percentage of the equity sold to the private sector; if the government retains more than 50 per cent of the equity, it will maintain control over it; and

Selective privatization refers to the situation where the government sells or leases to the private sector selected parts of its operations or services while retaining other operations or services under its ownership and control; distinct sections may be sold as complete entities; in some situations, two or more sections may be combined to make a viable entity for the private purchaser.[6]

TABLE 1. MAIN REASONS FOR PRIVATIZING URBAN SERVICES

Main reasons	Characteristics	
	Government sector	Private sector
Reducing the cost of public services to consumers	Rigid structures may not allow for urgent measures	Highly motivated to minimize costs and maximize profits
Relieving the financial and administrative burden of government	Unable to meet demands for the provision of more and improved services; rising deficits, heavy debt servicing, limited borrowing capacity, backlog, delays in the provision of facilities, resistance of citizens to further tax increases	Has the capacity to pressure the government
Satisfying unmet needs	Related to above; examples of these are street cleaning, security patrols, solid waste collection, cleaning of roadside gutters and drains, child day-care centres; less responsive to consumer needs because there is no automatic demand-responsive mechanism in those markets where the government has monopoly	Community groups and NGOs are already performing services; in competitive market situations, private firms compete for customers to fulfill their needs
Increasing productivity and raising efficiency by promoting competition	Noncompetitive environment results in slackness and general inefficiency, misuse of resources, lack of responsiveness to needs of consumers and to technological change, and low levels of productivity; due to security of tenure of government employees nonproductive staff cannot be discharged	Competitive forces create an environment where good cost-efficient performance is rewarded by profits, otherwise bankruptcy or takeover may follow; staff can be used more flexibly and incentive payment systems are practiced

TABLE 1 (Continued)

Main reasons	Characteristics	
	Government sector	Private sector
Encouraging entrepreneurship, the formation of new businesses and the acceleration of economic growth		Transfer of selected services could create new business opportunities for local entrepreneurs and could be directed towards stimulating economic growth with multiplier effects
Innovation and adoption of new technology	More resistant to change and less responsive to changes in the relative costs of production	
Decision making	Many public-sector decisions are based on political criteria, government popularity with swing voters and special interest groups; misallocation of funds to secure political ends rather than efficient public service can be rampant	Economic factors drive decision making
Condition of equipment	Few individuals treat common property or public assets with the same care and attention as they give to their own equipment; lower level of maintenance	Strong economic incentive to have high level of maintenance
Interruption of service	Public services provided by a public monopoly can cut off entire supply because no alternative source of supply is permitted	Strong incentive to settle disputes quickly
Responsiveness to cost control	Status and salaries of public-sector managers are linked to the number of employees and level of expenditures	Private-sector managers' performance is judged by the contribution to the firms' profitability and is thus directly related to level of efficiency

Source: James McMaster, *Urban Financial Management: A Training Manual* (Washington, DC: Economic Development Institute (EDI), World Bank, 1991).

TABLE 2. PRIVATIZATION: IMPACT ANALYSIS

Level of Goal Achievement			
		Privatization options	
Government objectives, goals	Contracting service to firms	Provide grants to NGOs	Issue vouchers to citizens
1. Consumer objectives			
(a) Cost-effectiveness			
Objective			
Criteria: Cost per week			
(b) Quality of service			
(c) Reliability of service			
(d) Ease of payment			
(e) Convenience of service			
(f) Equity of charging system			
2. Government objectives			
(a) Administrative effort, practicality from administrative viewpoint			
(b) Ease of control monitoring, supervision			
(c) Cost of administration			
Impact on industrial relations			
Impact on government employee welfare			
Suitability for cost recovery, user charges			
Political acceptability			

Source: James McMaster, *Urban Financial Management: A Training Manual* (Washington, DC: Economic Development Institute (EDI), World Bank, 1991).

Solid waste collection may be classified as a private good. It also has the character of a collective good. Street sweeping, laying of streets and footpaths, and fire protection are a few examples of collective goods. To some extent and up to a certain time, some of the people who do not pay may actually get such service. This is called the "free-rider" problem in economics. However, for those contributing in cash and in kind to community-hired waste collectors, particularly in the *kampung*, this conceptual hindrance seems nonexistent, as the net social benefit far exceeds this free-rider "cost".

Privatization needs to be combined with other measures, such as combinations of grants and vouchers, zoning, and licensing to achieve cross-subsidization by private firms. Cross-subsidization (or so-called "socialized pricing," as applied to electric billing in the Philippines) may be part of the solution for servicing periurban and rural areas which are too remote or unprofitable for the private sector to service. The private sector could perhaps provide services to these areas with government subsidies or grants if deemed necessary. Whether this would be necessary is a significant research area in metropolises, where much of the daytime population lives in areas which require over an hour's commuting time. This working population lives in privately-developed (such as housing subdivisions) or public housing areas that may not be within the collection routes covered.

Collection Efficiency

Based on a survey of Asian cities undertaken by UNCRD in 1988, and some of the data on Latin American cities,[7] the extent of privatization in these metropolises and the performance of the private sector compared with the public authorities are presented here.[8] The extent of privatization in the six Asian cities surveyed is shown in table 3 by number of collection vehicles in use. These figures do not reflect the total payload capacity.

TABLE 3. COLLECTION VEHICLES IN USE IN SIX ASIAN CITIES

City	Number of vehicles (per cent)		
	Direct management	Private contract	Total
Penang	25 (33.8)	49 (66.2)	74
Greater Bombay	134 (18.0)	610 (82.0)	744
Metro Manila	136 (24.3)	396 (75.7)	532
Kuala Lumpur	336 (87.5)	48 (12.5)	384
Seoul	540 (54.8)	446 (45.2)	986
Nagoya	102 (33.2)	205 (66.8)	307

In terms of collection workers (table 4), there is a sharp difference between Greater Bombay and the three other cities. Except in Greater Bombay, the proportion of workers in the public sector is much greater than in the private sector. The types of vehicles used are not shown here.

TABLE 4. COLLECTION WORKERS IN FOUR ASIAN CITIES

City	Number of collection workers (per cent)				
	Direct management		Private contract		Total
Greater Bombay	1,316	(23.6)	4,249	(76.4)	5,565
Metro Manila	3,000	(84.6)	546	(15.4)	3,536
Kuala Lumpur	1,251	(87.4)	180	(12.6)	1,431
Seoul	5,122	(67.2)	2,502	(32.8)	7,264

Labour efficiency is indicated by the number of people served by each worker (table 5). There is a large discrepancy in the figures for public and private service in Buenos Aires. The possible low values may be due to the level of mechanization in South American cities.

TABLE 5. COMPARATIVE LABOUR EFFICIENCY MEASURES IN SELECTED ASIAN AND LATIN AMERICAN CITIES

City	Labour efficiency (pop/wkr)
Greater Bombay	1,481
Metro Manila	2,132
Kuala Lumpur	1,048
Seoul	650 - 1,360
Santiago	1,400
Buenos Aires	pvt: 900 - 1,300
	pub: 133
Rio de Janeiro	460

In terms of vehicle efficiency, the daily tonnage of waste collected in Bangkok, Seoul, and Kuala Lumpur is shown in table 6. The private sector shows higher vehicle efficiency. Expressed in vehicle efficiency per trip (tons/veh/day), the figures are shown in table 7a. By comparison, some differences can be seen in terms of wkr/veh in table 7b. The public and private sectors do not show much difference in vehicle efficiency in Kuala Lumpur.

TABLE 6. COMPARATIVE VEHICLE EFFICIENCY MEASURES IN SELECTED ASIAN AND LATIN AMERICAN CITIES

City	Vehicle efficiency (tons/veh/day)		
	Public	Private	Trips/day
Bangkok	6.75	7.27	1.8
Seoul	11.08	16.35	3.4
Kuala Lumpur	6.9	7.8	1.5
	General		
Caracas	15.3		
Santiago	11.7		
São Paulo	29.2		2 shifts
Rio de Janeiro	14.0		

TABLE 7a. COMPARATIVE VEHICLE EFFICIENCY OF PUBLIC AND PRIVATE COLLECTION IN THREE ASIAN CITIES

City	Vehicle efficiency (tons/veh/day)	
	Public	Private
Bangkok	3.75	4.27
Seoul	3.26	4.81
Kuala Lumpur	4.60	5.20

TABLE 7b. COMPARATIVE VEHICLE EFFICIENCY OF PUBLIC AND PRIVATE COLLECTION IN VARIOUS CITIES

City	Vehicle efficiency (wkr/veh)	
	Public	Private
Greater Bombay	9.8	7.0
Metro Manila	22.0	1.4
Kuala Lumpur	3.72	3.75
Buenos Aires	0.8 - 1.1	8.4

Such figures may be used to enlighten planners and managers. Data over time and in consonance with changes in collection fleet and labour conditions can effectively improve the assessment of collection efficiency. Operating and maintenance costs can be reduced with appropriate collection vehicles (design and payload capacity or size), appropriate size of crew, more flexible work scheduling, and managerial innovations.

Contracting requires performance standards. The contractor's performance needs to be monitored. One such checklist of performance is by the American Public Works Association (annex 1).

INSTITUTIONAL MEASURES

SWM services may be provided through one or a combination of different arrangements (referred to as "multiple" or "compound" arrangements). A shift in responsibility may be necessary to achieve responsive SWM.

SWM Strategies: Institutional Measures

Shift of responsibility	Shift responsibility to a local autonomous agency, national/regional authority, or national/regional autonomous agency.
Intervention by high-level administration	Provide allocations/subsidies to utility authorities from the budgets of the national autonomous agency or other government agencies, including local government.
	Increase rates (to affect cost-recovery mechanisms).
	Limit tariffs meant only for operation and maintenance (O&M) costs.
	Include debt service expenses to be recovered by tariffs.

Types of Institutional Arrangements

The current institutional arrangements found in SWM are as follows:

- **Municipal service** is provided by a government agency using its own employees. Thus, the same government unit acts as both service arranger and service producer. The government agency can be a municipal department or the metropolitan authority.
- **Municipal public enterprise/corporation** is a body created by the government, charged with SWM tasks, and granted the power to collect tariffs. An example is the *PDK* in Bandung. It is governed by a board which reports to the mayor. The mayor appoints the board of directors.
- An **intergovernmental agreement** operates in such a way that a government agency (or public entity) hires or pays another government agency to provide a service. One is the producer and the other is the service arranger. Service responsibilities go beyond the jurisdiction of the service-producing government unit. One variation is that two or more contiguous municipalities are grouped together to form a "special district," and a "special office" is created to manage the service.

Ichi-bu jimu kumiai[2] is a kind of special office under intergovernmental agreement, as found in Japan. It is a good example of a multijurisdictional government organization. In Japan, such organizations are common where one or more community services are best handled by relevant agencies from contiguous local administrative areas. Not only

garbage disposal, but also homes for the aged, sewage disposal, management of crematories, transportation of infectious patients, fire fighting, and operation of holiday emergency centres are the types of services and facilities operated by the *jimu kumiai* in Japan. Municipal governments intending to form such an organization must seek the approval of the prefectural governor. Thus, it is a regional type of entity operating over a fixed area.

Joint public-private venture by itself has a semigovernmental and semiprivate character. Both local government and private companies participate and share in the capital investment. They enter into a formal agreement to create a separate legal entity to carry out development projects in local communities to ensure financial viability. In Japan, this is called *dai-san sekutaa*, which translates into "third-sector company". It should not be mistaken with the third-sector organization found in countries such as the US, where the term means a private nonprofit or not-for-profit organization. However, it must be pointed out that the same *dai-san sekutaa* may operate as a nonprofit foundation.

One example of a third-sector company in Kitakyushu, Japan, is the Hibikinada Kaihatsu Co., Ltd. It is responsible for the disposal of waste for sea reclamation, and subsequent land development. The reclamation area is within the boundaries of Kitakyushu City. The Fukuoka Prefectural Government and local private companies, together with Kitakyushu City, established this company.

Management contract of purchase of services is done by a government agency, with private firms and/or nonprofit organizations carrying out delivery of goods and services and/or managing publicly-owned assets. The government agency is the service arranger and a private organization is the service provider (e.g., refuse collection, demolition work, solid waste disposal, leaf collection, tree pruning, tree removal, utility billing, and training courses). The service provided by a private firm under contract to a government agency is called a "contract service". The equipment is usually owned by the firm or contractor. The contract may be awarded on the basis of competitive bidding (competitive contract) or on the basis of negotiation (negotiated contract; e.g., when only one bid is submitted or when an existing contract is renewed).

Grants or subsidies may come from the national government or other instrumentality. Taxes can be used to supplement the agency budget so that service can be provided at a discount to eligible households, such as low-income residents.

Community arrangements do not involve the government in any significant way, but the government may set service standards. A group of households in a community hires the services of a private firm to collect their refuse. Thus, it is assumed that "private service" exists in the market.

In some countries, forms of citizen participation or community participation of citizens living in smaller districts (such as the *kampung* in Indonesia, *barangay* in the Philippines, *chonaikai* in Japan, and *ban* in the Republic of Korea), sharing values of community self-help or mutual cooperation (*gotong royong* in Indonesia, and *bayanihan* in the Philippines) may directly deal with managing certain aspects of SWM. Such community arrangements are seen particularly in the storage, discharge-to-collection (mini-transfer stations), and collection points. In some cities in Indonesia, such community arrangements are used by communities to hire street sweepers and waste collectors and to pay for their services independently from the SWM authority. Thus, savings in collection can be realized by the SWM authority.

Voluntary arrangements are provided by a voluntary organization.

Self-service means that households and other waste-generating entities (commercial establishments, industries, and/or institutions) provide their own service.

Franchise is an arrangement under which a private firm is awarded the exclusive right to provide service in a defined area and collects fees directly from service recipients.

Lease is an arrangement under which a private firm leases and operates publicly-owned assets (such as equipment lease).

Private service is provided in open competition by private firms that own and operate their own assets and charge service recipients directly. The service may be regulated by a license and permit system.

Strengthening Local Government

Among the policy issues is how to strengthen the local government, which in many cases is in charge of SWM. The local government may have limited funds to start with, and relies on central government loans. Many attitudes that affect the provision of government services are inherent in the historical background of municipal government. History has shaped the structure, internal organization and process, functions, manner of staffing, and financing. An organizational culture has emerged over the years. This organizational aspect will be dealt with in the next section.

There are tough demands on the local government. Centralized planning and resource allocation do not seem to sufficiently support local government, whereas the local government is closest to the people. Reforms, though, are being undertaken in various forms. These reforms include decentralizing, devolving to local representative and state bodies, delegating to field officials, cooperating with voluntary and community organizations, and involving the private sector.

Financial strength is crucial for local governments to deliver services responsively. A local government must be able to deploy "resources under its own control, rather than having to beg and wheedle them from other agencies".[10] A principle of public finance relevant here is that the burden of paying for services should fall on those who benefit from them, and in proportion to their benefit. Subsidies from general taxation should be provided only when some degree of general benefit, or when consumers cannot afford the full cost of services regarded as essential to human welfare.

Taxation is part and parcel of public finance. It is usually judged in terms of criteria such as equity, efficiency, administrative capacity, and political sensitivity. Buoyancy, the extent to which tax bases expand or contract in response to forces operating on the expenditures they finance, is often neglected. Demands on municipal budgets are inevitable with inflation, increasing urban population, and economic growth (more waste is generated with higher incomes, for instance).

It is not uncommon that environmental infrastructure such as public sewerage and solid waste disposal sites receive low priority in comparison with other municipal projects. User charges (taxes) can be useful in increasing the revenue base. However, the collection of charges is a big administrative task unless other ways are provided, such as what is done in some Surabaya districts with the help of community organizations, and in Bandung by adding the fee to the electric bills. User charges can be tangibly linked with the quality of service. If service improves, citizens may be willing to pay more.

ORGANIZATIONAL MECHANISMS

Problems facing the SWM agency are either internal or external, each influencing the other. Administrative and housekeeping instruments are prerequisites to combat these problems, particularly the internal ones.

SWM Strategies: Organizational Mechanisms	
Training	Effect desired behaviour/bring out required skills
Incentives	Facilitate desired behaviour
Facilitation	Provide resources for organizational development
Reinforcement	Reinforce desired behaviour
Communication	Transmit messages effectively, close gaps
Public information	Reach out to the public through media
Coalition-building	Reduce complexity of operations; mobilize support for proposed actions

The *National Action Plan for Beautiful and Clean Malaysia (ABC)* contains programme components that would enhance the administrative capabilities of local governments. These are training and technical assistance, codes of practice, pilot testing, and a data bank.

Assistance to municipalities in the form of training in the area of refuse collection improvement and sanitary landfill, and technical assistance through the centralized procurement of equipment and parts are the backbone of the plan. Through these activities, expertise is shared and learning is expanded. The conversion of an open dump to a sanitary landfill has served as a good pilot-scale model for the rest of Malaysia. The amounts of solid waste brought to the disposal sites in some municipalities are continually monitored through computerized weighbridge systems. The use of a weighbridge makes for accurate and easy monitoring of contractor performance and accounting of tipping fees.

The importance of training in organizational, institutional, financial, and technical improvement efforts is obvious. Attitudes need to change, especially at the local government level. The Sri Lanka Municipal Project has the components for imparting basic skills, familiarizing councilors and staff with tasks and procedures, introducing new technology, mediating change, preparing professionals for managerial responsibility, and promoting support from central government officials. Indeed, change in local government is needed. Local government level training demonstrates the importance of local government and staff. Diffusing a technology, such as sanitary landfill, requires training for technical staff. Training, using the project casework approach,[11] appears to have worked successfully in Malaysia.

CONCLUSION

Meaningful partnership in SWM is not possible without a certain common understanding of the issues. Thus, the importance of the role of arenas[12] for stakeholders. Workshops, circulars, effective use of information, and communication media can facilitate the institutional and organizational problems. Efficiency indicators would not be possible if data are not conscientiously gathered and analysed.

The merits of privatization have been dealt with here. However, in order to privatize, the following prerequisites are necessary:

- An analysis of the distribution of any cost savings that result from privatization as part of the assessment of macroeconomic impacts; and
- Devising provisions and countermeasures (monitoring and control systems) in order to guard against awarding lucrative government contracts for political favours, bribery, or politicians using privatization to set themselves up, and other forms of corruption.

The free-rider problem was mentioned in the section on privatization, being that some sectors of society get free service. It appears necessary to expand the concept of partnership. In the *kampungs* of Indonesia, with the people contributing in cash and in kind to community-hired waste collectors, this conceptual hindrance becomes nonexistent. The net social benefit far exceeds the free-rider problem.

In further pursuit of this subject, social equity may be recalled. Again, because management is done in communities, particularly in low-income settlements, equity is no longer the issue. Willingness to pay by community residents must be recognized, but not without proper knowledge of their ability to pay and, more important, their value judgments pertaining to solid waste service. This is an area where social methods of research merge with economic concerns.

Opportunities for new businesses to emerge besides traditional junk dealers must be recognized. For a true partnership, authorities must be sensitive to the strengths and weaknesses of old and new arrangements so that proactive strategies can be formulated and implemented.

NOTES

1/ Antonio L. Fernandez, "Integrated Solid Waste Management for Asian Cities: A Strategic Planning Perspective" (Paper presented at the International Expert Group Seminar on Policy Responses towards Improving Solid Waste Management in Asian Metropolises, Bandung, 4-8 February 1991).

2/ Quoted from Sherry R. Arnstein, "A Ladder of Citizen Participation," *Journal of the American Institute of Planners* 35 (July 1969):216-44, reprinted in Frank S. So *et al.*, eds., *The Practice of Local Government Planning* (Washington, DC: Published by the International City Management Association in cooperation with the American Planning Association (APA), 1979), p. 559.

3/ Carl V. Patton and David S. Sawicki, *Basic Methods of Policy Planning and Analysis* (Englewood Cliffs, NJ: Prentice-Hall, 1986).

4/ Sandra J. Cointreau, *Environmental Management of Urban Solid Wastes in Developing Countries* (Washington, DC: World Bank, 1982).

5/ James McMaster, *Urban Financial Management: A Training Manual* (Washington, DC: Economic Development Institute (EDI), World Bank, 1991).

6/ *Ibid.*

7/ C. R. Bartone, "Investing in Environmental Improvements through MSWM" (Paper presented at the Regional Workshop on National Solid Waste Action Planning, World Health Organization/Regional Center for the Promotion of Environmental Planning and Applied Science (WHO/PEPAS), in 1993 renamed the Environmental Health Centre (EHC), Kuala Lumpur, 26 February-2 March 1990).

8/ Data for Asian cities are mostly for 1987, while those for South American cities are for 1989.

9/ Kiyoharu Kuribayashi and Hiroshi Mizoguchi translate *ichi-bu jimu kumiai* to mean "work union". See their "Trends in Diversification of SWM Practice in Kitakyushu" (Paper presented at the International

Expert Group Seminar on Policy Responses towards Improving Solid Waste Management in Asian Metropolises, Bandung, 4-8 February 1991).

10/ Kenneth Davey, "Strengthening Municipal Government" (Discussion paper; Infrastructure and Urban Development) (Washington, DC: World Bank, 1989).

11/ Guenter Tharun, "Approaches to Manpower Development in the Field of Solid Waste Management in Asian Metropolises," *Regional Development Dialogue* 10 (Autumn 1989):90-109.

12/ John M. Bryson and Barbara C. Crosby, "The Design and Use of Strategic Planning Arenas," *Planning Outlook* 32 (1:1989):5-13; Christine Furedy and M. S. Shivakumar, "Reforming Solid Waste Management Perspectives of Concerned Citizens" (Paper presented at the International Seminar on Solid Waste Management and Resource Mobilization, Kathmandu, 28 October-4 November 1990).

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Flintoff, Frank, *Management of Solid Wastes in Developing Countries* (WHO Regional Publications; South East Asia Series; no. 1) (New Delhi: WHO, 1984).

Roth, Gabriel, *The Private Provision of Public Services in Developing Countries* (New York: Published for the World Bank by Oxford University Press, 1987).

United Nations Centre for Human Settlements (UNCHS) (Habitat), *Refuse Collection Vehicles for Developing Countries* (Nairobi, 1988).

Annex 1. American Public Works Association: Checklist of Performance Specifications for SWM Contracts

1. Definition of terms used in specifications and contract;
2. Classes and kinds of refuse to be collected;
3. Separation into classes and the number of separate collections;
4. Hours of collection (for different districts);
5. Frequency of collection (for different districts and various classes of refuse);
6. Holidays on which collection is not mandatory;
7. City to enforce the use of proper containers;
8. Contractor to report on violations of sanitary laws by citizens;
9. Kinds of properties to be served;
10. Area to be served (defined completely);
11. Contractor to establish routes; furnish maps of routes to city and keep them up-to-date;
12. Provision for extending service to new properties;
13. Location of containers for collection; replacing containers;
14. Kind of vehicles to be used (bodies enclosed, watertight, maximum allowable capacity);
15. Contractor to furnish adequate amount of equipment;
16. Loads to be covered;
17. Equipment to be maintained in good condition, painted uniformly;
18. Equipment to be numbered and labeled as specified;
19. Method and frequency of cleaning the vehicles;
20. Equipment not to be overloaded;
21. Scattered refuse to be collected (broom and shovel on each truck);
22. Direction and supervision of work must be satisfactory to city;
23. Office with telephone to be provided for receiving complaints;
24. Agent for contractor to be designated for receiving notices and orders;
25. City may appoint inspectors who are to have access to contractor's equipment and property;
26. Employees of contractor to meet local citizenship requirements;
27. Minimum wage rates for various kinds of workers;
28. Employees to wear numbered badges;
29. Complaints to be answered courteously and promptly;
30. Collectors not to trespass unduly on private property;
31. Collectors to follow pedestrian walks, not cross from one property to another;
32. Vehicles not to interfere unduly with traffic;
33. Certain kinds of streets not to be used for hauling to disposal sites;
34. Loaded vehicles not to be left standing on streets;
35. Collectors' vehicles shall be parked in suitable off-street parking areas overnight;
36. Collection to be quiet, not to create a nuisance;
37. Service not to be interrupted because of closed streets;
38. Refuse to become property of contractor (or to be delivered to specific locations);
39. Description of disposal methods to be used (including location, operation, and control of disposal sites);

40. Care of disposal sites or plants;
41. Disposal methods and locations may be changed;
42. Contractor to furnish city reports of operations and complaints;
43. City to control contractor's operations outside city in traveling to disposal sites or operating disposal plants;
44. Basis of payment for contract work;
45. Payments to contractor;
46. Approximate amount of refuse; guaranteed minimum;
47. City to prohibit collection by scavengers or private collectors (this should be modified in many developing countries);
48. Contractor to abide by all state, county, and local laws and regulations;
49. City to be free of any liability;
50. Contractor to carry liability and compensation insurance;
51. Bond to be furnished; equipment and facilities pledged as part of bond;
52. Contractor not to assign contract or dispose of property without permission of city;
53. Duration of contract;
54. Termination of contract on six months' notice;
55. In case of breach of contract, hearing to be held before council of city officials;
56. City may conduct operations with contractor's equipment in case of failure by contractor or bondsmen;
57. Right to reject all bids;
58. Sum to accompany bid;
59. Liquidated damages specified for various violations of specifications, such as:
    (a) Failure to clean up spillage
    (b) Overloading vehicle
    (c) Failure to answer complaints
    (d) Using improper vehicles
    (e) Failure to clean vehicles
    (f) Failure to keep vehicles closed
    (g) Loaded vehicles left standing on streets
    (h) Unabated nuisance at disposal sites
    (i) Failure to park vehicles overnight in off-street facility
60. Penalties

Source: Roland Schertenleib and Thelma Triche, "Non-Governmental Delivery of Urban Solid Waste Services" (Draft discussion paper) (Washington, DC: Water and Sanitation Division, World Bank, 1989).

COMMENT

BINDU N. LOHANI

Effective delivery of public services, such as solid waste management (SWM), must be considered as a joint effort of the beneficiary and the provider, otherwise efficiency will be very low. The joint effort, as Antonio L. Fernandez points out, is really a partnership, as both sectors have common objectives, motives, and activities. The partnership is more important in developing countries where financial and technical resources are limited. A partnership approach to SWM also encourages mutual understanding of the problem, which makes application of innovative solutions easier to implement.

As we start to appreciate the government's limitations on SWM technologies and budgetary constraints, the need for innovative solutions — such as recycling, reuse, and recovery — to reduce the volume of solid waste, becomes increasingly important. To reduce the volume of solid waste through recycling and reuse, the programme must be centred at the generation site — normally people's homes — which is beyond the government's control. Partnerships become a crucial component for success. While it takes time for trust and mutual understanding to develop into a real working partnership, social and institutional scientists have provided some guidelines. The case examples presented by Fernandez illustrate the growth and development of working partnerships in the Asian region using those concepts and principles to solve the SWM problems. While the case examples and principles may require modifications to suit the local culture, the basic principles of stimulating partnerships between the government and various sectors are the same.

Application of the basic principles to stimulate working partnerships may be part of the natural evolution of a city's institutions whereby the participants are mechanically carrying out their role, or it could be part of a well-designed public campaign with built-in evaluation factors. The case examples presented by Fernandez, could also clarify how the concepts and principles evolved for encouraging partnerships between the private and public sectors. Fernandez does not discuss how the findings of the original case studies could be utilized in other metropolitan centres, using the partnership principles he describes. Nevertheless, his article is important and timely in identifying the need for working partnerships to solve current SWM problems in Asian metropolises.

IMPERATIVES FOR RECYCLING AND RESOURCE RECOVERY

E. A. R. OUANO

RECYCLING POTENTIAL AND BENEFITS

Domestic solid waste is the lowest form of waste in terms of its potential for recycling and resource recovery due to the wide range of impurities and the variation in composition and quantity. The various components of the domestic solid waste generated in four Asian metropolises is shown in table 1. Apart from ferrous metals and glass constituents, manual separation is often used to segregate the various components of domestic solid waste. Industrial solid waste has a more uniform composition and predictable generation rates depending on the production cycle. Nevertheless, a casual examination of the solid waste composition in table 1 shows that almost all components of solid waste have potential for resource recovery and recycling.[1/] Putrescible materials and mixed paper can be composted and used as soil conditioner. Good quality paper which is too good to be composted can be repulped and reused. Metals can be sorted and melted for reuse. Metals which are rusted and contain impurities which could affect the metallurgical properties of the recovered materials, such as tin in steel, can be used in mines to leach precious metals and important minerals from low grade ores. Broken pieces of glass can be used as cullet to start the glass formation process from basic chemicals such as silica and soda ash in the manufacture of glass and later on as part of the raw materials. Large glass bottles can be cleaned and reused or they can be remelted and recycled as new bottles. Plastic materials can be remelted and turned into sandals, sewer pipes, chairs, and various other plastic products depending on the quality and type of the recycled plastic materials. Coarse and inert materials can be used as fill for depressed and flooded areas. When considering the potential use of each solid waste component, one may raise the question as to why solid waste disposal is a major environmental problem in urban centres throughout the world. The gravity of the problem can vary from uncollected solid waste lying in streets and floating in canals and water bodies in most cities of the developing countries to the lack of space for disposal facilities in the developed countries.

Table 2 compares the various wastes generated, the energy consumed, and the raw materials required to produce a ton of steel, paper, and glass from raw materials and the materials used to produce the same quantity of these products using materials recovered from domestic solid waste. The products shown in table 2 are major intermediate products in the manufacture of a wide range of consumer items. Ultimately, they end up in solid waste piles and hence have a high potential for recycling and resource recovery. The use

TABLE 1. TYPICAL COMPOSITION OF SOLID WASTE IN ASIAN METROPOLISES

	Bombay	Bangkok	Kuala Lumpur	Tokyo
Paper	10.00	13.90	11.70	42.00
Glass	0.20	2.00	2.50	1.20
Metal	0.20	1.80	6.40	1.20
Plastics	2.00	11.00	7.00	8.50
Textiles	3.60	6.90	1.30	3.80
Wood/Grass	20.00	14.90	6.50	4.70
Food Waste	20.00	36.50	63.70	32.90
Ash/Soil	38.00	12.60	0.90	0.10
Others	6.00	0.40	0.00	5.60
Total	100.00	100.00	100.00	100.00

Source: UNCRD, "City Profiles: Compendium of Facts and Figures on Solid Waste Management in Asian Metropolises" (1989).

of recovered materials not only reduces the solid waste disposal problem but it also reduces the cost of pollution control in the manufacturing sector, energy consumption, and exploitation of natural resources. From table 2, it is evident that resource recovery and recycling have a very positive impact on the environment and conserve energy and raw materials for future use. Again, one may raise the question why solid waste collection and disposal is a major problem, if the utilization of recovered and recycled materials from solid waste reduces the negative environmental impact during manufacturing when compared to the use of raw materials. If the use of recycled and recovered materials requires less energy and natural resources, and generates less pollutants requiring less expensive treatment processes, then products made of recovered and recycled materials should be cheaper than the same product using raw materials. However, a cursory inspection of market prices will show that products made from recycled and recovered materials are often more expensive than those from raw materials, not to mention the aesthetic qualities, which are inferior to those of the same product made from raw materials.

Environmental protection and energy and nature conservation constitute new dimensions of political and economic decision making. Throughout the history of human organizations and processes of decision making, the national interest has been the principal consideration in political decisions. Otherwise useless material can be made valuable through subsidies, taxes, tariffs, production control and quotas, as well as financial and social incentives.

The response from competing political organizations will be to enforce similar measures to protect their own interests. Initially, the political leadership will have to enforce its will for the members to accept the measures which distort the evaluation of resources and products, but after some time the measures become part of the culture so that to reverse the process would result in serious political and social upheaval. However, in most instances the political and social problems resulting from the reversal of traditional measures are often less than anticipated. Therefore, political commitments and sociocultural changes play a vital role in recycling and resource recovery.

TABLE 2. ENVIRONMENTAL IMPACT OF THE PRODUCTION OF 1,000 TONS OF STEEL, GLASS CONTAINERS, AND LOW-GRADE PAPER

A. Steel

Environmental Impact	Use of brand-new material	Use of 100% waste	Change rate due to recycling (%)*
Brand-new material consumption	2,278 tons	250 tons	-90
Water consumption	16.6 x 10^6 gal	9.9 x 10^6 gal	-40
Energy consumption	23,347 x 10^6 Btu	6,089 x 10^6 Btu	-74
Air pollutant	121 tons	17 tons	-86
Water pollutant generation	67.5 tons	16.5 tons	-76
General waste generation	967 tons	-60 tons	-105
Mining waste generation	2,828 tons	63 tons	-97

Source: Midwest Research Institute, "Economic Studies in Support of Policy Formation on Resource Recovery" (Unpublished report to the Advisory Committee on Environment)(1972).

Notes: * Each negative numeral indicates quantitative decrease achieved by recyclying in the item concerned.

B. Glass Containers

Environmental Impact	15% of cullet used	60% of cullet used	Change rate (%)*
Mining waste generation	104 tons	22 tons	-79
Air pollutant generation	13.9 tons	13 tons	-6**
(for all generation sources)		10.9 tons	-22****
Water consumption (intake - discharge)	200,000 gal	100,000 gal	-50
Energy consumption	16,150 x 10^6 Btu	16,750 x 10^6 Btu	3**
		15,175 x 10^9 Btu	-6***
Brand-new material consumption	1,100 tons	500 tons	-54
General waste required to be disposed	1,000 tons	450 tons	-55****

Source: Midwest Research Institute, "Economic Studies in Support of Policy Formation on Resource Recovery" (Unpublished report to the Advisory Committee on Environment)(1972).

Notes: * Each negative numeral indicates quantitative decrease achieved by recyclying in the item concerned.

** Calculation was made on the Black-Clawson wet recovery system for recovering cullet from urban refuse.

*** Calculation was made on the incineration residue recovery system of the Mining Bureau for recovering cullet from urban refuse.

**** Mainly based on the surveys made in 1967 and 1969.

TABLE 2 (Continued)

C. Low-Grade Paper

Environmental Impact	Unbleached kraft pulp (brand new)	100% of waste paper pulp	Change rate due to recycling (%)*
Brand-new material consumption (oven dried fibres)	1,000 tons	0	-100
Process water consumption	24 x 10^6 gal	10 x 10^6 gal	-61
Energy consumption	17 x 10^9 Btu	5 x 10^9 Btu	-70
Air pollutant generation (transport, manufacture, timber-felling)**	42 tons	11 tons	-73
Water pollutant generation, BOD**	15 tons	-9 tons	-44
Water pollutant generation, SS**	8 tons	6 tons	-25
Solid waste generated in process	68 tons	42 tons	-39
General waste required to be finally disposed	850 tons***	-250 tons****	-129

Source: Midwest Research Institute, "Economic Studies in Support of Policy Formation on Resource Recovery" (Unpublished report to the Advisory Committee on Environment) (1972).

Note: * *Each negative numeral indicates quantitative decrease achieved by recycling in the item concerned.*

** Mainly based on the surveys made from 1968 to 1970.

*** 15 per cent fibre loss in the production of paper and paper products was assumed.

**** It was assumed that 1,100 tons of waste paper was required to produce 1,000 tons of pulp. Therefore, 850 t - 1,100 t = -250 t expresses the quantity of general waste.

Source: Ueta, "A Socioeconomic Evaluation of Municipal Waste Recycling Schemes" (Paper submitted to the International Expert Seminar on Solid Waste Management held in Bandung, 4-8 February 1991).

RAW MATERIALS PRICING

Historically, the extraction and production of raw materials have been relegated to a stratum in society where the cost of labour is minimal. Mines and plantations were mostly manned by slaves and serfs until the last century. When slavery was abolished, indentured labour was substituted. Today, most of the production of raw materials is carried out in the developing countries where labour costs are low. On rare occasions where production is still being carried out in the developed countries, the industry is made viable only through extensive government subsidies and the availability of cheap energy sources. On the other hand, the consumption of finished materials takes place mostly in the developed countries and urban centres of the developing countries where labour costs are much higher. In the past, the major items considered in pricing raw materials were the costs of labour, storage, and transport. The values of raw materials were traditionally insignificant compared to the values of the final products. The value of the iron ore and coal as mined is less than 30 per cent of the value of steel and less than 1 per cent of the value of an automobile although 80 per cent of the weight of the vehicle is made up of steel components.

Today, the market mechanism is primarily responsible for fixing the prices of raw materials. With the improvement in farming and mining techniques, the opening up of forests, grasslands, and marginal land to human settlements, the availability of chemicals to control insects and improve productivity, and the almost unlimited supply of unskilled labour in the developing countries, the supply of raw materials has increased faster in relation to the demand. As a result, the prices of raw materials have decreased further in relation to the price of the final products. The prices of copper, iron, and gold are all expected to continue their decline over the next seven years. Gold, which has marginal utility in industry and which is consumed primarily for jewelry or kept in bank vaults, will have a minimum price decline compared to industrial metals. Except during unusual events such as wars and natural calamities in major producing countries, the price of raw materials has shown a downward trend in relation to the real value of major currencies such as the US dollar or the British pound. With a projected annual inflation rate of 2 per cent in the developed countries, the aforementioned metal prices will decline by 5 per cent to 8 per cent in real value. Governments in the developing countries often have to subsidize or provide price support or other incentives for the production of raw materials to maintain employment for the large segment of the labour force involved in the production of raw materials.

While major producers try to organize cartels and regulate the prices of their products, or negotiate a pricing mechanism with the consumers, the success of those organizations has been limited. Raw material production is a major, and often the only, reliable source of foreign exchange for many developing countries. The demand for foreign exchange to repay foreign debts and to import consumer goods, armaments, and food forces the producers of raw materials to produce more than their quota or more than the expected demand of the users. This results in the failure of cartels, producers' and consumers' organizations, and the collapse of the market prices of raw materials. Due to oversupply and prices below production costs, a considerable proportion of the raw materials in the market is really solid waste. Faced with a collapsing market, the raw material producer's ultimate option is to dispose of this excess as solid waste. For this reason, farmers kill and bury their sheep and cattle instead of bringing them to the market, or plough in their peanut crops rather than harvest them for sale. Coal, copper, and tin mines are closed or abandoned even if ores still exist in commercially viable quantities for exploitation.

As mentioned earlier, the excess supply of raw materials is made possible through the use of chemicals such as fertilizers, insecticides, and hormones, the opening up of forests, grasslands, and marginal land to human settlements, extensive utilization of farming and mining machinery, and the availability of cheap energy sources. All these activities have a negative impact on the environment which is not accurately accounted for in the pricing of raw materials. The cost of environmental protection is often limited to rehabilitation of mine sites, and waste treatment facilities in mines and farms. The loss of forestlands, wetlands, species diversity, and other components of the ecosystem displaced by the raw material production activity is seldom accounted for. The environment then absorbs the disposal of the excess raw materials which creates further strain on it.

Since most consumption takes place in the developed countries and urban centres of the developing countries where labour costs are higher compared to labour costs in the areas producing the raw materials, the cost of maintaining consumer products is often

higher than the cost of raw materials themselves. This has resulted in the development of disposable products. Technological development places a low value on the raw material content of existing products being used by consumers. Old but still useful products are accepted for trade-in to stimulate sales of new products. Traded-in goods are often disposed of as solid waste since the value of the materials in the products is very low compared to the cost of recovering them from obsolete products. The high labour cost at the point of consumption makes the cost of collection and disposal higher than the value of raw materials contained in the discarded products. As a result, the solid waste generation rate in the developed countries and urban centres of the developing countries is increasing every year with a corresponding increase in the cost of disposal due to shortages of appropriate sites for sanitary landfills and incinerators. Solid waste has to be transported greater distances thus increasing the transport cost component of solid waste management (SWM). Higher awareness of the negative environmental impacts of incinerators and sanitary landfill has also increased the cost of operating the disposal facilities. Policymakers are giving priority to the development of options for reducing the solid waste generation rates over that of new technologies for collecting and disposing the ever-increasing quantities of solid waste generated. Awareness of environmental conservation and the increasing costs of collecting and disposing of the solid waste rather than the financial incentives from recovered raw materials are the major stimuli for resource recovery and recycling not only in the developed countries but also in urban centres of the developing countries.

RAW MATERIALS SPECIFICATIONS

Industrial processes are normally operated in a virtually "steady state" condition in order to maintain product uniformity and guarantee a specific quality and performance to the users. Products made during the start-up operations are normally discarded as their qualities are often out of the range of the buyers' specifications. As automation in industry increases, the buyers' specifications of raw materials and semifinished products become more rigid and precise. Formerly, in the early stages of industrialization, if a factory received materials which did not exactly meet its requirements, the materials were sent to a workshop for grinding, polishing, or alterations. Today, industrial robots and sensors merely reject the materials and products which do not meet the specifications. With high labour costs and more complicated product lines it is more economical for industry to discard materials and products which do not meet the specifications than rework them. A factory which manufactures products of variable quality can expect to lose its clientele or waste a large portion of its output. In a highly competitive environment, industries with uncertain product quality will invariably go bankrupt.

To maintain consistent industrial operations, the raw material input must be of uniform quality and quality variation, if any, must be limited within a narrow range which will allow the instrumentation to automatically adjust the operating conditions of the equipment without jeopardizing the product quality. The wider the variations in raw material quality, the longer it will take for the process to attain a "steady state" and therefore the higher the probability of product wastage. Hence, industries require suppliers to maintain the quality

of raw materials within specified limits and in sufficient quantities.

Since the cost of raw materials is small in comparison to the price of the final product, the industrial user prefers to pay higher prices for raw materials with uniform quality and sufficient quantity rather than incurring a higher rejection rate for the finished product due to uneven raw material supply and characteristics. When all costs are considered, the industry with a lower finished product rejection rate will be able to sell its products at a lower price using expensive raw materials than an industry using cheaper raw materials with uneven quality and quantity. Lastly, industries will have to consider customers' perceptions of product quality and reliability. Customers' perceptions are not very critical in trading between industries where product quality is determined by laboratory testing. Customers' perceptions are the most important factors in determining whether or not to manufacture a product and how to present it to consumers. For this reason, the packaging, advertising, and public relations costs of some consumer items may exceed the raw material costs and in some instances even the production costs.

Industries often operate off-cycle due to consumers' demand especially those producing seasonal products. Summer clothes are manufactured in winter while winter clothes are made during the summer months. It is uneconomical for an industry to maintain a large inventory of raw materials especially if consumer demand and tastes are subject to seasonal change. To purchase the raw materials in advance, the industry will incur the costs of storage, insurance, interest on capital use, and unutilized materials. An industry will pay a premium price for raw materials which are available at short notice to synchronize with its production cycles.

To summarize, the three major criteria for industries to select a reliable raw materials source are: (a) uniformity in quality; (b) sufficient quantity; and (c) availability when needed.

CHARACTERISTICS OF RECOVERED MATERIALS

While glass accounts for 0.2 to 2.6 per cent of the solid waste in a typical Asian metropolis (see table 1), the waste falling in this category has various characteristics. A closer look at the solid waste stream into figure 1 shows that there are more than four different colours of glass produced and when taking one particular colour, for example amber, there are more than ten different shades and variations of amber-coloured glass. In terms of textures, some glass, such as that used for soft-drink bottles, is rough with bubbles and distinguishable particles of unmelted silica while those used for perfumes are finely textured. When the permutations due to the colours, as well as variations in shading and finished quality are considered, there could be more than 100 different types of glass. In addition to these characteristics, some glass contains antagonistic impurities such as tungsten in incandescent glass, mercury in fluorescent tubes, acetate lamination in safety glass, refractory coatings on window glass, and so forth. Antagonistic impurities are materials mixed with the solid waste which will destroy or lower the quality of the recovered materials through the introduction of poisons, colouring, or through adverse chemical reaction. When treated individually, the materials will have some value but when mixed together, the mixture has negative characteristics which make the recycling of the materials inadvisable. For

example, tungsten metal has a recyclable value similar to that of glass. The same is true for plastic materials, metals, textiles, and paper. Some plastic materials are made up of polyvinyl chloride (PVC), or polyethylene, or polybutylene resins, while some plastic waste has special chemical additives to alter its characteristics to suit previous uses. Polyethylene resins may undergo further polymerization to make high density polyethylene resins. Lime and calcium carbonates are added to PVC pipes. Metals can include various types of alloys. Some paper is made of short fibres, some is coated with plastic materials, while various types of inks are used on the discarded paper. Strict control over the quality of recovered materials is difficult to carry out due to wide variations in characteristics such as colouration, additives, textures, and sizes.

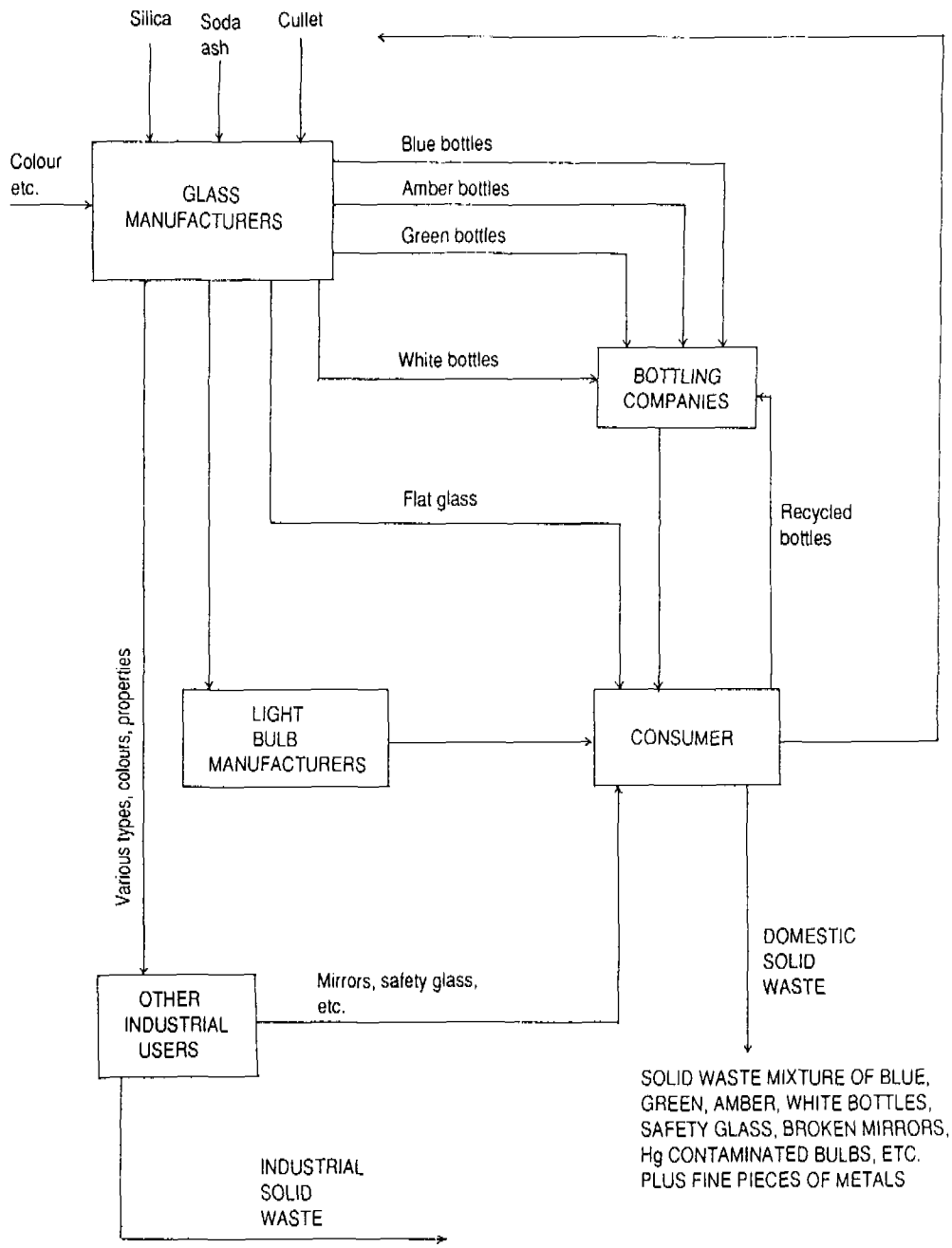
In addition, various impurities may adhere to, or be absorbed by, the recycled materials which are then difficult to segregate. Fish scales may adhere to the paper while juice and foul odours may be absorbed. Coal ash may also adhere to glass. Putrescible materials, dust, and paper may become entangled with plastic materials, while metals may undergo various degrees of corrosion or oxidation.

The quantity of recyclable materials varies greatly from one area to another. Upper-income residential areas generally have higher percentages of metals and glass while low-income residential areas have a high proportion of inert and vegetable wastes. Commercial areas have high percentages of paper and plastic wastes as compared to residential areas. The quantity of recyclable materials in solid waste also varies according to the season. During holidays, paper, glass, and metals may be higher than at other times. For this reason, the sorting of recyclable materials from solid waste often has to be carried out manually as equipment to detect the wide range of characteristics of recyclable materials is very expensive and usually inefficient.

Due to the difficulty in segregating the impurities and classifying the recycled materials to a specific standard, the use of recycled materials is limited to specific applications which can tolerate a wide variation in input material quality although this often results in low-quality products. Due to limited use of recycled materials in most countries with efficient recycling and resource recovery programmes, there is a glut of unutilized materials such as waste paper and plastics. For this reason, current legislative trends are aimed at standardization and increasing the utilization of recovered materials. This holds true for plastics, glass, and rubber products. Today, there is a glut of recovered paper, especially newsprint, in Europe which cannot be recycled.

To maximize the utilization of recovered materials from solid waste it is important that antagonistic impurities are minimized. When segregated, waste may have some use, but when mixed the resulting mixture will have no use due to the poor quality of the mixture. Introduction of antagonistic impurities takes place during manufacture as in the case of tungsten in incandescent lamps and inks on paper, but most of the antagonistic impurities are introduced in the garbage collection bin when all the waste materials become mixed. Further mixing of antagonistic waste takes place during collection. When solid waste is dumped at the disposal sites, further mixing takes place, resulting in formation of a mixture which has antagonistic properties. The energy and effort required for segregating antagonistic substances in a centralized resource recovery plant are higher than when segregation is carried out at source due to a wider range of potential antagonistic substances interacting with each other at the central facility.

Figure 1. Simplified Flowchart of Glass Products



For recovered materials to be classified as useful resources, they require pretreatment to upgrade the quality. Pretreatment and quality control take place at various stages of production, utilization, waste generation, and disposal. Pretreatment and quality control at the production site are enforced through a range of legislation which governs the size standardization to reduce the variety of waste generated and specification of recovered material. In the absence of legislation, strong public opinion will force producers to use recyclable materials and reduce the addition of antagonistic materials in their products. For example, the demand for recycled paper products has reduced the production of laminated and coated paper products for packaging. Segregation of recyclable waste at the point of consumption is the most important part of a solid waste recycling and resource recovery programme since most of the formation of antagonistic mixtures takes place during this process. Public participation, educational campaigns, and information drives are important activities to induce the waste generators to segregate the reusable materials and reduce the mixing of materials with antagonistic properties. The main difficulty of segregation and sorting at the waste generation site is the wide variety of types of solid waste generated. The waste generator will have to maintain a large number of containers for numerous waste categories such as different types of paper or different colours of glass. Ultimately, the solid waste generator will find that he has no space in his home for other activities. For this reason, it is important to institute the proper legislation to simplify the waste collection process in order to encourage public participation. Public participation must also be supported by an effective infrastructure to collect the recovered materials on a regular basis. Otherwise, the solid waste generator will have little motivation to recover recyclable material in the first place.

Pretreatment could take place at transfer stations and disposal sites. Ferrous materials are segregated by magnetic separators while glass particles and rocks are segregated by centrifugal separators. Centrifugal separators segregate materials of similar sizes due to differences in their density. Centrifugal separators are more effective in separating small-sized particles. Bottles, paper, rubber, plastic, and other large-scale recyclable materials are segregated manually. When recoverable materials are intermingled with other waste which has antagonistic properties, they are often discarded.

As discussed earlier, the demands for some consumer products are seasonal in nature. The production of these goods may start four to five months in advance. On the other hand, the products may be retained by the consumer for a period as short as a few minutes as in the case of a soft-drink bottle or for as long as twenty years in the case of a fur coat. Hence, the availability of the recovered materials does not match the raw material demand of the producers unless extensive warehousing is available. Even in cases where the availability of the recovered materials matches the production demand or there is a glut in the supply, the users always feel insecure as to the reliability of recovered materials supply as the long-term reserves cannot easily be quantified or guaranteed. Unlike the supply of raw materials where the supplier may show proof of twenty-years of reserves, for recovered materials the reserve is with the consumers themselves who cannot be forced to supply the materials on demand.

One of the major difficulties in resource recovery programmes is for industries to market the recovered materials. The recovered materials may meet the most rigid international specifications but the buyers will require assurances of the product quality.

If the quantity of resources recovered is small, the cost of quality assurance documentation will be substantial — a fact which is often overlooked in the initial project evaluation. Even in cases where the industry could afford to subsidize the quality assurance documentation, marketing small quantities of recovered materials will still be difficult. For example, a company in the Philippines recovered tin from the waste sludge generated by electronic companies which amounted to half-a-ton per month of good quality tin. The cost of recovering the tin was only 50 per cent of the prevailing world market price for tin but marketing 500 kg/month of tin was difficult and after two years in operation the company went bankrupt with an inventory of almost 10 tons of tin.

PRICING OF RECOVERED MATERIALS

Traditionally, the cost of collection and disposal of solid waste was a minor part of municipal expenditure. A large portion of the solid waste generated was burned or buried in backyards and gardens. The cost of solid waste collection and disposal was absorbed by various taxes collected by the municipalities and it has only been in recent years that specific solid waste collection and disposal taxes have been imposed to cover the budgetary deficiencies caused by drastic increases in solid waste generation, higher levels of services, awareness of air pollution problems created by backyard burning, and higher labour and disposal costs. While SWM may be the largest recurring expenditure in the municipal budget, little attempt has been made to recover the cost of SWM as part of the product cost to discourage the use of bulky packaging materials and the production of consumer goods with only marginal utility. Although the producers and solid waste generators pay for SWM through various taxes levied by the government, the cost is not directly imputed to a particular product which is the source of antagonistic or nonrecyclable wastes. On the contrary, consumers may be attracted to a particular product due to its uniqueness in comparison to competing brands. The uniqueness of a product often results in a wider variation of waste and hence a reduction in the use of recyclable materials as discussed earlier.

However, resource recovery and recycling have been recognized as part of the SWM system. The cost of a separate collection for the recyclable materials, and the capital, operating, and maintenance costs of the magnetic and centrifugal separators, compost plants, and heat recovery systems in incinerators are charged to the SWM system. The government may subsidize the resource recovery and recycling component of the SWM system, but for purposes of project evaluation the resource recovery and recycling programme normally absorbs these costs which partially include the costs of solid waste collection and disposal. The cost of recovering even an expensive metal like platinum from waste catalysts cannot compete with the price of the raw metal due to various subsidies enjoyed by the mining and metal-processing sector while the resource recovery process has to absorb the costs of collection of used catalysts, segregation and disposal of residues, as well as the purification of the recovered metal.

As a result of price distortion, products made from recovered materials are more expensive than products made from raw materials. As discussed earlier, the price distortion in favour of the production of raw materials has been ingrained in the

socioeconomic system. To reverse the process in favour of resource recovery would be politically difficult. Even if a country had sufficient political will to initiate such a move, it would have to contend with the policies of its competitors in the world market. The country's exports would be more expensive than its competitor's while at the same time they would be tinged with impurities, as a result of inferior production processes and therefore less likely to succeed commercially. However, in recent years, environmental awareness has created a worldwide shift in consumers' attitudes towards recycled materials which, in future, will hopefully shift the price distortion in favour of recycled products. The initial market response may be to aggravate the price distortion as a glut in raw materials will result in lower costs of products made from raw materials in comparison to the price of the same products made from recycled materials. However, the drop in prices of products made from raw materials will be compensated for by an equivalent reduction in prices of products made from recovered materials due to economies of scale and a higher production efficiency induced by the higher demand. The current preference for paper made from recycled materials is an example of a worldwide shift in consumers' preference for recycled materials over raw materials due to an increasing environmental awareness of the importance of using recovered materials to reduce environmental pollution and the disruption of natural ecosystems in the extraction and production of raw materials. Consumers worldwide are paying a higher price for paper made from recovered materials than those made from timber. The price difference between paper made from recovered materials and paper made from timber is decreasing and if this price trend continues, by the start of the next century the pricing structure will be reversed.

COMPARISON BETWEEN RAW AND RECOVERED MATERIALS

In order to appreciate the importance of resource recovery and recycling, it is necessary to provide a comparison in terms of the characteristics, pricing, and environmental impacts, between recovered materials and raw materials. The comparison sketched out below generally holds true for a wide range of recovered and raw materials.

Environmental Effects

The use of recycled materials generates less air, water, and solid waste pollutants than the use of raw materials. It also requires less energy and hence generates less thermal pollution. The requirements for chemicals, water, and other natural resources to produce similar products from recovered materials are lower than those using raw materials.

Pricing

Products using raw materials are generally cheaper than those using recovered materials. The higher cost of products using recovered materials is due to cheap energy pricing, inequitable labour rates at both the production and consumption sites, subsidies and other incentives given to the production of raw materials, diseconomies of scale owing to low consumer demands for products using recovered materials, and improper pricing policies which do not reflect the costs of environmental protection, natural resources consumed in the production of raw materials, and the collection and disposal of the discarded product

using raw materials. On the other hand, materials recovery and recycling often absorb part of the cost of collection and disposal of solid wastes.

Quality

Recovered materials generally have a higher quality than the source of raw materials due to previous processing. However, the impurities in solid waste are diverse and subject to such considerable variations that when recyclable materials are mixed in the solid waste, segregation is more difficult than extraction of the raw materials. The quality of recovered materials from mixed solid waste is generally low due to incomplete segregation of antagonistic substances.

Quantity

The quantity of useful materials in solid waste is high but, due to the difficulty of segregating materials with antagonistic properties, large quantities of useful materials cannot be recovered. At present there is a global oversupply of many raw materials due to the various incentives and subsidies given to primary production industries as well as a general improvement in materials-processing and extraction technology, agriculture, and forestry.

Reliability of Supply

The supply of raw materials is highly reliable with the improvement in global transport systems, warehousing and preservation technology, mineral exploration techniques, and weather forecasting. However, social and natural disasters in major producing areas could cause a temporary scarcity. Reliability of supply is not well defined for most recycled products as an established market is often nonexistent. For seasonal products the reliability is also low as the generation of solid waste may not be synchronized with the demand.

Imperatives for Resource Recovery

The requirements for an effective resource recovery and recycling programme can be classified into two categories. The first category covers those programmes which can be implemented at the national and local levels immediately without recourse to international agreements. The second category requires action on a global scale and pertains to international trade, technology transfer, and fiscal and economic policies. Current indications are that it would be difficult to come up with any global agreements of this nature due to the great diversity of national interests and even if such agreements were to be reached, implementation would be extremely slow.

National Initiatives

Like pollution control and environmental protection, the cost of resource recovery and recycling is an externality to the waste generator. It is the government's accepted role to develop a proper mechanism in which the waste generator pays for the environmental damage caused by his waste generation. Willingness on the part of the waste generator to comply with the government's regulation is affected by social pressure, appropriateness of the regulations, uniformity of regulation implementation, his own concern for the environment, and penalties and incentives incorporated in the regulations. As the

environment has become a major issue only in recent years, there is a need for public education and information campaigns to inform the public of its responsibility, create social initiatives and pressure for a change, and raise awareness about environmental issues. There is also a need for the development of pilot and demonstration projects to test the appropriateness of the regulations and programmes related to resource recovery and recycling and establish the long-term incentives required to sustain the resource recovery and recycling programmes. At the national level, the following programmes can be implemented simultaneously:

(1) Development of legislation to simplify the waste generation cycle in order to facilitate improved resource recovery and recycling. Related legislation should include standardization of bottles, plastic containers, and other reusable packaging materials.
(2) Development of a national programme which will include an intensive public education and information campaign on the importance of resource recovery and recycling in relation to the environment and the promotion of public health. The education programme should embrace all ages — from schoolchildren to adults. It should create awareness of the need to reduce solid waste generation and change public attitudes towards avoidance of unnecessary packaging and purchase of products using recovered materials.
(3) Development of demonstration projects to test ideas and concepts and their appropriateness to local conditions. The demonstration projects should look at maximizing the segregation of recyclable materials at source, the required infrastructure support to collect and process the segregated materials, financial and social incentives for resource recovery, and penalties for noncooperation.
(4) Creation of research institutes to develop new products from recovered materials, develop reusable products as substitutes for throwaway products, carry out preproduction testing of new products, establish quality control standards for recovered materials for various industrial uses, and serve as a clearinghouse and catalyst for technology transfer.
(5) Provision of incentives for inventors and industry to utilize recovered materials and reduce the use of raw materials.
(6) Imposition of a solid waste tax on consumer products to operate like a sales tax, based on the potential volume or weight of solid waste generated by the product. For simplification, the tax can be based on the gross weight of the product. Taxation of throwaway products should not affect public health. A deposit system for reusable products provides an economic incentive for recycling.
(7) Development of a programme to require government offices to use products containing recovered materials or give preference in procurement to products using recovered materials. There is a need to develop a market for products using recovered materials and, through economies of scale, reduce the cost of such products to make them more competitive with products using raw materials. The government should give the necessary leadership in the use of products containing a high proportion of recovered materials.
(8) Review of the incentives and subsidies given to the extraction of mineral resources, harvesting of forest products, and agricultural production such that the prices of raw materials will reflect their real costs in relation to recovered materials.

International Initiatives

While there is a growing awareness on the part of the international community towards environmental conservation, there is strong resistance to the transport of waste materials across political boundaries. The problem is not only limited to the transfer of waste across national boundaries but also takes place across boundaries of local governments. The trade in recovered materials, especially very low-quality materials, is subject to suspicion as it may be considered as a transfer of waste materials across political boundaries. To stimulate the trade in recovered materials and their use, there is a need for the development of acceptable international quality standards for recovered materials and the establishment of an international exchange market.

International trade negotiations normally focus on the subsidies and support for materials production from one country to another, and there is little concern over the effect of those subsidies and price-distorting mechanisms on the pricing and utilization of recovered materials. From the technical point of view, raw material should be more expensive than recovered material since production of raw material requires more energy, chemicals, and natural resources such as water than recovered materials. The prices of recovered material can be a good indication of the real price of raw material.

Countries implementing a strong resource recovery and recycling programme may be entitled to impose stiff tariffs on imports of consumer goods using a high content of raw materials which will compete with local products using recovered materials. Tariffs on products using raw materials, as they affect local production of the same product using recovered materials should be exempted from the scope and coverage of trade liberalization discussions. As noted earlier, products using recovered materials tend to be more expensive and have lower appeal to consumers. Protective tariffs on products using recovered materials may be acceptable in the short term against competitions from well-established products using raw materials. The protective tariffs on products using recovered materials will only partially offset the subsidies and incentives currently available to producers of raw materials.

CONCLUSIONS

Recycling and resource recovery are major components in the important task of increasing the production of consumer goods while conserving natural and environmental resources. However, recycling and resource recovery programmes have to contend with the pricing and social biases in favour of the use of raw materials. There is an urgent need to develop national programmes for resource recovery and recycling which will overcome these biases and develop a firm industrial sector on the basis of recovered materials.

NOTE

1/ Recycled materials are those recovered from solid waste which can be utilized in a similar manner to the original uses, i.e., glass bottles reused as bottles. Recovered resources are materials from solid waste which will have to undergo physical or chemical change to alter their properties to enable subsequent uses, i.e., organic materials used for composting. In this article, the term "recovered resource" is used for recycled and recovered materials.

PARTNERSHIP IN SOLID WASTE COLLECTION: MALAYSIAN EXPERIENCE

KAZAL SINHA

INTRODUCTION

The largest portion of the operating budget of most local authorities in Malaysia is allocated to solid waste management (SWM). About 50 per cent of the operating budget is used on SWM and, out of this, the largest slice, around 70 per cent, is spent on the collection of solid waste. In 1988, the local authorities spent M$110 million[1/] on SWM, and this is expected to double by 1995. In addition, a high proportion of manpower in the local authorities is deployed for this service. However, this service is being provided without any proper planning. Given such a huge input of resources, the service is nevertheless deficient in quantity and quality; as a result, it is not cost-effective, and is punctuated with numerous complaints. Furthermore, the huge investment in the SWM sector has curtailed many local authorities from developing other public infrastructure and services.

These difficulties in providing effective SWM have led local authorities to privatize this service, along with other service sectors. The guiding philosophy of this decision is that if the private sector can provide the service as efficiently as or more efficiently than the public sector, then the service should be privatized, hence relieving the local authorities of the financial burden of providing an efficient service. Another guiding concept is the government policy on trimming the size of public services, particularly SWM, which has a large allocation of manpower among the public services.

BACKGROUND

The nation of Malaysia is comprised of the Malay Peninsula (West Malaysia), and Sabah and Sarawak (East Malaysia). However, this article will focus on West Malaysia. Peninsular Malaysia extends 740 km from Perlis in the north to the Straits of Johor in the south. It has an area of about 131,500 km^2, and consists of the States of Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Pulau Pinang, Selangor, Terengganu, and the Federal Territory of Kuala Lumpur.

Peninsular Malaysia has an equatorial climate, which is characterized by high temperatures and heavy rainfall (most places get between 2,500 and 4,000 mm of precipitation per year). The high temperature and humidity accelerate the decomposition

of organic wastes, requiring more frequent refuse collection than in countries with temperate climates. Heavy rainfalls, especially during the monsoon season in the northeast, hit the east coast between December and February, disturbing the refuse collection and final disposal works. During the fruit season, generally between July and September, depending on the location, the generation of refuse increases by as much as 40 per cent in extreme cases.

In 1990, Peninsular Malaysia had a population of about 14.6 million, with a density of approximately 101 persons per km^2. Malays and related ethnic groups comprise 56.5 per cent of the total population, Chinese 32.8 per cent, Indians 10.1 per cent, and others 0.6 per cent. Each ethnic group has its own life-style, which affects not only the pattern of refuse generation, but also the availability of work force for refuse collection. In view of this, *Hari Raya Puasa* and Chinese New Year are the most critical seasons for SWM in Malaysia.

The country is endowed with rich natural resources (forests, tin, crude oil, and natural gas) and has suitable land for cultivation. Despite favourable economic conditions in the 1960s, with an annual gross domestic product (GDP) growth rate of 6 per cent and a low inflation rate of less than 1 per cent, the country faced problems of widespread poverty and racial and regional imbalance in the distribution of income, employment, and ownership of assets. In 1970, the government formulated the New Economic Policy (NEP), aimed at achieving equitable income distribution, eradicating poverty and social inequity to provide the direction of development over the next two decades. This policy has provided the basis for each of the succeeding five-year development plans and the government's overall development strategy. Malaysia's overall development performance since 1970 has been impressive. During the period of 1971 to 1980, real GDP grew at 7.9 per cent annually. Real GDP for the country as a whole was M$37.89 million in 1978 (1978 prices), M$44.5 million in 1980, increasing to M$57.86 million in 1986, and to M$115.14 million in 1990.

However, since 1984, the worldwide recession, accompanied by reduced demand for commodities, seriously hit the Malaysian economy due to its dependency on the export of commodities such as rubber, palm oil, tin, and tropical timber. The Malaysian economy recorded a negative growth in 1985 for the first time, and the average per capita income in 1985 and 1986 was 11 per cent and 16 per cent respectively, below the 1984 level, resulting in reduced purchasing power and affordability for Malaysians. The unemployment problem, including that of university graduates, became visible. As part of an overall strategy to revive the Malaysian economy, the government introduced privatization as a policy to encourage private entrepreneurship and investment. Reduction in the size of the public sector has also been promoted by the public service department. All of these actions have direct or indirect implications on municipal SWM. The Malaysian economy has gradually recovered since 1987.

Malaysia's industrial structure and development strategy have some special implications on its SWM. First of all, the tin mining industry has created a lot of old mining pools in Peninsular Malaysia, which should be filled and used for other productive purposes. One of the filling methods suggested is sanitary landfilling with solid waste, although such a method has not been fully established or the working conditions proven. Secondly, the launching of a National Car Project — Proton Saga — has created a basis for the Malaysian

automobile industry. Although some truck bodies for refuse collection vehicles have already been produced locally, with the experience gained, it is possible that the whole array of SWM equipment will be produced locally in the near future.

Thirdly, the generation of hazardous industrial solid waste is increasing rapidly, along with the industrialization of the country, requiring special attention for its proper management. For example, Malaysia is one of the biggest producers of semiconductors and of various types of organic solvent wastes. A national plan for the management of hazardous industrial solid waste is to be formulated and implemented by the Department of Environment, and the close coordination between that plan and the Ministry of Housing and Local Government's *National Action Plan for Beautiful and Clean Malaysia (ABC)* will be crucial for overall SWM and the sound development of Malaysian industries.

Lastly, the government has been giving emphasis to the development of the tourism industry to make it into a leading foreign exchange earner for the country. Intensive campaigns are being carried out to bring visitors to the country, but such efforts will be defeated if tourists find that the country is not so clean. The cleanliness of cities and tourist spots should be improved and maintained, not only through *ad hoc* cleanup campaigns, but also through overall strengthening of SWM at the federal, state, and local levels.

Malaysia's development has been guided by its five-year development plans. Although municipal SWM is the most expensive part of the operation carried out by the local authorities, so far it has not been given due consideration in the country's five-year development plans. For example, although a request has been made for a national SWM plan, it was turned down due to the shortage of funds. In the *Fifth Malaysia Plan (1986-90)*, only a cursory evaluation was made on the situation of final waste disposal in the country. However, the government was very keen on improving the cleanliness of the country, and this is best illustrated by the launching of the National Cleanliness Campaign towards the end of 1983, and by the "Beautiful and Clean" programme in 1990. In the *Sixth Malaysia Plan (1991-95)*, a total of M$22.5 million was allocated for improvement at disposal sites throughout Peninsular Malaysia. Although this is a relatively small amount, its inclusion in the plan indicates that the government is seriously considering SWM and its impact on the environment.

PRIVATE-SECTOR INVOLVEMENT IN SWM

Traditionally, local authorities have been using government workers and vehicles to collect solid waste. But as development growth accelerated, traditional methods of service provision could not keep up with the pace of expansion and urbanization, or the acceleration of rural-to-urban migration. With this rapid development, houses mushroomed and many rubber estates were converted into new housing estates.

While most local authorities continued to provide services in the city centre, services in the housing estates were contracted out to the private sector. Usually the housing estates of 3,000 to 10,000 units were grouped together and served by a private contractor, depending on their size or concentration. The successful contractor must provide door-to-door collection service three times a week for all private residences in the designated area. Collection by the commercial centres should be on a daily basis.

Under the *Garbage Collection and Disposal By-Laws,* all householders are required to dispose of their solid waste in bags, put them in standardized bins, and place them either in the backlanes or on the curbside on the appointed collection days. The contractor provides its own vehicle and labourers to collect the bags containing the solid waste from the bins and other large containers provided by the local authorities for flat dwellers and at marketplaces. The contractors must use compactor trucks to collect the solid waste, as required under contract.

Contracts for the collection of solid waste are established after tender bids are invited from all interested parties. Quotations are based on unit rates for the various types of bins per m^3, i.e., household bins, commercial establishment bins, bulk bins, and others. The offers are properly costed and evaluated, and the contract is offered by the Tender Board.

In many local authorities, contracts are given for ten years with a grace period of two to three years. This is because of the heavy capital outlay on vehicles and the time allowed for contractors to amortize their vehicle costs. In all or most of the contracts, the local authorities reserve the right to terminate the contract, should the services provided prove to be unsatisfactory.

To guide the tenderers in preparing the bids, information such as the area to be covered with maps showing the layout of the roads and houses, and the numbers of row houses, detached houses, commercial units, and others, is properly spelt out. An estimate of the daily amount of solid waste generated is also given.

When selecting a tenderer, the local authorities ensure that the tender price is realistic so that the contractor will not suffer a loss which can lead to unsatisfactory service or to service termination. Extra emphasis is given to the company's financial standing, its management setup, workshop facilities, and experience in solid waste collection. The average contract price is about US$1.00 per month for a new house and US$1.30 per month for a detached house. Payments are made on a lump sum basis.

As of the end of 1992, most local authorities had contracted out between 10 per cent and 80 per cent of the solid waste collection services to between one and nine contractors. These contractors provided one to five compactors, one open truck (to collect bulky waste and garden refuse), and between five and thirty workers and one and two supervisors. Of these contractors, about 80 per cent provided good to better services. They complied strictly with the contract conditions, and the public was generally satisfied with their services. Should the service deteriorate, warnings, fines, and guidance are given to the contractors so that they will improve their services. Should all of these measures fail, then the service will be terminated, which would be the last option taken by the local authorities. Table 1 shows the percentage of the collection services contracted out and the level of service.

COMPARISON BETWEEN AVERAGE SERVICES PROVIDED BY LOCAL AUTHORITIES AND CONTRACTORS

A comparative analysis was made between the services provided by local authorities and those provided by the contractors in Malaysia. It was concluded that the contractors undertook the services in a more cost-efficient manner. The contractors used their vehicles

TABLE 1. PERCENTAGE OF PRIVATIZED COLLECTION SERVICES

Local Authority	Percentage Contracted (Privatized)	Payment System	Level of Efficiency*	Any saving in cost?
M. P. Kangar	25	Lump sum	Better	No
M. P. Kota Setar	25	"	"	Yes
M. P. Melaka	70	"	"	"
M. P. Seremban	15% weight of garbage	Per premise – only for residential area	Equivalent	No data
M. P. Taiping	50	Lump sum	Better	Yes
M. P. Seberang Prai	15	"	Less	No
M. P. Pulau Pinang	Residential – 80	Fixed amount/ monthly (tender)	Equivalent	Yes
M. P. Petaling Jaya	Market – 100 Residential – 10	Per bin Per unit	"	No
M. D. Kulim	10-15	Lump sum	Better	Yes
M. P. Klang	42% of total number of premises	"	"	"
M. P. Johor Bahru	Less than 10%	"	"	"
M. D. Gombak	60	"	"	No
M. D. Johor Bahru	20	"	Less	No data
M. D. Muar Selatan	15-20	"	"	No
M. D. Temerluh	20-30	"	Better	Yes
M. D. Petaling	20	"	"	No
Dewan Bandaraya Kuala Lumpur	30-40	"	"	Yes

Note: * as compared to the local authority.

more intensively. The average number of trips made per contractor vehicle was 30 per cent higher. Local authorities achieved an average of 1.2 trips per vehicle, collecting from 600 houses, while the contractors made 1.6 trips per vehicle, collecting from 1,200 houses during the same eight-hour work period. The tonnage of solid waste collected by local authorities per compactor trip was 4.6, as compared to 5.2 attained by the contractors. The most efficient contractor collected 8.5 tons per vehicle per day, whereas the most efficient local authority collected 5.7 tons per vehicle per day. There is an increase in efficiency of approximately 49 per cent.

In terms of cost, the contractors provided the service at 32 per cent less than the local authorities (if all hidden costs are taken into consideration). Even when the contractors had a pretax margin of 20 per cent, the cost of service was 23 per cent lower than the cost of service provided by the local authorities.

BENEFITS OF PRIVATIZATION

From the preceding discussion, it is seen that the private sector can achieve a higher efficiency in solid waste collection. This is so because a local authority operates like a

government department, where staff employment is very secure and lifetime employment is almost guaranteed. Disciplinary action, especially in the form of dismissal, is difficult to enforce. Therefore, the worker output is usually low.

The local authorities' supervision of the operation is also less rigid than that of the contractors who personally supervise the workers and monitor the output to maximize profit. Entrepreneurs reacting to profit signals would be more efficient than civil servants responding to bureaucratic commands. In the private sector the workers are controlled by their tasks and output, whereas in the local authority they are controlled by time. Local authority supervision is often very slack, thus resulting in malingering and absenteeism. It is no wonder that the government's labour output is lower.

When undertaking privatization, the local authority does not have to take loans and organize heavy capital outlays for purchasing the fleet of collection vehicles. Heavy capital outlays are converted into steady and even monthly payment to the contractors. The local authority finance managers prefer the contract or lump-sum payment system, as the payments can be more comfortably made from current revenue sources.

Another benefit of privatization is that it releases staff for other projects or purposes. The freeing of staff enables the local authority to extend services to the rural areas and to redeploy them for other services which are considered to be urgent, hence developing other sectors of public concern.

By making the contractor responsible, the Complaints Bureau established by the local authority can, without hesitation, take measures to correct complaints due to unsatisfactory services. To facilitate this, the Complaints Bureau's telephone number is printed on all collection trucks to encourage people to complain about inadequate solid waste services. This serves as an enforcement measure for the contractors to perform according to the terms of the contract. It helps to ensure that the contracted services are up to the householders' expectations.

HIGHER LEVEL OF PRIVATE-SECTOR INVOLVEMENT

As mentioned above, local authorities do not attempt to perform every SWM task on their own. Ten to 80 per cent of local government responsibilities are carried out by private contractors who generally perform more efficiently. Without private-sector participation, it is doubtful whether the local authorities could have coped with the high rate of expansion that is being experienced. Private-sector involvement in SWM was sought in response to a felt inability by the public sector to cope with increased demand. The experience has shown tangible positive results, such as lower costs and more reliable services provided by the private contractors.

Notwithstanding the apparent advantages, local authorities do not feel inclined to contract out 100 per cent of their SWM responsibilities. Local authorities always consider it important to have their own work force as contingency reserve, in case the contractors' services are disrupted. This spare capacity enables the local authorities to take punitive measures on defaulting contractors. Without it, local authorities could be held for ransom, either in the form of higher contractor prices or in the lowering of the service standards. Whenever complaints are received that the contractors have failed to collect the solid waste

on the appointed day of collection, local authorities send in their reserve work force to undertake the collection services. Payment is deducted from the contractor for work done by the local authorities.

Another factor to be taken into account is the need for the local authority to use the costing of its services as a measure of reasonable expenditure by the contractors in assessing the tender offers. It also serves as a deterrence against contractors' collusion. In general, the percentage of services to be contracted out depends on the following factors:

(1) Magnitude of difference in the service expenditures between the contractor's work and that of the local authority (a larger difference will make it feasible to contract out more of the services).
(2) Availability of reliable contractors. (The greater the availability of reliable contractors, the more the services can be contracted out.)
(3) Level of utilization of existing labour and equipment. (It is irrational to contract out the services when the local authority's resources are or will be underutilized.)

Although there are valid reasons for having a standby capability, keeping it between 20 per cent and 90 per cent, especially at over 50 per cent, would not be cost-effective. This figure can easily be reduced, as shown in the example of one local authority which successfully privatized 80 per cent of its collection services. Other local authorities could similarly strive to contract out more of the collection services on condition that the factors enumerated in the above paragraph have been fulfilled.

Another service which local authorities could consider contracting out is the operation of disposal sites. One local authority is in the process of contracting out the management and operation of a new disposal site which is to be shared by six neighbouring local authorities. The private contractor will be responsible for managing the disposal site to comply fully with the environmental protection standards set by the Department of Environment, and to operate the transfer stations and haul the compacted solid waste from the transfer stations to the disposal site. The local authorities will then pay the contractor tipping fees at the tendered rates. As far as the local authorities are concerned, they will bring the solid waste to the transfer stations, weigh it, and pay the agreed amount of tipping fees to the private contractor. These local authorities will jointly supervise the contractor's operation of the disposal site, monitor the quality of the leachate before discharge, and ensure that the physical conditions are free from nuisances.

MEASURES FOR STRENGTHENING PRIVATIZATION

Local authorities tend to contract out the services to the private sector to relieve themselves from further involvement, and thus blame any shortcomings on the contractors. Local authorities should adopt a more facilitative stance, and recognize that the contractors play an important role in SWM and need guidance and supervision. Measures should be undertaken to ensure that their services remain continuously satisfactory.

First of all, it should be realized that SWM is a specialized subject deserving more attention. It consumes the largest portion of the local authority's budget. Traditionally, solid waste is a neglected adjunct of the Public Health Division, with a medical doctor in charge, assuming responsibility over its management and operation. In municipal

councils, the Public Cleansing Department is separated from the Health Department, and has a senior administrator to plan and manage the solid waste services. The department is engaged in a continuous effort to improve the collection system, paying attention to the rerouting of vehicles for smooth collection service.

A weighbridge provides the basic data for monitoring the use of vehicles, attainment of optimum collection capacity, and the rate of solid waste generation in the respective collection areas. Data analysed are then made available to the officials who prepare the plan for the sector.

Separation of solid waste and subsequent recycling are studied and tested in pilot areas. These are still in the experimental stage in all or most of the local authorities. Public cooperation has, however, not been very satisfactory. Many other ideas and projects have been undertaken to elicit public cooperation.

Local authorities consider that competition among the contractors is an important factor for greater efficiency. For this reason the collection service is not amalgamated to form a large-scale contract. Administratively, it would be easier to deal only with a few large corporate companies. Instead, the service is broken up into packages, and competitively tendered. As contractors gain more experience, lower tender prices are offered at subsequent tenders. None of the contractors would ever take for granted that they would be retained for the next contract period. Hence, they try to remain competitive all the time.

The Public Cleansing Department involves the public in monitoring the performance of the contractors. As explained earlier, this is done by inviting the public to complain about unsatisfactory services by contacting the Complaints Bureau. This bureau is part of the Enforcement Unit. The department does not adopt double standards when it comes to ensuring quality service from its own crews. They are also subject to public complaints, and all grouses are promptly and speedily acted upon by the Public Cleansing Department.

Local authorities assist the contractors in providing satisfactory services throughout the ten-year contract. This enables the contractor to spread out the high capital outlay on compactor trucks over a longer period. A two- or three-year contract would make the privatization scheme financially unfeasible.

SHORTCOMINGS OF THE PRESENT SYSTEM

We have seen that where city cleanliness is concerned, the present SWM is satisfactory. Admittedly, the expenditure on this sector alone is very high. Large sums are spent on enforcement and supplemental cleaning which are classified under other expenditure items. Although the contracted system of collection is more cost-effective than that provided by the local authorities, there is still room for improvement.

The payment system for the contractors' work can be improved if it is based on the tonnage of solid waste collected and hauled. As it is, contractors are paid according to the number of bins located within their area. The presumption is that the contractors empty all the bins according to the contracted frequency. This necessitates very close supervision and the imposition of fines.

A better system would be to pay the contractors according to the tonnage of solid waste collected and hauled. This ensures that payment is strictly based on work performed, as

evidenced by the tonnage of solid waste brought to disposal sites. An electronically operated weighbridge has already been installed at most disposal sites. Experience in a municipality showed that on a weight-payment basis, the contractors, in their zealousness to earn more, would pick up every bit of solid waste in their allocated areas in exchange for payment. An incentive mechanism is created to clean up the area of solid waste. Should this system be adopted, there would be a reduced need to have supplemental cleaning as is now being practiced. The overall cost would be reduced, and enforcement would be easier. The *ABC* predicts that a 15 per cent cost saving could be made if the service is contracted out on a weight-payment basis, and if a number of other attendant improvement measures are adopted.

Local authorities focused on cleaning up the urban centres, but have not paid sufficient attention to the operation of a good disposal system. Most sites are subject to a lot of complaints, and their management is below the desirable level. Flies and odours are common problems. Leachate treatment has never been implemented.

Because of their relative indifference towards cost reduction, local authorities have not considered sanitary landfill as a possible alternative to incineration. On the other hand, most municipalities in Malaysia will not consider installing an incinerator unless there is very little land left in the surrounding area that can be used as a disposal site. Local authorities, being used to getting the budget they need, do not appear to feel obligated to find low-cost solutions to their problems.

Local authorities have also not made much effort to involve the public in SWM. The emphasis has been that if it is dirty then it has to be cleaned. There is hardly any attempt by local authorities to get public participation in their cleanliness programmes. Local authorities have no links with the Friends of the Environment group which is set up to create awareness of the adverse effects of pollution. Similarly, the Hawkers' Association is a strong and well-organized body. The education and training of hawkers in hygiene could be delegated to the Hawkers' Association, but this has not been done. All the efforts are made by the local authorities alone. This may explain the high cost of keeping the urban centres clean, and it has also resulted in a culture which considers cleanliness to be the exclusive responsibility of local authorities. When the Ministry of Housing and Local Government embarked on a national cleanliness campaign, highlighting the citizens' responsibility in maintaining cleanliness, most urban centre residents thought that there was a semantic error in the slogan, "When the Public is Clean the Nation Will be Healthy". They found it hard to believe that the public needed to be clean. It is the government that has to do the cleaning and to be clean. That is its job and responsibility.

Solid waste recycling and resource recovery can help prolong the life of disposal sites. Recycling has other benefits, such as conserving resources and inculcating awareness of cleanliness. All or most local authorities have no programme to incorporate recycling activities in their SWM. It is also admitted that a pilot scheme to get householders to separate the recyclables at source was introduced in a housing estate. Over time, the householders have gradually lost interest in the project.

The Ministry of Housing and Local Government is exploring the prospects of encouraging the local authorities to adopt a programme of recycling and has found that there is a ready market for recyclable items. The problems lie in organizing the separation of household solid wastes, and collecting and delivering them to the companies that deal

in those items. With greater interest among members of the public to conserve the resources and to undertake recycling, a few municipalities are embarking on recycling. This is being tried out as a pilot project in a few housing estates.

Local authorities do not have any mechanism for resolving SWM issues beyond the activities of the Complaints Bureau. It is a "fire fighting" approach and not proactive. Local authorities are confident that the residents are happy with the services provided and do not see the need to anticipate public demonstrations and blockades.

CONCLUSION

As noted earlier, the privatization of collection services brings substantial and important benefits. These benefits come about because of the competition inherent in contracting the services with private companies. Most consumers would agree that competition is beneficial, and that it forces efficiency, innovation, creativity, investment, and ultimately, improved results.

When a local authority decides to ask private contractors to bid on its collection services, it has taken the first step in creating a competitive environment. We have reviewed here the method by which a contracting authority can be assured of a competitive tender process.

Through a tender process modeled on the points raised here, it is expected that experienced and professional contractors will present bids which reflect the competitive nature of the entire bidding process. This will ensure that the contracting authority receives the best value for its money.

Using responsible, experienced private contractors for collection services has produced clean, healthy, and more enjoyable environments for many of the urban centres in Malaysia.

The competitive atmosphere created by farsighted local authorities contracting with private companies results in more efficient, thorough, productive services at a lower cost. Moreover, it frees the local authorities from the difficulties of operations, and allows them to devote their energies to supervising, managing, and establishing policies — the true challenges of governing.

The privatization of collection services is an ongoing and growing activity because the concept is well tested and proven. Government authorities should consider it as an attractive alternative to the public provision of services.

NOTE

1/ US$1 = *ringgit* (M$) 2.6 (in January 1993).

COMMENT

CARL R. BARTONE

The provision of municipal solid waste services is a vexing problem for local authorities in most developing countries. Service coverage is low and uncontrolled dumping is common, with resulting pollution problems. Moreover, substantial inefficiencies are often observed in publicly-operated services. One solution commonly proposed is to contract service provision with the private sector in the belief that service efficiency and coverage can be improved. Recently, evidence in support of this claim is emerging in several developing countries. Keys to success include creating contestable markets, establishing appropriate regulations and standards for contractors, and strengthening local government capacity to negotiate contracts and monitor performance.

Kazal Sinha is to be commended for his important contribution to improved understanding of the potential benefits of public-private partnerships for the collection of municipal solid waste. The Malaysian experience described in his article is consistent with similar findings from studies of service contracting in four large South American cities (Buenos Aires, Argentina; Caracas, Venezuela; Santiago, Chile; and São Paulo, Brazil).[1/] Likewise, his recommendations for improving private-sector participation in collection services are corroborated by the South American experience.

Several important lessons can be learned from the Malaysian case and the South American studies, which can be summarized as follows:

Competition counts. The private sector can operate more efficiently than the public sector in providing municipal solid waste services, as long as the requirements for contestable markets[2/] are met — that is, easy entry for local private firms, the establishment of exclusive service districts, and competitive bidding. This is consistent with results of rigorous studies conducted in other countries. Research from the US, Canada, and the UK, which surveyed more than 2,000 cities, showed that services provided by public monopolies typically cost 25 to 41 per cent more than competitively contracted services.[3/] The Malaysian data also fall within this range, and the South American data showed even greater efficiencies in some cases.

Political will is important. Participation of the private sector as municipal contractors depends mainly on political decision making. Though contracts are awarded after competitive bidding, true competition depends on government attitudes, as expressed in bidding conditions and the behaviour of the officials in charge of the bidding process. Political will is also important for achieving a greater degree of self-financing. It is interesting to note that promotion of private-sector involvement in Malaysia was achieved

in part through the preparation of a "Guideline on the Privatization of Solid Waste Collection Service" by the Ministry of Housing and Local Government.

Build local technical capacity. In cities in developing countries, an important step in achieving effective private-sector involvement is, paradoxically, to strengthen the technical capability of the public sector so that it is better able to exercise proper contract control, inspection, and supervision. The existence of public agencies that are capable of specifying, negotiating, and monitoring contracts efficiently without unnecessary burdens on private operators is important. Also, technical capacity in cost accounting and municipal tax administration is vital for municipal solid waste services as for all municipal services. Better knowledge of real service costs is important for contract negotiations. An additional consideration is that municipal departments can also compete for contracts and thus improve competitiveness and bring down overall costs. This approach has proven successful in several US cities such as Phoenix, Oklahoma City, and San Diego, and is practiced widely in the UK.[4]

To collect — divide and conquer. There are few barriers to entry for local private firms, given that economies of scale are very limited in collection operations, while economies of contiguity are large. The operations are relatively simple and the investment requirements are moderate. This is borne out by the number of small- and medium-sized construction and transport firms engaged in collection operations in the four South American cities studied. In Santiago, for example, there are seven small- to medium-sized firms contracted for twenty-one of the twenty-three collection districts there. Collection districts in Santiago are also small (an average size of 170,000 people), which enhances contestability. In Malaysia, the ease of attracting many small firms in diverse small- and intermediate-sized cities also corroborates this lesson.

Consolidate for environmentally-safe disposal. Disposal operations benefit from centralized solutions because they have significant economies of scale and major environmental spillover effects (called "externalities" by economists), as well as greater investment and skill requirements. These characteristics offer opportunities for private-sector involvement through comprehensive management contracts, lease contracts, or concession arrangements to operate disposal or recycling facilities. In all four South American cities, private firms successfully built and operated a variety of disposal facilities, including transfer stations and sanitary landfills. Another advantage of transferring disposal operations to the private sector is that local authorities are relieved of the conflicting responsibilities of being both operator and regulator, and can focus on enforcing environmental standards. The Malaysian proposal to contract out the management and operation of a single landfill to service seven cities explicitly recognizes the advantages of both consolidation and of emphasizing the regulatory role for local authorities. In South America, the privately-run landfills studied were among the best observed in the region in terms of meeting environmental protection objectives.

Emphasize performance measures. Both the award of contracts and payment for the contractual services provided should be based on specific performance measures — for example, price per ton collected, per km of road swept, per ton/km hauled, or per ton disposed of. Service quality, coverage, and environmental standards to be met should also be specified in the contract conditions. On the other hand, the choice of specific technology options should mostly be left to the private sector so that it can optimize operations while

meeting the performance requirements. Performance monitoring can include both inspection and direct measurement, such as the use of weighbridges or landfill monitoring wells, as well as mechanisms for receiving and dealing with customer complaints. The Malaysian experience illustrates the effectiveness of involving the public in monitoring the performance of contractors through the creation of a Complaints Bureau.

NOTES

1/ See Carl Bartone *et al.*, "Private Sector Participation in Municipal Solid Waste Service: Experiences in Latin America," *Waste Management and Research 9* (1991):495-509. Similar supportive data for Bogotá, Colombia, are presented in Sandra Cointreau-Levine, *Private Sector Participation in Municipal Solid Waste Services in Developing Countries* (Discussion paper series)(Washington, DC: Urban Management Program, World Bank)(in press).

2/ For a discussion of contestability, see W. J. Baumol and K. S. Lee, "Contestable Markets, Trade, and Development,"*World Bank Research Observer* 6 (1991):1-15.

3/ J. D. Donahue warns against some other forms of private-sector participation: "Open competition and monopolistic franchising are often plagued by inefficiency or illicit collusion. Contractors chosen by fair and honest bid contests typically outperform public monopolies. But competition improves the performance of both public **and** private garbage operations." As summarized in his book, *The Privatization Decision: Public Ends, Private Means* (New York: Basic Books, 1989).

4/ For example, see "Public Collectors Inject Competition into Operations," *World Wastes* (May 1993):10.

WASTE MANAGEMENT IN SURABAYA: A PARTNERSHIP APPROACH

EDDY INDRAYANA AND JOHAN SILAS

INTRODUCTION

Indonesia is at present preparing its second long-term development plan (1994-2019) and sixth five-year development plan (1994-99). In terms of the urban environment and more specifically, waste management, recycling will be given a higher priority. Recently the Department of Domestic Affairs working with nongovernmental organizations (NGOs) and the United Nations Development Programme (UNDP) organized a one-day seminar to evaluate action research projects implemented in Jakarta, Bandung, and Surabaya. The seminar's aim was to discuss the role of recycling and the involvement of waste pickers in the overall solid waste management (SWM) of the city.

Results of this seminar can be summarized under the following three issues:

(1) Recycling and the involvement of waste pickers should be integrated in the overall urban SWM system; and a budget should be made available to increase its effectiveness.
(2) Although professional waste pickers will have an important role to play in the foreseeable future, the work should be made safer and easier and be of short-term duration only. It should be ensured that the work is not handed on to the second generation.
(3) Cities which have yet to begin this scheme should start as soon as possible and should utilize the experience of cities such as Surabaya, which has been implementing the scheme for the last three years. In Bandung and Jakarta, the experience is limited to on-site, small-scale composting.

The seminar participants agreed that the partnership approach involving all levels of the population would not make the work of bureaucracy more difficult, time consuming, or costly. The result would be a sustainable, well-managed, and clean city; attractive to visitors while not inducing in-migration or higher population growth, nor creating new slums or a low-quality environment.

CONTEXTUAL BACKGROUND

Major urban areas in Indonesia are generating increasing amounts of waste which require disposal. Jakarta, with a population of 8.5 million, produces an average of 23,706 m^3 of

waste daily while Surabaya, population 3 million, produces approximately 7,600 m^3 of waste, daily. Indonesia's fourth largest city, Bandung, with a population of 2 million people, daily produces 6,860 m^3 of waste. So far the effectiveness of waste disposal has reached only 80 per cent, which means that among the three cities, a total of 2.7 million m^3 of waste annually is not disposed of. In Jakarta, each month, about 145,000 m^3 of waste is not properly disposed of, which is equivalent to the volume of four high-rise office blocks along the main streets. The same applies to Surabaya, but uncollected waste amounts only to about one office block per month.

Yet in both cities nothing like this quantity of waste is actually visible, which means that a group of invisible collectors or waste pickers is responsible for making the major cities in Indonesia clean. In general, organic waste generated in Jakarta and Bandung amounts to 70 per cent of the total waste, which has so far not yet been effectively recycled. In Surabaya, the nonorganic/recyclable waste was estimated by various studies to be as high as 40 per cent; the rate being higher than in Jakarta or Bandung. This, of course, makes the role of waste pickers in Surabaya more important, a fact which the city government has already anticipated and taken fully into account.

Urban development in Surabaya is typical of most Indonesian cities; and is also little different from most cities and towns throughout Asia and Africa. As the oldest city in Indonesia, Surabaya is celebrating the 700th year of its establishment in 1993. The city grew up around a natural harbour supported by well-managed agricultural activities. In modern times a strong industrial and commercial base was gradually established, partly in response to the growth of large-scale plantations in the hinterland.

Historically, the population of Surabaya grew moderately. By the sixteenth century the population had reached about 10,000 households. After the First World War, Surabaya experienced rapid population growth, but only a small portion managed to settle in formal and planned residential areas, which had been introduced in the latter part of the nineteenth century by the private sector and the Dutch colonial government. The city government was established in 1908 when the city housed a population of about 350,000 people. This figure remained basically the same until the early 1950s, after independence.

According to the 1990 census, Surabaya had a population of 2,473,272. The average growth rate was 4.48 per cent in the 1960s and 2.9 per cent and 2 per cent in the last two decades respectively. It showed that like most big cities in Indonesia, the city has a stabilized and controlled population growth rate. But to these official figures, another 20 to 25 per cent should be added to account for circular or seasonal migrants coming from the neighbouring towns and villages. Their stay in the city is only temporary and for the purpose of income generation. An estimated 63 per cent of Surabaya's population lives in *kampungs*, although these settlements cover only about 10 per cent of the total city area.

By the year 2000, Surabaya is expected to have a population of about 3 million people. In 1985, the per capita income was Rp 740,000 (US$654 at current prices). By 1990 this had increased to Rp 1,030,000 (US$911) or an increase of 40 per cent. In these figures, the informal sector production was not included, although about two-thirds of the work force belonged to the informal sector. The economic growth of the city over the last five years has averaged 8 per cent per annum, not including the higher growth in the Greater Surabaya Region which is the centre for industrial and economic development of East Java Province and the eastern part of Indonesia. (East Java Province is the second most

populous province in Indonesia with a population of slightly over 30 million — an annual growth of 1.2 per cent in the last decade.) It has also shown high and well-balanced economic growth.

To manage efficient urban development, Surabaya is subdivided into five suburban areas, each headed by an Assistant Mayor. Each suburban area is further divided into districts and subdistricts. In 1992, Surabaya consisted of twenty-four districts and 163 subdistricts or villages, with each level having a specific local authority. The existing Sanitary Department was established in 1980, being previously part of the Department of Public Works. To delegate the management further, three waste management working areas within the city were established: the North, East, and South Regions with a total of 1,722 employees, including those working in the offices and the field. The annual budget amounts to US$5 million, with additional and substantial "in-kind" support from the private sector roughly equalling the official budget.

This small public resource is far from sufficient to carry out its large-scale and complex functions. However, the partnership approach in waste management, involving the community as well as the private sector, is the strength of the management system, enabling the department to keep the city clean. Before discussing the collection and disposal system in detail, it is important to note that of the amount of waste produced daily by various sources, domestic waste constitutes only about 70 per cent of the total waste generated.

Compared to most other cities, Surabaya produces less waste, particularly among people living in *kampungs*, which house mainly low- and middle-low-income families. Based on a survey conducted by a Japan International Cooperation Agency (JICA) study team in April 1992, households generate more waste than markets, commerce and industry, and streets and open spaces combined. Table 1 shows the composition of waste generated in Surabaya:

TABLE 1. WASTE GENERATION BY SOURCE

Source	Average	Percentage	During Rainy Season	Percentage	During Dry Season	Percentage
Households	1,108	68	1,168	67	1,048	70
Markets	258	16	291	17	225	15
Commerce and industry	177	11	173	10	180	12
Streets and open spaces	83	5	116	6	50	3
Total	1,626	100	1,748	100	1,503	100

Source: *JICA Study*, October 1992.
Note: Commerce and industry includes the port area.

Furthermore, to estimate the composition of waste during the rainy season, a study was carried out in depots around the city. The figure does not represent the real or average figure, because before reaching the depots, about 10-15 per cent of the reusable materials have been recycled by waste pickers and garbage collectors. The process of recycling continues at the final disposal ground. Where part of the waste is incinerated, about 10 per cent should still be removed, including plastic bags that would damage the inside of the kiln. Here waste pickers are again involved and paid as part of the incinerator management, in addition to the money received for recovered materials afterwards. As a percentage, the composition of waste is shown in table 2.

TABLE 2. AVERAGE PHYSICAL COMPOSITION OF WASTE

Items	Residential	City
Combustible:		
Paper	13.54	15.92
Textiles	1.85	2.57
Garbage	52.93	40.98
Wood/grass	19.15	17.33
Plastics	7.7	11.14
Leather/rubber	0.45	0.99
Others	0.13	0.24
Noncombustible:		
Metal	1.07	2.33
Glass	0.79	2.89
Stone	1.15	4.37
Bones	0.22	1.25
Others	-	-
Total	100	100

Source: *JICA Report*, October 1992.

As can be seen from table 2, the strategy to manage the waste should be based on the "4R" approach — reduce, reuse, recycle, and recover. So far, only the nongarbage materials have been recycled and recovered by waste pickers, although the effectiveness has grown from less than 10 per cent to about 20 per cent in the last four years. This amount can be increased further to at least 30 to 35 per cent. The Surabaya waste pickers, numbering between 2,500 and 3,000, are known as *Mitra Pasukan Kuning (MPK)* (Partners of the Yellow Force) and are included in the overall system of waste management and street cleaning. The name is derived from the fact that the street sweepers with whom they work in Surabaya, had earlier been issued with bright yellow uniforms (now throughout the country) to enhance their personal safety during night-time work.

Since early 1992, the city governments of Jakarta, Bandung, and Surabaya have cooperated in sharing their working experience, capacity development, and formulation of waste management models, including the improvement of the role of waste pickers. Each

city has its unique problems and potentials, as well as its own ways and means of dealing with them. Surabaya developed the partnership approach involving actors at horizontal and vertical levels including university professors and businessmen. Another mechanism developed in Surabaya makes waste pickers an integral part of the urban waste management system and acknowledges them as equal to other actors in the waste management process.

During the past two years, NGOs in the three cities have worked closely together and organized meetings and have become closely linked to local governments in order to strengthen their roles and know-how in working as catalysts and role-model developers. Research findings are also communicated, simultaneously promoting a soft and humane approach in dealing with waste pickers. The findings are disseminated to other NGOs, public officials, and city governments. At present, the focus of the NGOs is to assist local governments, especially those outside of Jakarta, Bandung, and Surabaya, to make the role of waste pickers more effective and their work safer, and also to offer alternative employment where possible.

The 2,500-3,000 waste pickers of Surabaya, constituting the *MPK*, generate an attractive and substantial income for themselves, which now amounts to about US$180 to US$200 monthly per family, and they also manage to save the city government a substantial amount — up to about one-fifth of waste disposal costs. This means that in Surabaya, annually the *MPK* manage to generate an income totaling US$7 million and at the same time save the city budget about US$3.5 million in waste disposal costs. In the long term, some of this money should be reinvested to assist the work of waste pickers with the aim of substantially upgrading their future incomes.

PROBLEMS AND POLICY

Surabaya has played a significant part in the historical development of cities in Indonesia. Cities have basically developed as the result of agglomeration and the expansion process of existing villages and *kampungs* by the inhabitants themselves, with the intervention of external factors. Only much later was a formal urban development model introduced and superimposed on the existing settlements and not always to the benefit of the earlier settlers. Therefore, the approach to city development and management has been implemented in two ways: what people have and can do for themselves, and what the public sector should additionally do or should not do to further support this process.

This has been the approach adopted since the very beginning of the current administration and dates from the late 1960s when urban development was effectively implemented. It can be seen as an integral part of the development in Surabaya: a real partnership approach. The people's self-help activities are gradually being integrated into the policy-making process, with such activities covering most aspects of urban development. This role has been welcomed by the people to the extent that their response has grown increasingly vigorous over the years of implementation. The reasons for this will be discussed further in this article.

Surabaya, with a total area of 300 km^2, requires an army of 13,000 sweepers to collect waste and keep the streets clean. Of these people, only 10 per cent are employed by the

government. The rest are paid by residents' associations, individually, or by the *kampungs* themselves. A two-tiered system is in operation whereby households and other waste generators have the responsibility for collection and transportation of waste to the nearest depot or collection point. The City Sanitary Department then has the responsibility of transporting this waste to its final disposal point. For this service and the cleaning of main streets, households pay a monthly fee of Rp 1,000 (high-income groups) or Rp 500 (other income groups).

It is important to note that some members of the *MPK* also recycle the waste while carrying out house-to-house collections. Other waste pickers collect recyclable materials and sell them to intermediate buyers who resell them to end users such as factories. Some of these workers are part-time with more conventional jobs which do not pay sufficient wages. Full-time waste pickers have generally opted for the life-style because it pays comparatively well and permits a certain degree of independence. However, for most waste pickers it is hard work.

Managing the urban environment is indeed a complex, costly, and interrelated undertaking. Part of the management policy should include the support of the informal sector. Such activities as *becak* (motorized trishaw) driving have, for a long time, been organized professions which have gradually developed into cooperatives. The *becak* drivers have recently introduced a 1,000 cc minitruck remodelled into a taxi-*cum*-goods carrier which is operated on a fixed rate system. It is hoped that the profession of *becak* driver can gradually be replaced by more regular occupations.

A number of informal sector activities support the general effort to maintain satisfactory environmental standards. The improved conditions help to raise the awareness of the citizens which ensures that such an environment, once attained, is maintained in its improved state.

In most large cities, it is difficult to find large, clean, white walls without defacement from graffiti. In Surabaya, on the contrary, it is unusual to find graffiti. This result has been achieved by the concerted efforts of students working with waste pickers and staff members from subdistrict offices. It is a testament to what can be achieved by organized group effort and also shows that younger community members can be instilled with a sense of community pride — contrary to the views held about them by their elders.

Surabaya's waste management policy embraces all citizens, regardless of their status, in its urban development programme. The informal sector is given constructive encouragement to organize itself in such a way as to be able to form cooperatives whose activities can be supported by the government. This is an important aspect of Surabaya's programme of partnership for development. Another component of this policy is local-capacity building and skill training which, in turn, will provide the informal sector with the means to improve itself. This has important implications economically. The formal sector is unable to keep pace with the expanding need for employment and therefore informal sector employment with adequate remuneration is one method of easing the unemployment problem. These efforts are still in their early stages compared to the ongoing efforts to conduct more formal training programmes by the Department of Manpower, initiated many years ago.

PARTNERSHIP AND THE PRIVATE SECTOR

A mistaken conception continues to pervade attempts to recognize the important role which the informal sector can play in urban development. This misconception is that such official recognition and stimulation of informal activities on the part of city governments will encourage in-migration from the rural areas to the cities and that such a resulting influx of unskilled low-income people will create further overcrowding and chaos, making the already difficult task of urban management considerably worse. This misconception is still widely held among high-ranking public officials, journalists, and academicians. The same views can often be heard being voiced in international gatherings, though often in the absence of those people who are directly involved in these informal sector activities.

The reality is of course completely the opposite, as the experience of Surabaya has amply demonstrated. By fostering a partnership with the informal sector, the city government has been able to do more with fewer resources, has actually had its workload reduced, and has successfully managed to make Surabaya a clean and safe city with a pleasant green environment, ideal for attracting potential investors. The city has not been swamped by rural migrants, indeed, it has been able to create an environment which has garnered four international awards in the last five years—the most recent being the "World Habitat Award". Nevertheless, the development objectives of Surabaya remain the same: to serve more, and to include more people in these efforts. In terms of the amount of budget/expenditure on waste management in Surabaya, table 3 contains the outlay for the past five years.

TABLE 3. SURABAYA'S EXPENDITURE ON WASTE MANAGEMENT, 1988-93

Year	Total value in Rp
1988-89	5,382,098,000
1989-90	5,277,904,000
1990-91	8,481,858,000
1991-92	9,192,730,000
1992-93*	11,516,260,000

Source: Surabaya Sanitary Department.
Note: * To November 1993 only.

An unusual component is the provision of gift parcels to all workers involved in keeping the city clean. These parcels, provided by the business community, contain food and clothing and are usually distributed prior to important Moslem holidays.

High-income groups are further involved in the effort through voluntary work such as street-sign painting, tree planting, and organizing parties for sweepers, collectors, and waste pickers.

PREREQUISITES AND APPROACHES TO WASTE MANAGEMENT

The approach to waste management in Surabaya does not happen in a vacuum, unrelated to other activities or sectors. Three prerequisites are necessary to support the implementation of what are, in fact, three separate but interrelated approaches to the problem, namely:

(1) The policy itself: it must have the avowed aim of helping, as far as possible, to improve the conditions of the urban poor, as quickly as possible. In Surabaya, as soon as the current administration was in place, efforts were made at environmental improvement among the low-income groups. The Kampung Improvement Programme (KIP) was reinitiated in Surabaya in 1968 before being implemented nationwide after 1979. It proved effective and an economical way to deal with the problem. The KIP was later extended with the aim of making the whole of Surabaya a clean and pleasant place in which to live.

(2) There must be a willingness among decision makers in city government to acknowledge the efforts of citizens to contribute to urban development and recognize the results of such efforts. Urban development in Surabaya began by supporting these efforts as well as initiatives already begun by governments. By continually involving the local people in the process of improving current city functions and the more efficient provision of services and facilities, conditions are fostered for further partnerships to be initiated. In this way, the involvement of the people is further strengthened.

(3) Open relationships must be established with all the parties involved. This includes NGOs, local institutions of higher education, and relevant agencies and ensures the possibility that all available resources are fully synergized no matter what scale they are.

Efforts should be made to ensure that these prerequisites are continually strengthened so as to enable the task of urban waste management to consistently be improved.

One area which requires improvement is the level of local expertise or the lack of local experts in specific fields. This situation results from the fact that the development premises used are not based on local conditions. In order to take this aspect into full consideration, the following three approaches are suggested.

(1) People should be allowed, even encouraged, to perform those tasks which they are perfectly capable of performing. This is consistent with the second prerequisite mentioned above. In such a process, development resources will be multiplied both in quality and in quantity, thus increasing their availability for other activities.

(2) There should be a determination to deliver the results of activities to city officials and the general public as quickly as possible in order to convince all parties involved that the efforts are indeed worthwhile. This will have the effect of stimulating further efforts, increased interest, and a willingness to become more deeply involved.

(3) Effort should be made to recognize the involvement of all parties, particularly the low-income groups, in a humane manner. This is essential, in order to convince such groups that all their efforts are equally regarded and that they are not subject to misuse. It is also important to disseminate the information that benefits will be shared proportionally among all involved parties. This principle is the basis for a real partnership in

sustainable waste management.

Among the middle- and upper-income groups of Surabaya these approaches are broadly interactive with their interests as citizens, although sometimes only indirectly. But the impacts resulting from these approaches have consistently positive effects on their lives. Eight years of experience provides strong evidence in support of this hypothesis.

DEVELOPMENT PROGRAMME

In the process of maintaining the city as a pleasant environment in which to live, every citizen should be a participant. The role of the waste pickers and street cleaners should be regarded as being on the same level as other development actors and they should receive acknowledgment and material reward commensurate with their contributions. Most of the people working in this area are from the informal sector and therefore capacity-building programmes aimed at this section of the population could be most useful.

Urban waste management in Surabaya has developed in three stages, consecutively but also overlapping. Following its separation from the Department of Public Works, the Sanitary Department, now fully independent, began consolidating its working methods. An action plan was drafted and subjected to improvements, over time. Beginning with a detailed map showing the waste problems existing in the city at that time, questions were posed as to why, how, when, where, and by whom waste management should be carried out. Appropriate action was proposed and detailed plans formulated. Implementation followed and the results of close monitoring of the results were constantly fed back into the system to facilitate improvements.

Improvements in existing operational methods constituted the next stage. The department's external activities were given top priority which included the fostering of partnership activities with all sections of the community. As part of this action, over 13,000 street-sweeping and waste-collecting jobs were created. Due care and attention was given to the working conditions of these people and the welfare of their families was accorded special attention, particularly in terms of health care and income. As has already been mentioned, the private sector was encouraged to participate in the process with both cash and "in-kind" support. The scale of involvement gradually expanded to embrace the entire city.

The city governments' role in the management and development of the waste pickers and street cleaners of the informal sector came rather late. This was not because of a lack of importance being attached to them but more a case of shortage of personnel within the bureaucracy to perform the task. Staff members and students from the Laboratory of Human Settlements, *Institut Teknologi 10 Nopember (ITS)*, were involved at this stage and proved very effective as this stage required an intensified academic input. Also important was an emphasis on the humane aspects of the waste management process.

Following the organization of street sweepers and waste collectors, more attention was paid to the waste pickers who had often been subject to negative connotations. As mentioned earlier, they became known as the *MPK* having formerly been called *pemulung* or scavengers. Subsequent improvement efforts aimed at upgrading the quality of their lives have had positive results.

The *MPK* were organized into an informal group by the *becak* cooperative and the *ITS*; this group's name was the *Paguyuban Mitra Masukan Kuning (PMPK)*. Group members were provided with identification cards which were endorsed by the local district chiefs or *camat*. The group received official recognition from the city government and members were issued with uniforms and waste-picking tools. Their work is the subject of ongoing monitoring by city officials and the *ITS* assists in identifying areas for further improvement.

It is important to note that although the policy regarding the *MPK* was to upgrade their lives and to recognize the importance of their work, in no way were they encouraged to feel that their jobs were permanent or that they were trapped in that type of employment. Various types of training were introduced to enable them to improve their level of skills. The aim was to enhance their self-awareness and regard to the level of other citizens. They were included in important city functions such as the inauguration of development projects or meetings with top officials and visiting dignitaries. At all times the training was tailored to their specific needs and aspirations in addition to being organized in halls and meeting places in close proximity to their homes.

The training consisted of three basic parts. The first was an introductory session aimed mostly at the wives and female members of the waste pickers' families. Central to these sessions were family care issues such as cooking, clothes-making, and literacy lessons (for mothers and older sisters); kindergarten classes were provided for children under five. Other family care aspects such as health care and family planning were included. The trainers themselves were usually members of women's organizations, local elders' wives, or lecturers from local colleges and universities, particularly *ITS*. Being the subject of training by such distinguished personnel was itself a strong motivation for self-improvement.

At the end of each training session, a certificate of training completion was presented to each participant in a ceremony attended by high-ranking city officials. The first certificate was presented by the State Minister for Population and Environment, during the inauguration ceremony of a building donated by the private sector to be used as the headquarters of the waste-pickers' organization. Other training sessions included skill improvement training as needed by the waste pickers to improve their income, and cooperative development to increase their working capacity for a better profession in the future.

A number of studies have been carried out by local universities and private consultants which have proved to be an important component of the management system. They have enhanced the knowledge and understanding of the actual problems and the impacts of the various policies and programmes undertaken as part of the management system. This has facilitated the improvement of the system. Pilot projects and action research projects have been initiated to test new approaches to improving the management system. During the preparation of this report, a third model for training waste pickers was being conducted which involved a major waste generator acting as organizer of an *ITS*-supported training programme. This model is an improved version of the earlier models which were organized mainly by *ITS* and the Sanitary Department.

From the researcher's point of view, the knowledge gained was important to developing an appropriate concept or model to effectively manage the ever-increasing volume of

waste, to protect and improve the urban environmental quality in general, and to carry out community-based sustainable development. From the students' and university staff's point of view, their involvement in this type of activity provides an important real-life "academic" experience, and a possibility to integrate the experience with knowledge of waste management.

CONCLUSION

It is evident that the system of waste management has in most respects, managed to overcome the lack of public resources by stressing the humane partnership approach. However, this still does not solve the problem of lack of space for waste disposal facilities. Although recycling has been in operation for some time it will take a while longer before it becomes really effective and accepted in all cities. Landfill is still the preferred method but by the year 2000 Surabaya will require at least an additional 250 ha of land. It is thus imperative to examine alternatives, as waste continues to be produced in increasing volumes.

In 1990, a French system of waste incineration was installed in Surabaya on a trial basis. During this trial period, city officials, assisted by experts from the Institute for Study and Development of Technology (BPPT) together with *ITS* assessed the system for its environmental impacts and its technological appropriateness and tried to determine whether such a system could be adopted elsewhere in the country. The system was controversial, particularly in terms of its energy efficiency levels and its environmental impacts. The city government is therefore well aware that neither landfill nor incineration will satisfy everyone, particularly the environmentalists, but with waste generation continuing at an ever-expanding rate and the urban population continuing to increase, the city government must adopt whatever means are necessary to tackle the waste disposal problem. It will be an extremely difficult task to both tackle the problem and take into account criticism from all the actors involved.

COMMENT

KUNITOSHI SAKURAI

After observing the solid waste management (SWM) systems in many cities of the developing countries, I am convinced that from the waste pickers' viewpoint, Surabaya has one of the most humane systems anywhere. This is my conclusion after participating in a study of Surabaya organized by the Japan International Cooperation Agency (JICA). In response to a request from the Government of Indonesia, from 1991 to 1993, JICA prepared a *SWM Master Plan for the City of Surabaya*. I had an opportunity to participate in the project as the leader of the preliminary study team as well as being a member of the advisory committee for the full-scale study.

SWM in Surabaya embodies a number of positive examples worth emulating, although it is of course possible to identify some areas where improvement is needed — such as the need for conversion of open dumps into sanitary landfills. Surabaya has repeatedly received acclaim, both locally and internationally, for its efforts to achieve better SWM. This shows that Surabaya's performance in SWM is widely recognized. Management philosophy and the style of Surabaya's SWM are described as "a real partnership approach," words frequently used by the authors of this article — Eddy Indrayana and Johan Silas. Indrayana, who served as the Director of the Cleansing Department of the City of Surabaya, is the best person to talk about the above-mentioned management philosophy.

Like many big cities in the developing countries, Surabaya has a considerable number of circular or seasonal migrants coming from neighbouring towns and villages. They come to the city for the purpose of income generation, but job opportunities are limited. When jobs are available, they are in many cases informal ones as shown in table 1. Under such conditions, it is very important for the SWM service to create job opportunities for unskilled workers who are abundant in the city.

The solid waste collection system in Surabaya consists of primary collection, which is carried out by local communities, and secondary collection, borne by the Cleansing Department of the city government. Streets are swept by both the communities and the Cleansing Department. This system, which is called "a two-tiered or dualistic waste collection system" by the authors, is based on the partnership between the public waste collection services and communities. This partnership system is widely observed throughout Indonesia and seems to be indispensable for delivery of a reasonable waste collection service to as many people as possible with the limited resources available from local governments.

TABLE 1. CLASSIFICATION OF SURABAYA'S POPULATION BASED ON OCCUPATION (1987)

Occupation	Percentage
Civil servant/private office worker	20
Farmer	2
Merchant	10
Fisherman	1
Factory worker	3
Carpenter	4
Retired	4
Unemployed	13
The poor	5
Others	38
TOTAL	100

Source: Enri Damanhuri and Budi Listyawan, "Public Participation as a Variable in the Metropolitan Solid Waste Management System of Surabaya" (Paper presented at the International Expert Group Seminar on Policy Responses towards Improving Solid Waste Management in Asian Metropolises, held in Bandung, 4-8 February 1991).

This dualistic system is effective also from a technical viewpoint. As mentioned in the article, approximately two-thirds of the population of Surabaya live in *kampungs* where household waste can only be collected by handcarts because of the narrow lanes. Therefore the transfer of waste from handcarts (primary collection) to motor vehicles (secondary collection) is essential for efficient collection and transportation. This transfer is carried out at small transfer stations called depots.

Thus, as mentioned in the article, the SWM system in Surabaya generates 13,000 garbage-collecting and street-sweeping jobs. If waste pickers are added, this figure becomes approximately 16,000, which means that almost 3 per cent of the population is estimated to be directly dependent on SWM — if family members are also taken into account. Therefore, it is possible to conclude that the SWM system in Surabaya is fullfilling one of the most important missions delegated to it, namely, job creation for unskilled workers.

Moreover, it is done in a most humane manner — the waste pickers are considered as "partners of the yellow force". While their vested interests as waste pickers are respected, they are also given training so that they will be able to gain more respectable jobs as soon as possible. This is to avoid creating the feeling that waste pickers are trapped in this profession. The following illustration may show just how friendly to waste pickers the SWM system in Surabaya is.

If one visits Surabaya, he or she will immediately notice twin trash bins painted in yellow and blue. They are placed regularly along all main streets. In residential areas, twin concrete enclosures painted in yellow and blue can be observed instead of garbage bins. Yellow bins or enclosures are for wet waste while blue ones are for dry or recyclable wastes. I originally thought that this system had been introduced to improve the

operational conditions of the incinerator located at Keputih landfill. The 200-ton per day incinerator, which was the first modern incinerator in Indonesia and began operating in 1991, had been suffering from the poor quality of mixed waste. Accordingly, I thought that the objective of the separate discharge system was to supply dry waste with a higher calorific value to the incinerator.

It was, however, not the case. The separate discharge system was introduced in order to make the work of street waste pickers easier. After the waste picking, the waste deposited in both yellow and blue bins/enclosures is collected as mixed waste. While waste pickers in Surabaya are treated with respect, the Keputih incinerator continues to suffer from poor quality waste. It will be worth studying the use of a separate discharge system not only for the benefit of waste pickers but also for that of incinerator operation.

It can be said that the SWM system in Surabaya is well-adapted to the present socioeconomic and physical conditions. It is based on well-established community organizations as well as the traditional Indonesian way of life epitomized by *gotong royong* (helping one another). It is also oriented towards the future development of Indonesian society, assisting waste pickers to pursue their own career development.

As the conclusion to this comment, I would like to list some further research needs. Firstly, it is necessary to make clear how the present partnership could and should be developed further, together with the development of Indonesian society. Secondly, a study is needed into how this valuable Indonesian experience can be effectively transferred to other societies.

WASTE MANAGEMENT AND THE NEED FOR PUBLIC PARTICIPATION IN BANGKOK

KSEMSAN SUWARNARAT AND WATANA LUANRATANA

GENERAL VIEW

Thailand covers an area of 513,115 km^2, and its population was 55.8 million in 1989. Bangkok, the capital city, is the centre of the country's development. It is characterized as a primate city, with a population of 5.5 million, or about 10 per cent of the country's population. If the temporary population of Bangkok were added, the daily population may be as high as 8 million. The city area covers 1,565.2 km^2.

Although Bangkok is the country's most important socioeconomic centre, it nevertheless suffers from a shortage of infrastructure. The rapid urbanization, the great freedom of the private sector to build, and the inefficient management by the public sector have resulted in a shortage of much needed infrastructure.

In the earlier stage of the city's urbanization, water channels were its main source of transportation, but the construction of roads since around 1940 has rapidly changed its urban structure. Land development projects are the sole activity of the private enterprises. Construction activities have taken place along the main roads, first in the form of commercial row houses and later, housing projects. These construction activities have increased the number of vehicles in the main roads without a corresponding increase in through-traffic capacity.

Along with the traffic congestion and noisy roads, the city faces many problems relating to urbanization, such as water pollution, floods, litter, and low-standard human settlements. Refuse disposal is the most important task of the Bangkok Metropolitan Administration (BMA), the municipal authority.

Bangkok is a very rapidly developing city. It has 90 per cent of the country's economic wealth. The city used to be a small community on a riverside where most of the population lived on house-rafts or floating-homes. The river and tributaries served as water supply, waste disposal, and transportation. The climate was mild and life was easy. Natural disasters such as earthquakes, bushfires, volcano eruptions, or typhoons were relatively rare. There has been a lack of planning and implementation of public utilities such as water supply, public transportation, telephones, and others.

Bangkok is about fifty times larger than the largest regional city.[1] The governmental, financial, educational, and cultural centres, as well as the largest harbour are located in the city. Over 90 per cent of the country's imports and exports pass through it, and the major industry and trade establishments (38 per cent of the industrial firms) are located in

Bangkok metropolis. Thirty-two per cent of the gross domestic product (GDP) and about half of the value added are generated in Bangkok. Other indicators of Bangkok's primacy are its electricity consumption, which is five times higher than elsewhere in Thailand, and its telephone connections and motor vehicle registrations, which are respectively 5.4 and 3.5 times higher than the national average.

Bangkok serves well as a full-scale physical model to show how badly the environment can be abused as a result of an unplanned development which is solely driven by the surge of economic growth and commercial incentives. The weak political principles and the bureaucracy have not provided the necessary effort to solve the public problems. The total amount of taxes collected and the annual BMA budget have always been very low. Per capita funding of about 1,940 *baht* (US$77.6) or 6.9 million *baht* (US$0.28 million) per km^2 per year is too low for the BMA to expect an adequate level of public services. The BMA had to set priorities to cope with the situation.

WASTE MANAGEMENT PROBLEMS

In the course of economic development, as people gain new commodities, they discard the old ones. Both the content and volume of waste discarded reflect the population's standard of living. Bangkok has not yet been overwhelmed by throwaway beer and soft-drink cans or multiple layers of TV-dinner packaging and discarded gift wrappings. Sixty per cent of the refuse per day in weight is organic, and 60 per cent or more is in moisture. But the city is growing, and it is predicted that the increase in per capita rate of refuse generation will bring the total daily amount collected up to 9,500 tons per day by the year 2000.[2/] For example, the BMA collected about 4,200 tons of refuse per day in 1991, which were transported to two disposal sites, one east and the other one west of the metropolitan area.[3/] Of fifteen major laws pertaining to refuse disposal in Bangkok, some govern the municipal authority while others regulate the people. Most important are the *Public Health Act of 1941* and the *Factory Act of 1969*.

The *Public Health Act of 1941* forms the basis for management of all community solid wastes. The act places the disposal activities under the responsibility of local authorities, such as provinces and the BMA, stating that the authorities should be responsible for safeguarding the public health. While the law demands the local authority to take care of refuse, it also limits the level of the collection and disposal fee to the value specified. In many cases, this is an obstacle to the development of the services.

The *Public Cleansing and Orderliness Act of 1960* specifies property owners' responsibility to prohibit the disposal of refuse and excreta in public areas. However, the level of fines is limited to only 50 *baht* per offense.

The *Factory Act of 1969* specifies that persons operating a factory provide for the removal of solid waste from the factory and for the protection of public health. The implications of this act are somewhat in-between the Public *Health Act* and the *Public Orderliness Act*, because the factory owners are not allowed by the *Public Health Act* to take charge of refuse disposal on their own, nor are they allowed to litter public places. In effect, the factory owners will have to find ways to eliminate the refuse on-site, or obtain disposal service from the local authority. Otherwise, they will have to find ways to treat

the refuse as other than refuse.

However, a considerable amount of refuse left in public places, such as parks and road surfaces, is also a burden to road sweepers. The number of road sweepers required in Bangkok is in fact, more than for solid waste collectors. The ratio between the road length and the number of sweepers is presently about 1.3 km/person.

COST AND REVENUE

The cost of solid waste collection in the Bangkok metropolis differs from one district to another. There are thirty-six districts which cover about 1,500 km^2. Factors affecting the difference are related to the tonnage collected, demography, transportation costs to the landfill sites, and the efficiency of manpower and equipment usage. The range of both collection and transportation costs in Bangkok varied from 187 *baht*/ton to 690 *baht*/ton in 1986.[4/]

Almost half (45.97 per cent) of the expense was for the collection and disposal of refuse (table 1). Night-soil disposal accounted for 40.97 per cent of the annual payment. However, the revenue from night-soil collection fees was highest among all the revenue groups in 1989. This may reflect the importance of the night-soil disposal services, compared with the refuse disposal. One may conclude that people want the night-soil service and are willing to pay a lot for it, while the officials pay more attention to the refuse disposal service. The revenue collected from the refuse disposal service was very low (see table 2). For example, an average Bangkok household earns 50,000 *baht* a year, and produces 1.46 tons of refuse per year, costing the city about 248 *baht* to dispose of. However, the city is legally allowed to collect only 150 *baht*.

Fees for solid waste collection were originally set in the *Public Health Act of 1941*, amended in 1954, 1962, and 1986. The fees vary according to the source and amount of waste collected. The fees collected are shown in table 3. Each district is responsible for the collection of fees. In 1987, approximately 25.8 million *baht* were collected from all sources.

In 1989, the total number of trips made by collection trucks was 33,358. The total amount collected was 124,931 tons, and a total of 2.64 million *baht* was collected in fees. In other words, the fees collected were 21 *baht*/ton or 79 *baht* per truck-trip. This value is very low, compared with the actual acquisition and investment costs of the trucks.

The income from refuse collection and disposal is much less than the income from night-soil disposal (table 4). The night-soil service yields a high share of income for the Department of Public Cleansing (DPC). The total income of the DPC increased to about 24.46 million *baht* in 1990, with similar proportions in the categories shown in table 4.[5/]

PUBLIC PARTICIPATION

The legal implications demand that refuse collection be under the responsibility of the local authority. Whatever may be left in public spaces will be considered as municipal refuse to be removed and disposed of in a hygienic manner by the local authority. The amount

TABLE 1. VARIOUS CATEGORIES OF EXPENDITURES IN 1989

Expense	B/cap	Type	*Baht*	Per Cent
Privatized collection	6.30	ref.	33,400,000	6.28
Privatized dispoal	5.66	ref.	30,000,000	5.64
Refuse disposal	17.12	ref.	90,721,300	17.06
Privatized klongton	0.02	ref.	100,000	0.02
New compost plant	9.43	ref.	50,000,000	9.40
Incinerator for infectious waste	7.55	ref.	40,000,000	7.52
Privatized Bangkok noi	0.02	ref.	100,000	0.02
Privatized klong toey	0.02	ref.	100,000	0.02
Night-soil treatment	14.54	n.s.	77,061,400	33.26
New night-soil plant	7.74	n.s.	41,000,000	7.71
Cleansing service	30.38	c.l.	161,002,100	30.28
General administration	1.05	adm.	5,540,600	1.04
Promotion	0.50	adm.	2,649,600	0.50
TOTAL	100.32		231,675,000	100.00

Note: ref. = refuse; n.s. = night-soil disposal; c.l. = public cleansing; and adm. = administration.

TABLE 2. REVENUE FROM REFUSE COLLECTION IN 1989

Number of trips	Tons	Baht fee	B/ton	B/trip
33,358	124,931	2,644,101	21	79

TABLE 3. REFUSE COLLECTION FEES

Source	Daily volume (in litres)	Baht/month 1962-85	Baht/month 1985-present
House or building	20	4	40
	40	6	60
	60	8	100
	80	10	150
	100	12	200
	200	-	300
	300	-	500
	400	-	700
	500	-	900
Market, factory, or other places	0-1 m^3	40	2,000
	Over 1 m^3	400/m^3	2,000/m^3

TABLE 4. DEPARTMENT OF PUBLIC CLEANSING INCOME PER CAPITA OF BANGKOK METROPOLIS POPULATION

Income 1989	*Baht*	B/Cap
Night soil	12,796,381	2.387
Fines	5,132,009	0.957
Mobile toilet fees	931,300	0.174
Refuse collection fee	367,585	0.069
Bid formula fee	224,500	0.042
Water-tank service fee	143,650	0.027
Dry-sludge sale	39,200	0.007
Plastic bag sale	30,260	0.006
Water-tank sale	16,600	0.003
Compost sale	13,200	0.002
Dustbin sale	10,280	0.002
TOTAL	19,704,965	3.676

and location of the refuse generation is, therefore, unlimited and beyond any legal regulation, while its removal and disposal by the municipal authority is limited by the available budget and the level of revenue generated. Such a situation is clearly illogical when observed systematically.

The cost of collection will be significantly reduced if the public participates. For example, each household keeps refuse bins in good condition and places them at the right location where the municipal truck crews can come to collect them.

Large amounts of waste may be avoided if individuals were to buy goods without unnecessary packaging, or the dealers recycle the packaging materials back to the origin of production, or else assist in transporting the waste directly to the disposal site. Used objects such as furniture and electrical appliances may be returned to the dealer for collective disposal or recycling.

The authority provides receptacles at public locations and institutions such as marketplaces, schools, and government offices, while individuals should be requested to bring the refuse to those receptacles. Collection and transportation costs will be lower than a house-to-house collection system.

While merchandise is transported into a community, refuse has to be removed from it in order to maintain a healthy environment. Therefore, the public may help reduce refuse by buying durable goods.

The per capita amount of refuse to be disposed of in an urban area is related to the capability of a person to bring goods into his/her residence. If he/she is capable of bringing in big amounts of refuse in the first place, there ought to be no excuse why he/she should not be able to take it out for disposal. If the excuse were to be that he/she "has no time," the answer would necessarily be that he/she ought to then "be able to afford its disposal".

Therefore, the public can also participate by paying fees to cover the cost of disposal.

Accurate economic and population forecasts ensure that an adequate budget will be allocated for a reliable service. Therefore, there is a need for planning for refuse disposal in line with urban development schemes.

The refuse dilemma in Bangkok is due to the fact that the law demands that people have a right to dispose of waste, while the municipal workers are responsible for removing the waste from every public space. The law implies that the cost of the refuse disposal service will be met adequately by the public who pays for the service in terms of taxes and fees.

WASTE RECYCLING

The most striking feature of the municipal solid waste system in Bangkok is the extensive presorting of materials for sale. The major materials which are sorted out include paper and cardboard, glass bottles, plastics (both bottles and sheets), metals (ferrous and nonferrous), and rubber. Materials are separated at several stages of the collection process, including at source, prior to collection; by the crews of collection vehicles; and by waste pickers at the dump sites.

In each case, the materials are generally sold, perhaps through middlemen, to small-scale recycling businesses who sort and clean the materials before selling them to a wholesaler who deals directly with user industries.

Some materials (e.g., newspapers, magazines, cardboard, and bottles) are separated directly at source. When a deposit has been paid, for example, for returnable bottles, these materials may be returned to a retailer. Alternatively, they may be sold to collectors who operate a door-to-door collection on three-wheeled cycle-carts.

Street pickers also sort out more valuable items (e.g., cardboard, white paper, shoes, and clothes) from waste bins and containers prior to collection by BMA crews. These pickers generally sell to local junk shops, which also buy larger items directly from householders. These junk shops are licensed in a similar way to pawnshops. There are currently about 950 such junk shops in Bangkok.

The majority of refuse collectors, whether employed by the public or private sector, sort recyclable materials from the refuse collected on their routes. The method of sorting varies among vehicle types. For example, it is easier to sort refuse collected on a side loader where the waste is easily accessible for hand sorting, than on a rear-end loader where selection must be made before loading and compacting.

These pickers work in a team. The collectors, who move ahead to pull out the baskets of waste in advance, sort out visible valuable items. On a side loader, one of the crew is inside the vehicle to pack and store the waste and performs more intensive sorting. The driver, though not involved in the sorting activities, acts as a public relations man establishing good rapport with the residents, shop owners, or factory owners. Occasionally, the driver may give orders to the crew.

Earnings from the sorting of recyclable materials vary from 100 *baht* to 300 *baht* per vehicle/day, thus representing an important additional source of income (20 *baht* to 60 *baht* per person/day).

Selective sorting is practiced to recover the most "valuable" or "salable" items, such

as clean paper, cardboard, bottles, and plastics. These materials are segregated by type or grade into bamboo baskets and are sold to small-scale recycling shops adjacent to the two main waste disposal sites.

The final stage of the recovery process takes place at the dump site itself. Waste pickers there use only simple tools, such as spiked-sticks and a woven plastic bag hanging on their belts while they go on top of the garbage mountains to do their work. Some wear protective gear such as gloves and boots. They sort through the refuse as it is tipped, and separate out recoverable materials. The amount of material recovered varies from 50 kg to 150 kg per person/day, and the daily income varies from 30 *baht* to 300 *baht* per person. Like the waste collection crews, the pickers sell their output to the shops near the dump sites, either prior to or after further sorting and cleaning at their homes. Of the shops and trucks observed, roughly 50 per cent of the recovered materials was paper products, 20 per cent was glass, another 20 per cent was a mix of hard and soft plastics, and the remaining 10 per cent was metals.

At the Nong-Kaem dump site, 2,500 tons of solid waste are brought daily into an access road, Petkasem 104, which is about 1 km long. There are seven recycle shops along this road. Reportedly, 5 to 15 tons of recyclables are brought into each shop everyday. The sorted materials and their outlets are as follows: plastics, both hard and soft, will be sold to shops in Bangbon, Bangkoontien, Bangprakok, and Prapadaeng, southwest of Bangkok; iron scraps to the south (Prapadaeng); bottles to the north (Don-muang and Ladkrabang); and paper to the west (Nakornchaisri). There are 400 waste pickers at the Nong-Kaem disposal site. Their productivity per capita is shown in table 5.

TABLE 5. EFFICIENCY OF PICKERS AT THE NONG-KAEM DUMP SITE AND SALE PRICE OF RECYCLED MATERIALS

Materials	Kg/person/day	Baht/kg
Bottles	50	2.50
Hard plastics	18	2.00
Soft plastics	10	2.00
Iron scrap	4	1.00
Pieces of identifiable articles	3	1.25
Brass, copper, and aluminum	2	10.00
Cardboard	3	1.00

At the On-Nut dump site, 1,500 tons of solid waste are brought daily. There are eight recycle shops flocking around the entrance of the disposal site. However, many shops along On-Nut road, which is about 10 km long, also extract recyclables.

Reportedly, 1.3 tons of recyclables are brought to each shop everyday. The shops have about a 2,000-*baht* buying capacity. The materials are further sold to unidentified reproduction factories. The profit margin can be seen in table 6. There are 200 waste pickers on the On-Nut disposal site. Each one earns about 80 *baht* per day.

The margin between the buying and selling prices depends on the size of the material to be stored at the shop before further transaction. There is certainly a level of rationality even in this kind of trade in Bangkok.

TABLE 6. BUYING AND SELLING RATES OF RECYCLABLES AT THE ON-NUT DUMP SITE IN BANGKOK

(in *baht*/kg)

Materials	Buying	Selling
Glass	0.50	0.70
Plastics	2.00	3.00
Iron scrap	1.00	1.20
Cardboard and paper	1.00	3.00

Paantip Petmaak and Kannika Angsutanasombat[6] reported that most waste pickers were migrants from the central area provinces. Most families consist of five persons. Two of them work, while the rest are dependents. Each family had an average income of 4,027 *baht*/month and worked seven to nine hours per day. Most of the workers use three-wheeled cycles of a single rear-wheel type as their vehicles. Two-thirds of the workers (64.58 per cent) have their own vehicles. The rest rent vehicles for 10 *baht* to 30 *baht* per vehicle/day. A main operational problem confronting the waste pickers was that the police limited their access to the main roads. They were asking for recognition as a legalized occupation. However, the police limited access to the dump sites to the three-wheeled vehicles on the basis of traffic regulations and type of vehicle in relation to the type of roads, but not on the basis of the drivers' occupations.

Shops buy and clean recyclables for sale to reproduction factories. Each shop registered as an "antique dealer" deals with about thirty-five transactions per day. About 15.5 per cent of the shops rent three-wheeled vehicles. The average daily transaction is 18,920 *baht*. The weight of the materials dealt with daily is 4,411 kg. The total value of transactions by the 120 shops interviewed is 2.27 million *baht*/day. The total number of households engaged in this trade in Bangkok is 3,000 families.

THE REUSE OF ENERGY FROM WASTES

In their study on refuse disposal, Yupin Prachuabmoh and Nukul Yuenyong[7] concluded that the Department of Sanitation failed to serve the population properly. They pointed out correctly that the BMA had been operating the waste management system with constant subsidies from the income of other sectors. The expenses had always exceeded the revenue in this sector.

Yupin and Nukul[8] also studied the use of refuse for generating electricity and waste management improvement. They found that the refuse generated in Bangkok was wet, and used an economic model with a range of viable calorific values. Results of the model application showed that the best cost-benefit ratio of the project was only 0.45. It would be economically viable only when the investment cost was covered by an external source of funds, such as from the central government. Then the cost-benefit ratio would be just above 1. Such findings tend to substantiate the point of view that people will ultimately have to participate in waste reduction and management activities.

THE MISSING SOCIAL LINK

The BMA has realized the importance of waste pickers and recycling. In 1990, the Department of Sanitation started a vigorous campaign to recycle newspapers and packaging materials. Training programmes have been organized to train people in the low-income sector to turn waste paper into useful materials, such as baskets and boxes. It was suggested that colourful magazine covers and advertising leaflets can be reused as attractive gift-wrapping paper. Styrofoam was successfully banned in water-float festivals.

Several practical methods for reuse have been promoted by the Department of Sanitation, apparently due to the Director-General's appreciation for environmental problems concerned with waste disposal. The Director-General's practical approach in this case is unique. Her role as a stakeholder in the BMA is equivalent to the activities of "Magic Eyes," a nongovernmental organization (NGO) which operates under the leadership of a socially well-recognized personality from a banking business group. Magic Eyes concentrates on raising public awareness on the environment. The "stakeholder" stipulated in UNCRD's 1991 Bandung conference was exactly what the Director General of the Sanitation Department has been doing at the BMA, and also what the distinguished lady chairperson of Magic Eyes has been pursuing in the private sector for many years.

A missing link between the stakeholders and the actual achievements of the urban waste management is the absence of amendment of regulations concerning waste disposal. The BMA has not yet improved the regulations concerning the type, size, and number of garbage bins per home. There is no official colour coding of the bins to facilitate recycling, although the BMA is building the largest compost plant in the world (1,000 tons per sixteen hours/day). Such a missing link may cause toxic contamination of the compost and render source-separation uneconomical. Such social missing links may, in fact, unfortunately spoil many good ideas and render stakeholders' earnest efforts wasted.

TACTICAL FRAMEWORK

To ensure that an effective outcome reaches the goal of total management of waste streams in an urban area, one may formulate a strategy based on experiences. A unified goal which is fully acceptable to a community must be set and regularly referred to, in order to form a single frame of reference and a common public policy which will drive every individual to follow the goal. The most effective objectives are community welfare, economic development, human health, and environmental quality.

A policy must be set with achievable goals. There must be credible evidence of success and effective technology or manageable procedures. What can be done and by whom must be clearly stated. A timetable should be worked out for implementing the management strategy. In the case of a recycling project, for example, what will be sorted by the householders must be made clear. They also have to know where they can deposit or sell the materials. Otherwise, the whole philosophy of recycling may end up with people complaining about the heaps of material in their houses which are not going anywhere.

Some policies may be fully acceptable to the citizens, but others may be acceptable only after certain conditions are met. Various effective activities may be proposed,

including drafting new legislation, motivation campaigns through the mass media, setting-up recycling communes, promoting a less wasteful life-style, and self-help in waste reduction and individual composting for gardening.

Other activities may be partially acceptable and require some conditional provisions, such as: increasing service fees may require improved service; reuse of waste retrieved from dump sites require hygienic processing; sorting in trucks on the way to the disposal sites demands proof that there is no loss in overall efficiency; utilizing garbage as landfill material where no soil pollution danger is likely; municipal composting where the garbage is mainly organic; and incineration where the energy recovery is high and the air pollution is controllable.

Each of these strategy components needs a stakeholder to advocate and provide the education to the public by informing them of the relationship between such undertakings and the common goals set earlier.

CONCLUSIONS

Waste disposal problems arise as the community grows and becomes prosperous. The occurrence of wastewater and solid waste is not accidental. Economic and urban development generates an increasing volume and diversity of waste which will have adverse effects on the well-being of the communities if management is inadequate.

The legal implications of waste management may be unrealistic if the ecological and economic systems are overlooked. For example, the law allows for discharge but does not include a provision to meet the demand on the cost of service.

Waste disposal costs time and money. However, such expenses are worthwhile for the urban economy. Public participation also serves as a means to reduce the burden and difficulties of refuse disposal. Although such efforts are not up to the level that they may replace the municipal service, and the urban situation does not provide the space and time required for individuals to dispose of their wastes, the individuals can help simplify the collection and disposal processes.

The technology available for solid waste management (SWM) is diverse. It might be asked whether landfill is better than composting, or whether composting is really better than incineration. The complex structure of urban areas, the changing characteristics of wastes, and the availability of sites for disposal will not allow such an absolutely generalized solution. All the technological approaches have their drawbacks and merits.

The BMA is still in its early stages of utilizing appropriate disposal technology. Although any additional method of disposal will do more good than damage at this stage, the administration has been very cautious in its investment plan.

If less funds are available, there will be a need for more public participation. Refuse is derived from commodities brought into the homes and these are originally separated. Those who brought the goods into the homes must be able to take them out or help to make their removal easy by performing source separation. The separation is in fact not extra work because mixed refuse will not occur if no one mixes the discarded materials together. If this cannot be done, the waste generator will have to pay someone to do it for him/her. If such a service is rendered by the municipality, a service fee must be adequately imposed.

A large city's SWM system is a costly necessity. Careful planning with due consideration to the available social resources should be carried out. Technology picked up as a piecemeal solution will be very costly, and unplanned development is dangerous for the population's well-being.

NOTES

1/ National Economic and Social Development Board (NESDB), International Bank for Reconstruction and Development (IBRD), US Agency for International Development (USAID), and Asian Development Bank (ADB) Metropolitan Planning Project Group, "BMR Study" (Bangkok Metropolitan Regional Development Proposals: Recommended Development Strategies and Investment Programs for the *Sixth National Economic and Social Development Plan (1987-91)*) (Bangkok, 1986).

2/ Tams-Pirnie International and Act Consultants, "Feasibility Study on the Management of the Disposal of Bangkok Municipal Waste" (Submitted to the National Energy Administration (NEA) and the Bangkok Metropolitan Administration (BMA)) (Bangkok, 1988).

3/ Department of Public Cleansing (DPC), "Bangkok, the Clean City 2534" (Bangkok: BMA, 1991) (in Thai).

4/ In 1986, the exchange rate was 25 *baht* to US$1.00.

5/ DPC, "Bangkok, the Clean City 2534."

6/ Paantip Petmaak and Kannika Angsutanasombat, "Relationship between the Informal Labor Forces in Slums for the Development of the Environmental Qualities in the Bangkok Metropolitan Economic System: Specific Study on the Collection and Trading of Waste Materials" (Bangkok: Human Settlement Foundation, 1990).

7/ Yupin Prachuabmoh and Nukul Yuenyong, "Private Investment in the Refuse Disposal Business: An Economic Analysis" (Bangkok: Department of Economics and Business Administration, Kasetsart University, 1991).

8/ *Ibid.*

COMMENT

M. B. PESCOD

Ksemsan Suwarnarat and Watana Luanratana point out deficiencies in the waste management system currently operating in Bangkok, and stress the need for rational planning and public participation. Their recommendations are entirely appropriate, but the past history of waste collection and disposal in the Bangkok Metropolitan Administration (BMA) area does not provide any reassurance that significant change will take place in the foreseeable future.

From the 1960s, when the city's population was starting to increase rapidly, solid waste management (SWM) has been a low priority with the municipality's administration. Even then, the collection service was poorly organized, inefficient, and inadequately financed, and waste disposal was in the hands of unqualified officials. One of the largest composting plants in the world was in operation at Din Daing in the centre of the city, but no coordinated attempt was made to utilize the product in the agricultural sector. Composted refuse was stockpiled on the site and yet several more composting plants were purchased by the municipality for other locations. Meanwhile, a mountain of refuse was accumulating at the Soi On-Nut dump site, then on the outskirts of the city.

Recycling has always been achieved informally in Bangkok, and has supported many families who would have been unemployed but for the presence of domestic and commercial refuse. The authors describe the stages of reclamation of recyclable components of refuse in Bangkok, from source via collection-crew sorting to picking at or near disposal sites. It is clear that while many poor people rely on refuse recycling for their survival, "middle-men" who purchase the sorted components from the pickers make more money. What is not mentioned by the authors are the severe health problems suffered by the families of pickers, who often live on refuse dumps. Skin and eye infections are commonplace and children are brought up under atrocious environmental conditions. While waste reclamation should be encouraged, and the families now relying on this activity should continue to gain support from it, the time has come for it to become a more organized and controlled system with proper health measures to protect those involved. Collection crews should be provided with incentives in the form of better wages and conditions to prevent them from participating in the reclamation process and allow more efficient and less costly collection of waste.

The authors' suggestions for public participation, although desirable, are somewhat idealistic. The first recommendation, to optimize the waste management system, is unlikely to be achieved by the BMA, which is not noted for its ability to plan or manage

effective waste systems. Packaging control is the next suggestion and is not feasible in the free-market environment of Thailand. Returning used materials to dealers, again is impractical in Bangkok as in most other major cities. Public use of centralized collection points requires planning by the BMA and public education, both difficult to achieve but, in addition, would give rise to significant environmental pollution at the collection stations, as occurs in Indian cities. The suggested approach of providing more durable goods seems unlikely to be taken up in an industrial culture of built-in obsolescence. Finally, the polluter pays principle applied in many countries around the world will be more difficult to implement in Thailand, where any form of taxation is difficult to collect and economic charges are not made for any public service. The BMA has a very poor record of property tax and waste management charge collection, so there is little prospect of an improvement in that direction.

In the last section of their article, the authors make some suggestions which they consider might be readily accepted by the public. Drafting new legislation is identified as a necessary and useful step towards improving SWM policies in Bangkok. However, the existence of appropriate laws and regulations does not ensure their implementation unless monitoring and enforcement are effective. To achieve that, it would be necessary to provide the BMA with qualified staff and resources to enable this function to be added to their current responsibilities. It would be impossible for the BMA to implement more appropriate solid waste legislation under the present structure because the Department of Sanitation does not have the number or quality of staff which would be necessary and cannot, at present, raise the revenue which would be required.

Another possibility which might be considered if the government had a real commitment to improving SWM in the city would be to set up a new independent solid waste authority, separate from the BMA. Such an authority could introduce economic charging rates for solid waste services and develop rational policies. Private-sector involvement would be more easily controlled and public participation could be more readily promoted through an efficient authority run on sound business principles with the power to enforce regulations. All the other suggestions given by the authors which are considered to be readily acceptable to the public, such as public motivation through the media, setting up of recycling communes, promoting a natural life-style, and encouraging self-help in waste reduction and household composting, could best be handled by an independent authority.

The current systems of waste disposal in Bangkok are not satisfactory, as the authors point out. There is an urgent need for rational planning in which options for treatment, reclamation, and disposal are considered from the technical, economic, and environmental points of view. Even if the public could be persuaded to indulge in household separation of recyclable components, or to reduce in other ways the quantity of waste generated, there will always be a requirement for a balanced waste handling and disposal system. A carefully considered waste management plan is essential if the people living in Bangkok are to receive an efficient and economic service and the environment is to be protected. Implementation of the plan, once it is conceived, is perhaps best placed in the hands of an independent solid waste authority. The responsible authority must be empowered through appropriate legislation, and the government must be prepared to accept the application of an economic charging system for solid waste services. Under the present institutional arrangements, little progress can be expected and, without the will to change coming from

the top, it is unlikely that a new structure for SWM will be set up in the near future.

PART II:

PARTNERSHIPS IN HAZARDOUS WASTE MANAGEMENT

IMPROVING THE MANAGEMENT OF TOXIC AND HAZARDOUS WASTES: A CASE STUDY OF SINGAPORE

JOO-HWA TAY

HAZARDOUS WASTE MANAGEMENT STRATEGY

A hazardous waste management strategy is a blueprint which outlines how, and by whom, hazardous waste will be managed. It determines the practical actions such as transport and disposal and the legislative and administrative controls. Supporting actions such as training, information, and laboratory services are essential parts of such a strategy.

The process of preparing a strategy is as important as the contents. The process includes the identification and quantification of the problems, identifying the waste management operations to be controlled, and establishing a common terminology and classification for waste. This is also the period when political support for a waste strategy is built, and when the essential process of communication with industry and the general public commences. All these preliminary deliberations lead to a clearer view of the purpose of a strategy and to a political commitment to pursue its implementation.

The contents of a strategy and the interrelationship between the legal, technical, organizational, and financial elements depend on the local factors prevailing in each country. The emphasis will vary from place to place, determined partly by the different nature of the problems, and partly by specific local constraints. An important early decision is to assign various areas of waste management responsibility. A large part of this will necessarily be assigned to the waste generators but the roles of government and the public are just as important.

Hazardous waste cannot be managed effectively outside a clearly defined legislative framework. The form of legislation will reflect the assignment of responsibilities. Even then, legislation cannot be implemented until it is clear that it can be complied with. This in turn may mean the establishment of new disposal facilities or the upgrading of old ones. The use of these facilities brings with it a requirement for training, education, and other support services. The entire strategy becomes a complex web of interrelated requirements. There are four main factors for the successful implementation of hazardous waste management strategies in the developing countries.

(1) The preparation of appropriate legal instruments for hazardous waste management taking into account the quality and quantity of available managerial resources in the developing countries. This will include: (a) practical definitions of hazardous waste, (b) practical classification of hazardous waste and development of corresponding technical standards, and (c) development of administrative standards.

(2) The development of appropriate managerial resources for hazardous waste management. This will include: (a) development of the necessary human resources involved in hazardous waste management, (b) preparation of an inventory of hazardous waste generators and its periodic updating, (c) development of data-processing capacity especially for the introduction of manifest systems, and (d) development of analytical capacity.
(3) The establishment of appropriate treatment and final disposal capacity in terms of both quantity and quality, because the system will become paralysed if the hazardous waste lacks an assured final destination.
(4) The provision of proper implementation and enforcement procedures. No matter how perfect a system may appear on paper, it is worthless if it is not effectively enforced.

In addition, there are some other basic requirements for hazardous waste management to be effective in the socioeconomic context of the developing countries. Any hazardous waste management system should have the following six basic elements. It should:
(1) Be clear and simple enough for the majority of the interested parties to understand;
(2) Have the least possible flow of papers, in order to avoid wasteful bureaucracy;
(3) Be harmonious with other systems of pollution control such as air and water pollution;
(4) Be so structured as to motivate changes in hazardous waste-producing processes instead of accepting them as nonvariable conditions;
(5) Utilize to the maximum the existing institutions and administrative structures; and, finally, it should
(6) Assure a balance between the demand for administrative and laboratory work originating from the implementation of the system and the supplying capacity for such work in the near future.

DEFINITION OF HAZARDOUS WASTE

In the last decade, considerable attention has focused on the question of what exactly constitutes hazardous waste. National systems differ both in the methods used for defining such waste and the type of waste to be included. These differences arise partly from variations in the institutional and legal frameworks of different countries. Hazardous waste is a special category of waste which, due to its toxicity, persistence, mobility, and combustibility, requires more stringent regulatory and technical controls when compared to waste such as municipal refuse. Hazardous waste covers a very wide spectrum including characteristics such as toxic, carcinogenic, mutagenic, teratogenic, ignitable, corrosive, reactive, radioactive, infectious, and malodorous.

The following definition of hazardous waste was prepared in 1985 under the auspices of the United Nations Environment Programme (UNEP) by the Ad Hoc Working Group of Experts on the Environmentally Sound Management of Hazardous Wastes.

> Hazardous wastes means [sic] wastes other than radioactive wastes which by reason of their chemical reactivity or toxic, explosive, corrosive or other characteristics causing danger or likely to cause danger to health or the environment, whether alone or when coming into contact with other wastes, are legally defined as hazardous in the State in which they are generated or in which they are disposed

of or through which they are transported.

There are two practical methods for the definition of hazardous waste. The first method is by analysis of hazardous characteristics and the second is by the lists method. The first method can be considered as a direct definition of hazardous waste while the second is considered an indirect definition.

In industrialized countries, both methods are used jointly to define hazardous waste. However, it is not advisable to depend on the direct definition method by analysing hazardous characteristics for the developing countries as these countries lack the expertise and sophisticated laboratories required for such analyses. The analysis method should be introduced only gradually into the definition system of hazardous waste when laboratory capacity for the analysis is available in the governmental agency responsible for hazardous waste management.

A practical definition of hazardous waste in many developing countries is based on the lists method. These lists usually include hazardous waste from various sources. Such lists may categorize waste by (a) specific technologies of origin, such as the petroleum refining, pesticides manufacturing, or organic chemical technologies; (b) waste from nonspecific sources, such as spent halogenated solvents used in degreasing or wastewater treatment sludge from electroplating operations, and (c) chemical names, such as polychlorinated biphenyls (PCBs), asbestos, or dioxin. A definition system of hazardous waste based on this listing method is used in Singapore and Malaysia, and waste materials categorized on the list are termed "scheduled wastes".

The advantage of the definition system based on the lists method is that the required laboratory work can be very little. The drawback is the fact that many nonhazardous waste materials may be included in these lists. A practical way to overcome this drawback is to request the generators to provide evidence if they claim their waste is nonhazardous. The limited analytical capacity of the public sector should be used to evaluate the validity of such claims and the pollution around hazardous waste management facilities.

QUANTITY OF HAZARDOUS WASTE

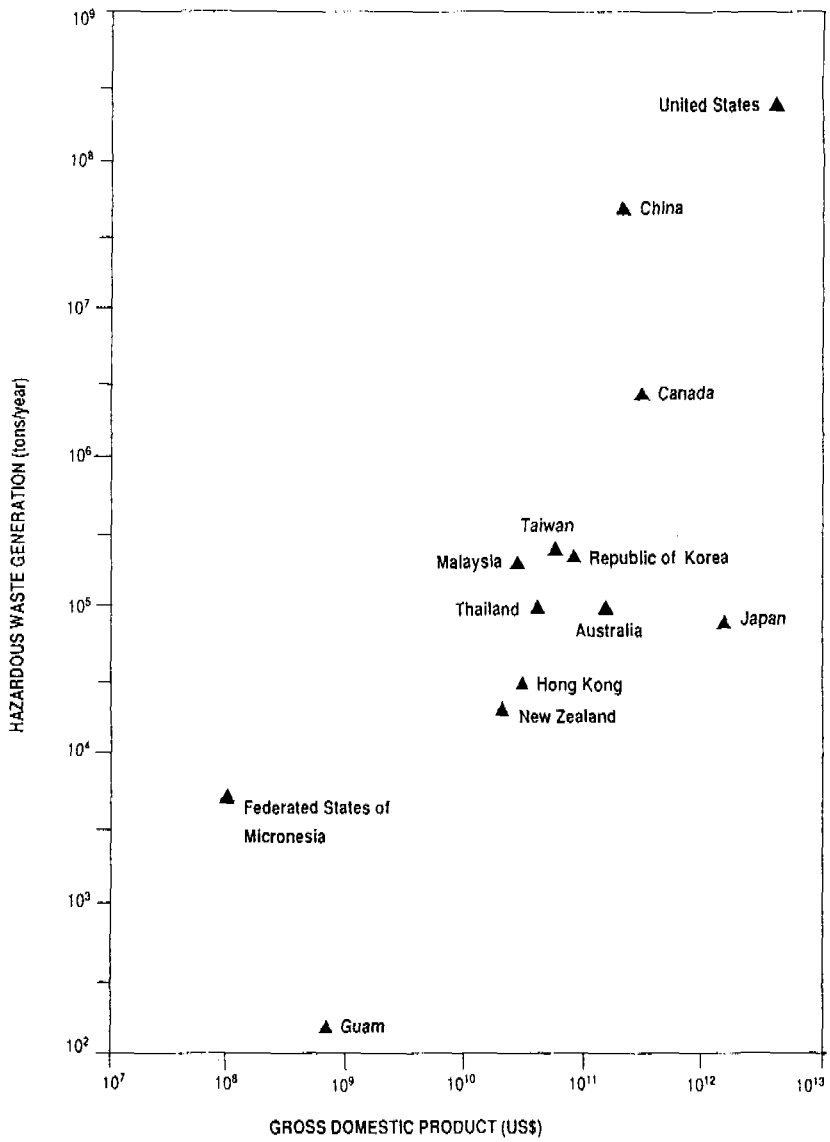
The effective management of hazardous waste requires information on the quantity, location, and source of the waste. Obtaining reliable information as to the quantities or types of hazardous waste produced by any country is very difficult. International comparisons are almost impossible because of the differences in the classification and definition of hazardous waste from country to country.

An attempt has been made by Yakawitz[4] to estimate the quantities of hazardous waste produced in different countries. It was estimated that for a number of Western European countries, hazardous waste production is about 5,000 tons per US$1 billion of gross domestic product (GDP). The figure for the USA is approximately 75,000 tons; the figure for the USA is higher because certain high volume wastewater streams are included in the calculations. The corresponding figure for Canada is 10,000 tons.

On the basis of very limited data, it was assumed that waste production in the former USSR could be estimated at 10,000 tons per US$1 billion of GDP, that in countries with mature industry at 5,000 tons, in newly industrialized countries 2,000 tons, and in

developing countries 1,000 tons. In recent years, the rapid industrial development in many countries of the Asian-Pacific Region has generated huge quantities of hazardous waste. Keen and Thaver[2/] studied the development of hazardous waste inventories in Asian countries and presented the rate of hazardous waste generation as a function of GDP as shown in figure 1.

Figure 1. Rate of Hazardous Waste Generation as a Function of Economic Activity



Note: Hazardous waste generation is not consistently defined from country to country.

The following four different approaches can be used for information collection on hazardous waste management.

Desk Study

In a desk study, relevant information on waste generators, types of industry, size, and location should be completed from the existing records. Estimates of hazardous waste generation can be obtained by the production capacity, number of employees, or other appropriate load factors established by other countries.

Monitoring of Waste Delivered for Treatment and Disposal

This approach attempts to measure the quantities of different types of waste currently being treated or disposed of, rather than measuring generation at source. The method can be applied either to all types of waste entering a site, or attention may be focused specifically on hazardous waste. Quantities entering recognized disposal sites are likely to underestimate the total, because of losses at various stages en route to the disposal site, for example, on-site disposal or temporary storage by the waste generators, intermediate salvaging of waste, and unauthorized dumping. Despite these limitations, this approach can give a reasonably reliable indication of the amounts and types of waste generated.

Sample Survey of Waste Generators

A survey of waste generation at source should represent a more accurate way of estimating quantities of hazardous and other industrial wastes. Ideally, an initial survey should be carried out by contacting all firms in the area under consideration, but the cost and time scale of a complete survey is likely to be prohibitive, so a compromise should be reached between cost and accuracy. In a sample survey, waste producers selected on a statistical basis are approached for information.

The survey may be carried out either by sending a questionnaire to waste generators for them to fill in and return, by conducting personal interviews, or by a combination of the two. However, it is advisable that the person carrying out the survey goes around the sites with the factory employees responsible for process operation and waste disposal. Invariably, answers provided by companies to waste survey questionnaires are quite inaccurate and must be verified by a qualified hazardous waste specialist.

Experience from many parts of the world suggests that personal interviews are much more reliable than postal questionnaires, although the latter may be useful as a supplementary source of information. The use of well-trained personnel is essential for interviews, so that the interviewer has a good idea of what types of waste to expect and is able to ask the right questions.

A particular advantage of carrying out a survey by personal interview is that it promotes information exchange, informing industry of the concerns and intentions of government and enabling the authorities to form a picture of the technical competence and expertise of the industries. The information gained through this type of exchange will assist in deciding whether treatment and disposal should be under the control of industry or under the control of government, or a combination of both.

Comprehensive Survey

A comprehensive survey of waste generators is generally not feasible. However, the desirability of producing comprehensive information should be kept in mind when drafting national regulations for hazardous waste management.

There are at least three ways in which comprehensive data can be produced as a by-product of regulations to control hazardous waste:

(1) The most comprehensive is the annual report by waste generators, which forms part of a registration scheme in a number of countries. The generator is required to make a regular report to the authorities on quantities, composition, treatment, and disposal methods. A number of countries view this as a vital part of the waste management system, providing useful information and allowing government to check existing data and learn more about waste production.

(2) The manifest or trip-ticker system is used in many countries to ensure that waste arrives at its designated destination. If a central authority receives a copy of each manifest, this information can be used as a basis for compiling data on that waste which is treated or disposed of outside the producing factory. However, such a system does not record information on waste which is treated or disposed of on-site.

(3) An annual report by treatment and disposal facility operators may also be required as part of a registration or licensing scheme. Compared to similar information reported by waste generators, data from treatment and disposal facilities give less insight into the origin of the waste and thus into the possibilities of alternative recycling treatment or disposal methods.

HAZARDOUS WASTE MANAGEMENT LEGISLATION

Preventing hazardous waste from being generated and the efficient disposal of such waste through legislation has intrinsic merit if it can be implemented technically and if it makes economic sense. However, the strategic adoption of hazardous waste management by governments and industries is affected by cultural, institutional, technological, political, and economic factors that vary from country to country. Therefore, the ease and speed of formulating legislation for hazardous waste management will differ among nations. In fact, the adoption of hazardous waste management legislation is proceeding slowly even in the industrialized countries.

Developing countries need to set priorities for formulating legislation in controlling hazardous waste. The available resources must be concentrated on the most significant problems and short-term solutions implemented to bring them under immediate control. It may be necessary to distinguish between long-term solutions, which may involve the establishment of centralized treatment and disposal facilities, and short-term solutions which aim to eliminate the worst of current practice.

In practice, it is helpful to regard short-term solutions as stepping stones, rather than as ends in themselves. Many established hazardous waste control systems have evolved in this way, with the information and experience obtained in the short-term providing the basis for planning the long-term solution.

Even in the longer term, there will be a need to develop solutions which are compatible

with the limited resources available. Much of the current work on hazardous waste management in the developing countries is directed at the transfer of technology from developed to developing countries. This needs to be complemented by more innovative work, adapting and developing both the technologies and the administrative control systems so that they become more appropriate to the specific needs and circumstances of the individual developing country.

The "cradle to grave" concept of waste management considers all stages of handling hazardous waste. The various sectors involved in the management of hazardous waste are public authorities, waste generators, transporters, and disposal operators. The legislation should clearly define the assignments of responsibilities for various sectors in order to achieve an effective management of hazardous waste.

The Public Authority

The first governmental task is to assign to an authority the legal responsibilities for the management of hazardous waste. Subsequently, this authority would establish the regulatory, administrative, and institutional framework to manage the hazardous waste programme.

For public authorities there are the following eight options:

(1) Adequate surveillance of waste generators, and control over chemicals in use;
(2) Strict control over waste operators;
(3) Prevention of dumping and illegal diversion;
(4) Monitoring of both the waste and the environment;
(5) To carry out certain disposal operations directly (using a different authority from the licensing authority so as to avoid self-regulation);
(6) Clean-up of contaminated sites;
(7) Administration of financial incentives; and
(8) Encouragement of the formation of an association concerned with waste management.

Waste Generators

Only the waste generators can directly control the quantity of waste and only they know the composition of the waste.

The responsibilities of waste generators therefore include:

(1) Using processes and raw materials and creating products which minimize the amount of waste produced;
(2) Effective waste recovery or recycling;
(3) Proper labeling, information, and containers for waste;
(4) Proper interim storage of waste;
(5) Deciding on transport, treatment, and certain disposal operations directly;
(6) On-site treatment where necessary;
(7) Provision of information about the waste;
(8) Bearing the cost of treatment and disposal; and
(9) Assumption of responsibility for training of personnel.

Transporters

The objective of the legislation for the transporters is to maintain control over the movement of hazardous waste through permits given to transporters and supervision of their activities. This control aims to guarantee that hazardous waste collected at its generation points will be transported in a safe manner and disposed of in the places which have appropriate conditions to receive it. It is necessary to establish a manifest system to track hazardous waste from its generation point to final disposal.

Hazardous waste to be transported should be packaged properly with appropriate labeling. Packaging and labeling standards should be set for each type of hazardous waste by the supervising organ followed by proper education of hazardous waste-generating industries. Establishment of appropriate standards for the vehicles to be used in the transportation of hazardous waste is also important.

The companies which are actually transporting or planning to transport hazardous industrial waste have to get a permit from the supervising authority. To apply for the permit, the following information should be submitted: (a) types of waste to be transported; (b) equipment to be used; (c) names of personnel responsible for the service; and (d) emergency procedure.

Each authorized transporter will be given an identification number which should be written clearly on the equipment to be used, in the manifest, and in all correspondences exchanged with supervising organs. The generators of hazardous waste should send their waste only to the transporters with permits corresponding to such waste. Moreover, the generators should send their waste to transporters indicating its final destination.

The responsibilities of waste transporters therefore include the need to: operate in accordance with safety standards; provide accurate and sufficient information including signs on the vehicles; ensure training of personnel, particularly drivers; have emergency procedures in case of accidents; and avoid the diversion of waste to nondesignated places.

Disposers

The responsibilities of waste disposers include the need to operate with minimum impact on the environment, including site closure and reclamation; provide accurate and sufficient information to the authorities; train personnel; draw up emergency procedures; and bear the same responsibilities as generators if hazardous waste is indirectly created by disposal activities.

WASTE MINIMIZATION

Waste minimization is a very important hazardous waste management strategy in developing countries. Minimizing the generation of hazardous waste has an intrinsic merit if it can be implemented technically and if it makes economic sense. However, its effective adoption by governments and industries is constrained by the cultural, institutional, technological, political, and economic settings of the country. Therefore, in each country, various measures need to be devised to overcome these constraints. Many companies which had implemented waste minimization schemes experienced not only their benefits due to reduction in treatment and disposal costs but also economic gains through the

lowering of manufacturing costs and improvement in product yields.

Waste minimization is the reduction of hazardous waste in terms of its total quantity or toxicity, or both, that is generated or subsequently treated, stored, or disposed of. Waste minimization also includes source reduction and recycling activities.

Source Reduction

Source reduction is the most prominent component of waste minimization and consists of product substitution and source control.

Product substitution is the replacement of an original product with another product suitable for the same end use, or the alteration of use of an original product which results in a decrease in hazardous waste generation at the place of manufacture. Examples include replacement of treated wood pilings with concrete pilings in marine construction, replacement of synthetic rubber with natural rubber, replacement of paint coating with longer-lasting coating in certain applications, replacement of tetrachloroethylene with petroleum solvent in dry-cleaning applications, and integrated pest management instead of application of pesticides alone.

Source control is the reduction or elimination of hazardous waste generation within the process and consists of: (a) input material alteration; (b) technology alterations; and (c) procedural changes.

(1) Input material alteration techniques include the purification of raw input materials to reduce subsequent waste generation and the substitution of higher grade (purer) or less toxic material for low grade or highly toxic material. The former technique, material purification, does not normally result in an appreciable decrease in the volume of waste. Examples of the material substitution technique include the use of a higher grade crude in petroleum refining and the substitution of biodegradable detergents for toxic chlorinated solvents.

(2) Technology alteration to reduce waste generation includes changes in process, equipment, piping, layout and operational settings, automation, and water and energy conservation. Improving the efficiency of chemical reactions through modification of catalysts, reactor design, and operating parameter has been shown to reduce significantly the quantity of waste generated. Process automation, which helps optimize product yields by automatically adjusting process parameters, has minimized operator error, the likelihood of spills, and the production of off-specification materials. Water conservation through efficient product washing results in reduced sludge generation.

Technology modification and the development of low-waste technologies are currently a central focus of waste minimization strategies. These changes are most cost-effective when implemented during the plant planning or design stage. The retrofitting of an existing plant with new low-waste technology is often expensive and difficult.

(3) Procedural changes are often referred to as "good operating practices" or "good housekeeping practices" and involve the alteration of existing procedural, organizational, or institutional aspects of a manufacturing process. Examples include employee training, management initiatives, inventory control, waste stream segregation, improvements in material handling and scheduling, prevention of spill, leak and overdose, and preventive maintenance.

It is difficult to quantify the effectiveness of these source reduction measures. The viability of a substitute depends on: (a) whether it can function adequately as a replacement; (b) whether its economic cost justifies the use as a replacement; (c) whether its manufacturing or disposal process reduces environmental consequences; and (d) sociopolitical factors such as government policy to promote its use. Trade-offs have to be assessed prior to the selection of substitutes. For instance, petroleum solvents can be used in dry cleaning but they are more flammable than tetrachloroethylene which is more toxic.

Recycling

Recycling activities include both reuse and reclamation of materials from waste and are characterized by three major practices: (a) direct use or reuse of waste material in a process; (b) recovery of a secondary material for a separate end use; and (c) removal of impurities from waste to obtain a relatively pure reusable substance. Examples of these recycling practices include the recycling of collected pesticide dusts as pesticide formulators; the reuse of ferric chloride waste from titanium dioxide manufacturing as a wastewater conditioner; and the reuse of solvents for equipment cleansing.

The proportion of waste that is recycled is both industry- and waste-specific. Certain types of waste tend to be recycled more often than others. Factors affecting the recyclability of waste include: (a) the type of waste generation process used; (b) the volume, composition, purity, and uniformity of waste; (c) whether uses or reuses of the waste have been identified; and (d) availability and price of raw materials relative to the cost of recycling. Waste streams that are recycled in great volume include spent acid and alkaline solutions produced in the chemical industry which are used for the transportation equipment industry; wastewater treatment sludge from electroplating and chromium plating processes; and spent pickle liquor in primary metal industry.

Certain types of waste can be used as fuels or have high calorific values so that they can be recovered as an energy source. Solvents tend to be used for energy recovery because they possess high energy values. Increasing quantities of high calorific waste are being used by cement plants and lime kilns.

Offsite recycling is becoming increasingly popular with the advent of commercial recycling and direct transfer of waste from generators to others who can reuse the waste through a waste exchange programme. Commercial offsite recycling is favoured by some industries, notably primary metals and small quantity generators of lead-acid battery waste. Waste exchange programmes can serve as information clearinghouses and act as brokers as well as occasionally transporting waste from one plant to another.

The waste minimization options are most effective when pursued through a well-publicized company programme which involves participation by all sectors of the work force. Incentives to managers and workers for waste minimization result in a powerful motivating factor.

The government can also exert influence over waste minimization efforts through legislation, technical support, financial incentives, and education, training, and information dissemination programmes.

HAZARDOUS WASTE TREATMENT TECHNOLOGIES

Many different hazardous waste treatment technologies can be used prior to ultimate disposal. They are designed to modify the physical and/or chemical properties of the waste. They reduce volume, immobilize toxic components, or detoxify. The choice of the best practicable way of treating a given waste depends on many factors, including the availability and suitability of disposal or treatment facilities, safety standards, and cost considerations. No disposal route offers absolute safety and any waste treatment or disposal technology has an associated level of risk.

The treatment processes for hazardous waste can be categorized into four classes: (a) phase separation processes, potentially useful in volume reduction or resource recovery; (b) component separation processes, capable of physically segregating particular ionic or molecular species from multicomponent, single-phase waste streams; (c) chemical transformation processes, which promote chemical reactions to detoxify, recover, or reduce the volume of specific components in waste streams; and (d) biological treatment methods, which involve chemical transformations brought about by the action of living organisms.

Three systems are commonly used for hazardous waste treatment: physical, chemical, and biological treatment systems.

Physical Treatment

These processes include various methods of phase separation and solidification. At the most basic level, phase separation encompasses lagooning, sludge-drying in beds, and prolonged storage in tanks. All three depend on gravitational settling, and the first two also allow the removal of liquid by decanting, drainage, and evaporation. Lagooning and tank storage are widely used to separate oil and water from mixed waste, sometimes following preliminary treatment with emulsion-breaking agents and occasionally, in the case of tank storage, combined with heating.

Chemical Treatment

Chemical treatment methods are used both to facilitate the complete breakdown of hazardous waste into nontoxic gases and to modify the chemical properties of the waste.

Biological Treatment

Many types of industrial waste are treated by biological methods similar to those used for sewage treatment. Hazardous waste is occasionally amenable to such treatment, even though the concentrations of toxic materials present are often lethal to microorganisms. Major industrial users of land treatment have included petroleum refining, industrial organic chemicals, wood preserving, petroleum production, plastics, materials, residues and paints, and allied products. The in-plant biological treatment of dilute aqueous effluent is well established, and microorganisms have been developed to selectively degrade specific toxic chemicals.

Selection of a treatment process for a given waste stream is not easy and involves consideration of the nature of the waste, the desired characteristics of the output stream, the technical adequacy of the treatment alternatives, and economic and financial, environ-

mental, energy, and operational and maintenance considerations.

LANDFILLS

Landfill is a disposal facility whereby hazardous waste is first dumped on the land and then stored in the soil. Landfills for hazardous waste are considered a technology of last resort to be used after every effort has been made to reduce or eliminate the hazards posed by the waste. The intent is to bury or alter the waste so that it is not an environmental or public health hazard. Landfills are not homogenous and are usually made up of cells in which a discrete volume of hazardous waste is kept isolated from adjacent waste cells by a suitable barrier. Barriers between cells commonly consist of a layer of natural soil or clay which restricts the downward or lateral escape of the hazardous waste constituents or leachate.

The advantages and disadvantages of landfilling for hazardous waste disposal can be listed as follows:

Advantages

Where land is available, landfill is usually the most economical method of solid waste disposal; the initial investment is low compared with other disposal methods; landfill is a complete or final disposal method as compared to incineration which requires additional treatment or disposal operations for residue, quenching water, and unusable material; landfill can receive all types of waste, eliminating the necessity of separate collections; landfill is flexible enough to handle the increasing quantities of waste and can be disposed of with little additional personnel and equipment; and submarginal land may be reclaimed for use as parking lots, playgrounds, golf courses, or airports.

Disadvantages

In highly populated areas, suitable land may not be available within economical hauling distance; proper landfill standards must be adhered to daily or the operation may result in an open dump; landfills located in residential areas can provoke vigorous public opposition; a completed landfill will settle and require periodic maintenance; special design and construction must be utilized for buildings constructed on completed landfill because of the settlement factor; and methane, an explosive gas, and other gases produced from the decomposition of the waste, may become a hazard or nuisance and interfere with the use of completed landfill.

INCINERATION

Incineration is an ultimate disposal process, applied to certain waste that cannot be recycled, reused, or safely deposited in a landfill site. It is a high temperature, thermal oxidation process in which hazardous waste is converted, in the presence of oxygen in the air, into gases and an incombustible solid residue. The product gases are released into the atmosphere, with or without gas cleaning, and the solid residues are landfilled.

Properly managed, incineration can serve several purposes: destruction of the waste

accompanied by a significant reduction in its weight and volume, and the production of a sterile solid residue. On the other hand, the risk of causing a nuisance as well as environmental pollution from emission of particulate, acidic gases, unburnt waste, and trace quantities of hazardous organic by-products would be important to consider when selecting equipment and siting hazardous waste incineration facilities.

Typically, incineration is chosen if the waste is biologically hazardous; it is resistant to biodegradation and persistent in the environment; it is volatile and therefore easily dispersed; it has a flash point below 40°C; it cannot safely be disposed of in a landfill site; and it contains organically bound, lead, mercury, cadmium, zinc, nitrogen, phosphorous, or sulphur.

Incineration may take place either in dedicated, purpose-built facilities in suitably adapted existing high-temperature process plants such as cement or lime kilns, blast furnaces, or industrial boilers. The high capital and operating costs of dedicated incinerators and their relatively high throughputs, typically upwards of 10,000 tons per annum, tend to limit their feasibility in smaller, less industrialized countries. Thus, although operating experience with coincineration of hazardous waste in existing facilities is relatively limited, this would appear to be a more promising approach for many developing countries.

Selection of Wastes

In general, if the hazardous waste contains a high proportion of organic material, it can be suitable for incineration. The types of waste that are suitable for incineration include: solvent waste; waste oils, oil emulsions, and oil mixtures; plastic, rubber, and latex wastes; hospital waste; pesticide waste; pharmaceutical waste; refinery waste such as acid tar and spent clay; phenolic waste; grease and wax wastes; organic waste containing halogens, sulphur, phosphorous, or nitrogen compounds; solid materials contaminated with hazardous chemicals (e.g., soil containing oil, capacitors containing polychlorinated biphenyl (PCBs); or water contaminated with hazardous chemicals).

Whether or not these types of waste can be properly incinerated depends on the choice of incinerator and its gas cleaning system — an important qualification, since the act of disposal should not in itself constitute a threat to the environment. Waste containing halogens, phosphorous, sulphur, or nitrogen require more sophisticated technology than waste containing just carbon, hydrogen, and oxygen, though all types can, under less than optimum incineration conditions, generate noxious by-products.

Waste that is not suitable for incineration includes that which does contain a significant proportion of organic material or is highly explosive or radioactive. Low radioactivity waste can be safely incinerated (contaminated clothing, scintillation liquids, and certain hospital waste), provided that its input is carefully regulated to control the emission of radioactive isotopes.

Factors Affecting Incineration

During incineration, oxygen in the air converts or oxidizes this waste into simple gases and solids. The gases consist primarily of carbon dioxide, water, and excess air, together with noxious halogen acids, sulphur, nitrogen, and phosphorous oxides, vapourized metal oxides, and ash. The material left behind on the hearth of the incinerator comprises ash,

metal oxides, and noncombustible material. The hearth solids are generally sufficiently sterile to be safely landfilled. The potentially harmful combustion products are reduced to a regulated safe level by gas cleaning.

There are four main factors affecting the incineration of hazardous waste. The four factors are the three Ts of combustion and oxygen — temperature, time, and turbulence.

The higher the temperature at which the waste is burnt, the more complete it will be destroyed, and the less chance there is of any unburnt waste being released or of trace organic by-products being formed.

The longer the waste is held at high temperature, the greater will be the degree of destruction and the less likelihood there is of trace organic by-products being formed. The residence time in the gas phase is of particular importance.

Turbulence controls the degree of mixing between the waste and oxygen within the furnace. Greater turbulence provides better control, better access to air, and more complete destruction of the burning waste.

The availability of oxygen is also an important factor in determining the degree of destruction of the waste and the formation of organic by-products. Not only should there be sufficient oxygen to satisfy the theoretical requirements of the combustion process, but an excess level of about 100 per cent over the theoretical air requirements, in terms of air, should generally be maintained, to ensure that oxidative as opposed to pyrolytic, i.e., oxygen-starved, conditions prevail at all times.

Optimum Conditions for Incineration

From the formulation of the three Ts and oxygen availability, the conditions for optimum incineration are: (a) high temperature; (b) sufficient (gas) residence time in the incinerators; (c) good turbulence; and (d) an excess of oxygen. All four conditions should be observed when the waste is incinerated.

Turbulence is achieved through good incinerator design, using tangential fans and liquid injectors to produce cyclonic burn paths, and the manual raking over of hearth solids on stationary hearths. In rotary kilns and multiple hearths, intimacy of mixing between solids and air is achieved through mechanical means.

When the above conditions are observed, it has been shown that even the most difficult and refractory wastes, such as PCBs, can be adequately and safely destroyed.

Energy Recovery and Gas Cleaning

If the heat energy of emitted gas is recovered and reused in some form, the operating costs of the incineration facility can be offset.

The advantages of energy recovery systems include lower flue gas volumes due to reduced water-vapour concentrations and gas temperatures resulting in smaller pollution control systems and reduced operating costs; reduced steam plume from the stack; conditioning of particulate aids agglomeration and removal downstream of the boiler; and revenue from sale of energy.

The constituents of the flue gas depend on the composition of the waste and the severity of combustion conditions. The purpose of gas cleaning is to remove as completely as is practicable, particulate and noncombustible contaminants such as fly ash, metal oxides, and acid gases. Unburnt waste and trace organic by-products are not removed to any great

extent by conventional gas cleaning equipment and the control of these latter emissions must be effected by proper operation of the incinerator and its afterburner chamber.

Local environmental quality regulations, coupled with the type of waste burnt, will determine whether or not a gas cleaning system is required. Open pit incinerators operating without gas cleaning are limited to low-ash waste which does not generate noxious or toxic gases. For small or in-house incinerators operating on carefully controlled waste that does not generate acid gases, the gas cleaning problem is reduced to one of particulate removal. Gas cleaning equipment cannot operate at the elevated temperatures of flue gas emanating from a furnace, and therefore some form of quenching is essential to reduce gas temperature to below 300°C. This can be effected by water sprays or by energy (heat) recovery.

CASE STUDY OF SINGAPORE

Study Area

The Republic of Singapore consists of a main island and fifty-eight islets covering a total land area of 636 km^2. The main island has a land area of 574 km^2. The climate is equatorial with relatively uniform temperature, high humidity, and abundant rainfall averaging about 2,400 mm annually.

Like many other countries in the region, Singapore generates a substantial quantity of waste through various industrial, commercial, agricultural, and other human activities. The waste creates difficult disposal problems. Currently, about 900,000 m^3/day of water from four water treatment plants is supplied to the population of 3.1 million, 65,000 industrial and commercial establishments, and 5 million tourists who visit Singapore annually. The domestic water consumption rate is about 140 litres per capita per day (1 cpd). The industrial sector consumes half the water on the island.

Approximately, 100 per cent of the population is served with public sewers. Households' and institutions' wastewater and pretreated industrial effluent are discharged into the sewers. The sewerage network consists of approximately 1,680 km of sewers of various sizes leading to six major wastewater treatment works. The treated effluent is discharged into the sea.

Refuse collected daily from various parts of the island is disposed of by landfilling and incineration. More than 5,700 tons of refuse is collected daily, half of which is generated by industries. Two incinerators with a total capacity of 2,800 tons/day handle half of the refuse, a third incinerator with a capacity of 2,400 tons/day has recently been commissioned. With the completion of the third incinerator, all the combustible refuse on the island can be incinerated in the three incinerators.

Hazardous Waste Management

In Singapore, there are more than 2,000 companies which handle or use hazardous industrial chemicals. These chemicals are used as raw materials and intermediates in chemical processes as well to support and facilitate production of a wide variety of products ranging from printed circuit boards and machine tools to consumer products. It is therefore essential that a comprehensive approach is established to ensure safe manage-

ment of such industrial materials at all stages of their life cycle to safeguard the health of the public and the environment. This approach includes establishing controls to manage the import, manufacture, handling, storage, transportation, use, and disposal of these materials.

Improper handling of the hazardous waste within a factory such as poor storage practices and failure to prevent and contain accidental spillage would also lead to the release of hazardous or polluting substances into the environment. These would cause pollution and endanger the health and safety of the workers. Mixing of incompatible types of waste can cause fires and explosions or even generate toxic gases.

A priority for the management of hazardous waste is to control spent acids, waste solvents, spent etchant, spent coolants, and photographic waste. These are generated by a wide range of processes and activities ranging from large petroleum refining, and from petrochemical and electronic industries to small engineering workshops and printing firms. About 41,600 m^3 of industrial hazardous waste is generated and collected for treatment and disposal annually. This quantity does not include liquid effluent treated by in-house wastewater treatment plants of waste generators.

Much of the hazardous waste generated could be recycled, reused, or become sources of valuable materials if appropriate management and treatment processes are adopted. The recycling, reuse, and recovery of valuable materials from this waste not only ensure the safe disposal of such waste but conserve limited resources. Waste recycling and reuse can only be achieved through proper management.

The key elements in the strategy for hazardous industrial waste management in Singapore comprise the following: avoid generation of intractable waste; encourage minimization and recycling; regulate collection, treatment, and disposal; ensure monitoring and enforcement; and promote and support educational and training programmes.

All new industrial development in Singapore is screened at the planning stage by the Pollution Control Department (PCD) of the Ministry of the Environment. One of the key areas to be checked in this screening process is the generation and disposal of waste from proposed industrial development. The PCD will approve the proposed industrial development only if the waste generated can be safely disposed of in Singapore. This measure is designed to avoid the generation of intractable waste which cannot be safely disposed of in Singapore.

In addition, the PCD will require industries to use processes that minimize waste generation or facilitate the recycling, reuse, and recovery of the wastes. Industries also need to incorporate measures into the design of their facilities to ensure that waste generated can be properly handled and managed. At the building plan stage, checks are made to ensure these measures are incorporated into the structural design.

The collection and disposal of industrial hazardous and toxic wastes are under the jurisdiction of the *Environmental Public Health Act (EPHA)* and the *Environmental Public Health (Toxic Industrial Wastes) Regulations (TIWR)*. Under the act, industries have to obtain written permission for the construction and operation of their waste disposal facilities. Industrial hazardous waste is required to be disposed of at the approved waste disposal facilities.

In addition, the Advisory Committee on Hazardous Substances and Toxic Wastes was set up in 1987 to advise the Ministry of the Environment on the control of hazardous

substances and toxic waste. The advisory committee comprises of industrialists, academicians, and senior government officials. The committee continuously reviews and evaluates the toxic substances and recommends action to be taken by the ministry.

Legislation

Environmental protection legislation. In transforming Singapore into a modern industrialized country, much has been done to make the country clean and green. This has entailed farsighted planning and development in terms of legislation, physical and administrative infrastructures, and other resources, not least the development of a new attitude among the people, institutions, and establishments to meet new environmental targets. However, as industrialization and modernization gather new momentum, environmental standards and measures have to be constantly reviewed and, if necessary, upgraded.

With the commencement of Singapore's first industrial revolution in the 1960s, a large number of industries gravitated to the country. A new need for environmental protection was recognized with the concomitant establishment of the machinery and authority to administer important environmental issues. The first major attempt to curb pollution was directed at the atmosphere. The Anti-Pollution Unit (APU) in the Prime Minister's Office was established in 1970. Backed by a range of legislation, it has ensured that the annual averages for air pollutants are maintained below the long-term goals of the World Health Organization (WHO).

The *Clean Air Act* was passed in 1971 to empower the APU to control air pollution from industrial premises. Standards for the emission of air pollutants are prescribed in the *Clean Air (Standards) Regulations of 1972*. With the rapidly growing number of industries, the regulations were revised in the *Clean Air (Standards Amendment) Regulations of 1978*, to reduce the permissible limits of emission.

The *Water Pollution Control Act of 1975* empowered the Ministry of the Environment to control the discharge of wastewater from domestic, industrial, agricultural, and other premises. Under this act, no person is allowed to discharge any trade effluent without the written approval of the ministry. A severe penalty may be imposed for the illegal discharge of a trade effluent which does not meet the minimum quality standard prescribed by the *Trade Effluent Regulations of 1976*. These regulations provide standards for effluent discharged into controlled watercourses, other watercourses, and public sewers.

Factories may apply to the ministry for permission to discharge biodegradable waste into the public sewer system if the pollutant concentrations exceed those prescribed in the standard. If permission is granted, a fee is levied based on the volume and strength of the waste discharged.

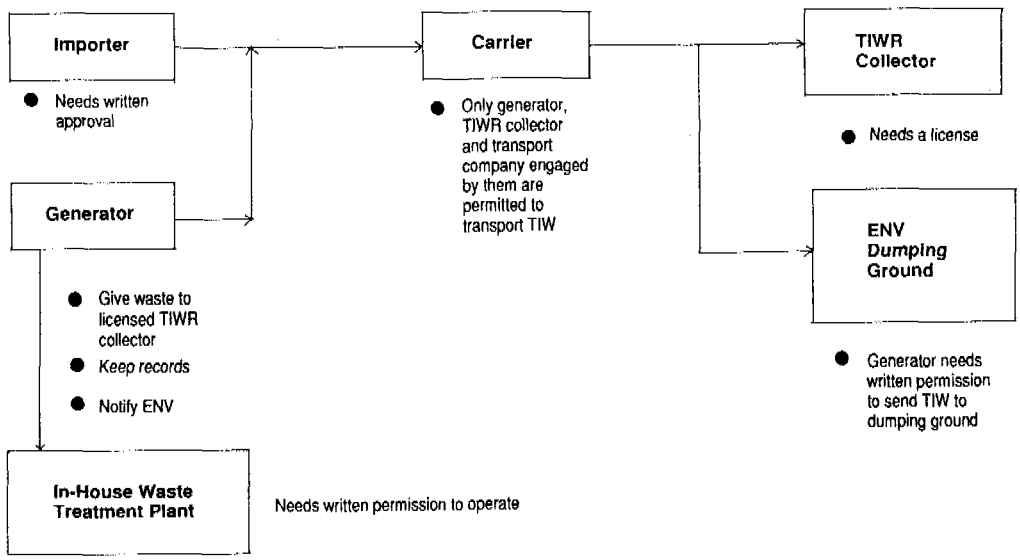
Environmental Public Health (Toxic Industrial Wastes) Regulations. The Ministry of the Environment regularly reviews the list of poisons controlled under the *1986 Poisons (Hazardous Substances) Rules*. The controls on toxic waste were further tightened when the *Environmental Public Health (Toxic Industrial Wastes) Regulations* took effect in August 1988. The regulations empower the ministry to control the import, sale, supply, receipt, transport, treatment, and disposal of toxic industrial waste. Under the regulations, only licensed toxic waste collectors are allowed to collect toxic waste. Transport approval is required for the transportation of toxic waste which exceeds the stipulated quantity.

In order to facilitate control and proper management, the functions and responsibilities

of key persons involved in the handling of the waste are clearly delineated in the *TIWR*. They are the importer or generator of the waste; collectors; carriers or transporters; and drivers.

An overview of the basic functions and responsibilities of the key persons is shown in figure 2.

Figure 2. Responsibility of Key Persons for Hazardous Waste Management



The Generator. If a generator does not have an approved in-house treatment plant, he needs to give his toxic industrial waste to a licensed TIW collector. The generator should keep proper records and notify the Ministry of the Environment if the quantity of toxic industrial waste exceeds the quantity prescribed in the regulations.

The generator will have to:

(1) Either treat the waste in his approved waste treatment plant or engage a licensed collector;
(2) Keep a record of the waste transported out of his premises and notify the PCD if the quantity transported over a year exceeds prescribed limits;
(3) Obtain written permission from the PCD to dump treated waste at the prescribed dumping grounds; ensure his waste is stored in proper containers which are then stored in controlled areas and properly labeled;
(4) Give accurate and comprehensive information to the licensed collector to enable him to carry out the handling and treatment of the waste properly and safely; and
(5) Prevent mixing of different types of industrial waste or mixing with general waste unless the mixing is part of an approved treatment process.

The Collector. A toxic industrial waste collector may be any person who receives or accepts any toxic industrial waste for storage, reprocessing, usage, treatment, or disposal. The collector does not include the carrier engaged by the generator. He has to:

(1) Obtain the license. He can only collect specific toxic industrial waste that is listed in his license and confine his waste storage and treatment activities to approved premises and facilities;
(2) Obtain written permission to alter or change the approved facilities or treatment processes;
(3) Obtain and verify all information on the waste he receives as will enable him to store, treat, reprocess, or dispose of the waste safely and properly; and
(4) Maintain records of all toxic waste collected and submit monthly reports to the PCD.

The Transporter. Written approval from the PCD is required for the transportation of waste in quantities which exceed those specified in the *TIWR* schedule. The responsibilities of the following persons in the transportation are clearly defined in the regulations:

(1) Consignor is a person who presents a consignment of controlled waste for transport. The consignor can be either the generator or the licensed collector;
(2) Carrier is a person who undertakes the transport of the controlled waste. He can be either the generator, the licensed collector, or the transport company engaged by either of them; and
(3) Consignee is a person who receives the controlled waste. He is usually the licensed collector.

The consignor has to:

(1) Apply for the transport approval from the PCD if the quantity of controlled waste to be transported exceeds prescribed amounts;
(2) Obtain three copies of the consignment note from the generator and give them to the carrier;
(3) Ensure that the tank, container, or tank-container of vehicles used for the transport of the waste is designed, constructed, and tested in accordance with an approved code of practice;
(4) Ensure that the tank, container, or tank-container used is not overfilled; and
(5) Provide the carrier with transport documents containing information on the necessary safety precautions and requirements, including emergency plans and routing instructions.

The carrier has to:

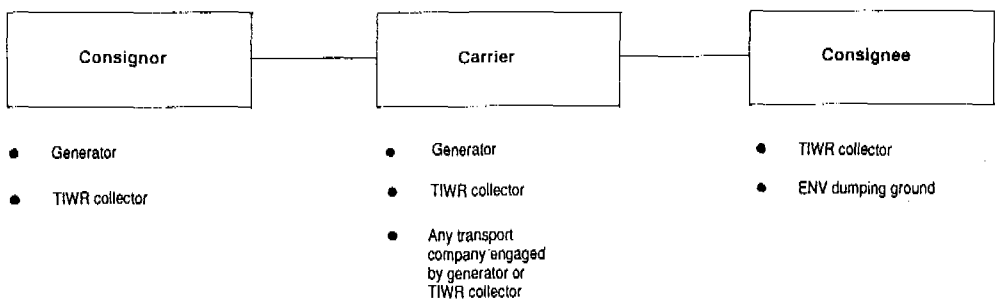
(1) Obtain transport documents and consignment notes from the consignor before initiating the transportation;
(2) Give a copy of the transport documents and two copies of the consignment note to the driver;
(3) Ensure that the driver is trained and able to carry out the instructions given in the transport documents; and
(4) Ensure that appropriate hazard warning panels or labels are properly displayed on the vehicles and their containers or tanks in accordance with an approved code of practice.

The driver has to:

(1) Carry with him a copy of the transport documents and consignment note when transporting the waste;
(2) Follow the instructions given in the transport documents; and
(3) Ensure that the vehicle, when not driven, is parked in a safe place or supervised at all times by him or by a competent person over the age of twenty-one.

The movement of the waste is tracked by means of the consignment note system (manifest system). A flowchart showing the consignment note system is shown in figure 3. The waste generators prepare five copies of the consignment note and give three copies to the consignor. The waste generator keeps a copy and submits a copy to the PCD. The consignor gives the three copies to the carrier. The carrier gives two copies to the consignee through the driver and retains a copy. The consignee keeps a copy of the consignment note and submits a copy to the PCD within three days of the receipt of the waste. In 1991, the PCD received and checked about 59,000 copies of consignment notes.

Figure 3. Consignment Note System



RESOURCE RECOVERY AND WASTE RECYCLING

About 80 per cent of the industrial hazardous waste generated and collected in Singapore by the licensed collectors is either recycled, reused, or has valuable components extracted and recovered before disposal. Such waste includes spent solvents, spent etchant, and photographic waste.

Spent solvents are generated by a wide range of industries. About 5,700 m^3 of spent solvents are collected by the licensed collectors annually. The spent solvents include acetone, chloroform, ethyl acetate, methylene chloride, and toluene. The spent solvents are recovered by distillation. Batch (differential) distillation is commonly used for their recovery. The equipment comprises of a still to heat up the solvents, a condenser to condense the vapours, and collecting vessels to collect the condensate and the residues. The recovered solvents are sold for reuse by industries.

Printing- and film-processing activities generate photographic waste such as spent fixers and bleaches. About 920 m^3 of photographic waste is collected and treated annually. This waste contains silver in solution. An effective and commercially viable method of electrolytic extraction is used to recover the silver. In this process, carbon is used as the anode and a stainless steel drum is used as the cathode. The silver which is deposited on the stainless steel drum has a purity of more than 90 per cent. The remaining liquid from the electrolysis process is treated and neutralized in a wastewater treatment plant before discharge into the sewers.

Etching is an important process used in the electronic industry especially in the manufacture of printed circuit boards. The process generates spent etchants such as cupric chloride, ferric chloride, and ammonia. Each year about 15,000 m^3 of spent etchant are generated and treated in Singapore. Spent ferric chloride etchant is regenerated using scrap iron and chlorine. In this process, scrap iron is first added to the spent etchant and the copper sludge that precipitates out is collected and sold as a valuable by-product. The etchant is next regenerated by passing chlorine through it. The regenerated etchant is sold for reuse.

MONITORING AND ENFORCEMENT

Monitoring and enforcement are essential for the success of hazardous waste management. The hazardous waste management and control methods can be easily rendered useless without an effective enforcement programme and good cooperation from industry. In Singapore, Ministry of the Environment officials make regular inspections of industrial and trade premises to ensure that all necessary measures are taken to minimize the discharge of hazardous waste. Samples of waste are collected for analysis and to check their compliance with the regulations.

In 1991, the PCD conducted about 1,000 special inspections and audit checks on the collection and treatment of waste by licensed collectors as well as 55,000 general factory inspections. This, coupled with the cooperation of the industry, has ensured that industrial waste (especially hazardous and toxic industrial wastes) is properly managed and disposed of in Singapore. The department also works closely with industry and academic institutions in promoting better management and disposal of waste through joint research and educational programmes.

CONCLUSION

The successful implementation of a hazardous waste management programme requires full cooperation from industries to manage their waste properly. In Singapore, the Ministry of the Environment has established regulations for the control, management, treatment, and disposal of hazardous waste.

The ministry has mapped out an effective strategy for hazardous waste management, the key elements of which include emphasizing the need to avoid generation of intractable waste; encourage minimization and recycling; regulate collection, treatment, and disposal; monitor and enforce all regulations; and promote and support educational and training programmes.

As industrialization and manufacturing processes become more sophisticated, environmental standards and control measures have to be constantly reviewed and upgraded. The ministry is working closely with industrialists and academicians to review and continuously evaluate toxic substances in order to take proper management control actions for the continued safe disposal of toxic and hazardous wastes in Singapore.

NOTES

1/ H. Yakawitz, "Background Information Concerning Hazardous Waste in Non-OECD Countries" (Paris: Organisation for Economic Co-operation and Development (OECD), 1985)(unpublished).

2/ Keen and Thaver (incomplete citation).

COMMENT

MICHAEL CHIU

According to the Global Waste Survey (GWS) implemented by the International Maritime Organization (IMO) beginning in September 1991,[1/] the existing hazardous waste management practice in many countries is far from satisfactory. Outside the countries of the Organisation for Economic Co-operation and Development (OECD), few countries have adequate recycling, treatment, and disposal facilities for managing industrial and hazardous wastes. A large number of countries have neither legislation nor facilities for the management of such waste while others have legislation but no means of providing enforcement or compliance monitoring.

Joo-Hwa Tay's article is timely as the need for improving the management of toxic and hazardous wastes is being recognized on a global scale. The article offers a general overview of the basic issues, including the legal, technical, institutional, and financial considerations that are relevant in formulating an effective hazardous waste management strategy. It explains in general terms the essential factors and requirements that are important in ensuring efficient management of toxic and hazardous wastes in an environmentally acceptable manner.

The author considers that the rate of hazardous waste generation may be expressed as a function of a nation's gross domestic product (GDP) and assumes that waste production in the former Soviet Union could be estimated at 10,000 tons per US$1 billion, that in other countries with mature industry at 5,000 tons, in newly industrializing economies (NIEs) 2,000 tons, and in developing countries 1,000 tons. However, these estimates do not appear to be in agreement with the data shown in figure 1 of the article. On the basis of the limited data given, which have not been adequately referenced, it is difficult to conclude that there is a consistent relationship between hazardous waste production and GDPs that can be applied to different countries.

While the general approach to hazardous waste management, as summarized in the article, is well established, the specific requirements must be addressed on a case-by-case basis. Relevant local factors and constraints must be thoroughly considered in order for a practical strategy to be developed with suitable measures to meet the unique local requirements. It is therefore useful to review the hazardous waste management experience of other countries, noting their different approaches and the reasons for doing so. In this connection, the second part of the article, the case study of Singapore, is particularly useful.

In Hong Kong, a comprehensive hazardous waste management strategy was formulated in the late 1980s following a series of investigations and studies designed to ascertain

the nature of the problem and the local factors or constraints that had to be considered. The term "chemical waste" was used to cover the range of toxic and hazardous wastes generated from the numerous industrial establishments throughout the territory. Based on targeted waste-source surveys, it was estimated that Hong Kong generates as much as 100,000 tons of chemical waste each year from some 9,000 waste producers. In the absence of suitable means of waste disposal, much of the chemical waste has been casually dumped into the sewers and surface waters. This malpractice has resulted in severe damage to the drainage and sewerage systems and caused significant deterioration in the water quality of the receiving waters.

The chemical waste management strategy was set in motion in late 1989 and has been one of the major environmental initiatives under Hong Kong's ten-year plan to tackle pollution as laid down in the 1989 White Paper, "Pollution in Hong Kong — A Time to Act". The strategy, to be implemented by the Environmental Protection Department (EPD), involved preparation of legislation to set out the control requirements, and development of a Centralised Chemical Waste Treatment Centre as an integrated disposal facility.

The *Chemical Waste Regulation* was enacted in February 1992, empowering the EPD to implement "cradle to grave" control of all chemical waste defined under the regulation. Chemical waste producers are required to register with the EPD and to ensure proper labeling, packaging, and storage of their waste before collection. The waste can only be picked up by collectors licensed by the EPD and it must be transported to licensed facilities for treatment and disposal. Each chemical waste consignment must be properly registered under the Trip-Ticket System, consisting of a triplicate form to be accurately completed by the waste producer, the collector, and the operator of the disposal facilities. The Trip-Ticket System, along with the licensing arrangements, enable full monitoring and control of chemical waste from the original source to the point of final disposal.

The Chemical Waste Treatment Centre was developed under a design, build, and operate contract arrangement whereby the contractor is responsible for all aspects of the facility. It is an integrated facility capable of treating a wide range of chemical wastes such as acids and alkalis, solvents, cyanides, and sulfides, heavy metal-bearing waste, and waste lubricants. The required treatment can be accomplished through one or more of the nine separate unit processes, including an oil/water separation system, various physical/chemical treatment systems, and a high temperature incineration system. With these facilities, the Chemical Waste Treatment Centre can meet the broad requirements of the large number of chemical waste producers, many of whom are located in multistory buildings and are thus unable to install their own treatment facilities because of space limitations. A fleet of specially designed lorries and tankers is provided by the contractor of the Chemical Waste Treatment Centre to collect chemical waste from the waste producers.

A secondary purpose of the Chemical Waste Treatment Centre is to serve as the designated reception and disposal facility for oily and noxious liquid waste from ships. This is to fulfill Hong Kong's obligation under the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL) as modified by the protocol of 1978. Parties to MARPOL are required to ensure the provision of facilities for the reception of oily waste (Annex I waste) and noxious liquid substances (Annex II waste)[2/] from ships

which normally use their port facilities. A purpose-built MARPOL collection barge is provided to collect MARPOL waste from ships.

The chemical waste management strategy has been successfully put into action with implementation of the *Chemical Waste Regulation* and the opening of the treatment centre in May 1993. Hong Kong is now able to prevent the widespread malpractice of dumping untreated chemical waste into the territory's sewers and surface waters and thereby to improve the water quality in the receiving waters, particularly in the inner harbour.

NOTES

1/ The IMO was mandated to undertake the GWS by sixty-seven contracting parties to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention 1972). Task 1 of the GWS is to compile a Global Waste Inventory.

2/ According to the terminology adopted in the 1973 International Convention on Prevention of Pollution from Ships (MARPOL), substances are classified into different types (although there are many types of classification) and these classifications appear as annexes at the end of the final document. This is the practice adopted in all other international agreements relevant to hazardous waste management.

IMPROVING THE MANAGEMENT OF HOSPITAL WASTES

HISASHI OGAWA

INTRODUCTION

The number of hospitals and health care institutions in Asian metropolises has been increasing to meet the medical and health care requirements of the growing population. The provision of such facilities and related services, including ambulance service, has been an essential component of any urban development plan. Although city planners have long taken into consideration the provision of medical and health care institutions and services, until recent years, they, and even municipal waste management authorities, have paid very little attention to the wastes generated from these facilities, which are potentially hazardous to human health and the environment.

There has recently been serious concern over hepatitis and human immunodeficiency virus (HIV) infections, however, as well as environmental contamination due to the improper handling and management of infectious and other wastes from hospitals and health care facilities. Awareness of and concern over these dangers are high in most developed countries, where regulatory programmes and guidelines are provided to control waste from such institutions. In developing countries, however, these programmes have not yet been fully developed.

This article reviews the development of hospital waste management programmes in countries of the Western Pacific Region and the World Health Organization's (WHO) activities in this field, and discusses issues and approaches suggested for the improvement of hospital waste management in developing countries.

HOSPITAL WASTE MANAGEMENT IN THE WESTERN PACIFIC REGION

Medical/clinical waste management has become an issue of urgent concern in most industrialized countries of the Western Pacific Region. In these countries, guidelines and manuals for the control of medical/clinical waste have been issued over the past several years. These countries have regulations on hazardous waste management in place, and medical/clinical waste is usually governed by these regulations.

In developing countries of the region, medical/clinical waste is not generally regarded as specially hazardous and is handled in the same manner as any other type of domestic waste. Municipal solid waste management (SWM) in these countries is crude and the

waste generated from hospitals and health care institutions is usually disposed of by open dumping or open burning on-site or at municipal dumping grounds. Some hospitals have incinerators, but most are old and not properly designed and operated for the safety and protection of human health and the environment.

A summary of the country-level situations is given below.

Australia, Japan, New Zealand, and Singapore

In Australia, national guidelines for the management of clinical and related wastes were published by the National Health and Medical Research Council in 1988. At the state level, guidelines or manuals have also been produced (e.g., "Manual for the Management and Disposal of Biomedical Wastes," by the Environmental Protection Authority, Victoria, and "Guidelines for Hospital Waste Disposal," by the Department of Health, New South Wales).

In Japan, the Ministry of Health and Welfare established a working group on medical waste management in 1988, and the working group prepared a report as well as the "Guidelines for Medical Waste Management" in 1989. A nonprofit organization, the Japan Medical Wastes Research Association, was also established in 1988, to promote research and development activities on medical waste.

In New Zealand, the Standards Association of New Zealand published the "New Zealand Standards on Health Care Waste Management" in 1990, to rationalize and recommend methods for the management of health care wastes within the country.

In Singapore, an *ad hoc* committee of relevant government agencies was formed in January 1988, which drafted guidelines for the management and safe disposal of hospital wastes in July 1988. The Ministry of the Environment subsequently provided to all hospitals the "Hospital Waste Management Manual," which included detailed guidelines for hospital waste handling and disposal and a standard format to assist hospitals in preparing their written policies and procedures. Pathogenic waste from hospitals is controlled as toxic industrial waste under the *Environmental Public Health (Toxic Industrial Waste) Regulations of 1988.*

Malaysia and the Philippines

In Malaysia, the Ministry of Health conducted a survey of hospital waste management practices and prepared preliminary guidelines for the management of hospital waste in 1988. Subsequently, the ministry has engaged consultants from the UK in preparing a national master plan for hospital waste management. This task has been completed, and the draft plan has been submitted for government approval. According to the draft plan, centralized regional incinerators will be constructed throughout the country to service those hospitals operated by the ministry. Hospital waste is listed as hazardous waste under the *Environmental Quality (Scheduled Wastes) Regulations of 1988.*

In the Philippines, the Department of Health issued a position paper on dumping toxic waste by Metropolitan Manila hospitals in 1990. This paper was an outcome of a study on SWM carried out in 1988 by the department at sixty-four public and private hospitals in Metropolitan Manila, and was accompanied by guidelines on effective and efficient methods of collection, storage, and disposal of solid waste by hospitals, clinics, and research laboratories. In 1991, the Metropolitan Manila Authority issued an ordinance

entitled, *Regulating the Management, Collection, and Disposal of Hospital Waste and those of Similar Institutions in Metropolitan Manila.* Hospital waste is controlled by the *Toxic Substances, Hazardous and Nuclear Wastes Act of 1990.*

Pacific Island Countries and Areas

In most countries and areas of the Pacific islands, hospitals and health care institutions are located in major urban centres. Many of the general hospitals located in national capital towns are equipped with incinerators, although in almost all cases they are not adequately designed or operated.

In these areas, solid wastes, including hospital and hazardous waste are disposed of at open dump sites. The handling, collection, and transportation of such wastes are also not safely carried out, and awareness of the dangers on the part of the personnel involved is low.

People's Republic of China, Lao People's Democratic Republic, and Socialist Republic of Viet Nam

In the People's Republic of China, no regulatory provision is in place for hazardous waste management, although the National Environmental Protection Agency is currently formulating the *Solid Waste Pollution Prevention and Control Law* and the *Regulations on Management of Hazardous Wastes*, among other laws and regulations. Solid waste from hospitals is generally collected and disposed of, together with other domestic wastes. The majority of hospital and waste management authorities are not fully aware of the dangers associated with infectious waste.

In Lao People's Democratic Republic and the Socialist Republic of Viet Nam, laws on solid and hazardous waste management, as well as on water and air pollution control, have not been enacted. Municipal solid waste collection and disposal services are grossly inadequate, and solid waste from hospitals and health care institutions is normally burned or buried on-site in an uncontrolled fashion, or collected and disposed of by the municipal solid waste services. Because no sewerage is provided in most areas, the liquid waste from hospitals and health care institutions is discharged directly into drains and open water courses. No significant government action on hospital waste has been undertaken.

WHO'S ACTIVITIES IN HOSPITAL WASTE MANAGEMENT

Among all international agencies, WHO is by far the most active organization involved in promoting safe disposal of hospital wastes. WHO has carried out a number of collaborative activities with member states concerning hospital waste management. This section introduces major activities planned and implemented for the improvement of hospital waste management.

Working Group in Europe

A Working Group on Hospital Waste Management was convened in 1983 by the WHO Regional Office for Europe. The purpose of the meeting was to review recent develop-

ments in the handling, transport, treatment, and disposal of waste from health care establishments, and to prepare guidelines for a code of practice to be used by administrators, engineers, and others in industrialized countries. The group's deliberations concentrated on three principal aspects of the subject: (a) the health of personnel and patients in health care establishments; (b) the risks to public health arising from the transport and disposal of infectious and hazardous waste; and (c) the environmental and economic implications of waste disposal methods. A report was published in the form of technical guidelines in 1985.

Recent Global Initiatives

At the WHO Headquarters in Geneva, the Forty-Third World Health Assembly was held in May 1990, which adopted a resolution on hazardous waste management. The resolution addressed the management of both chemical and infectious wastes, and requested WHO to contribute to the preparation of practical technical guidelines for the safe handling and disposal of hazardous waste.

In connection with this resolution, in 1990, the WHO cooperated with the United Nations Environment Programme (UNEP) and the World Bank to draw up guidelines for hazardous waste management in developing countries.

More recently, the WHO convened an interregional consultation meeting on the management of hospital/infectious waste in September 1992, at its headquarters in Geneva. The tasks given to this consultation meeting were:

(1) To review the actual status of infectious/medical waste management in developing countries and its health impacts.
(2) To discuss new dimensions in the health impacts of infectious waste, such as the transmission of HIV through the improper disposal of syringes.
(3) To review recent trends in infectious waste management in industrial countries, and discuss how far they may be extended to developing countries.
(4) To develop detailed terms of reference for the proposed WHO guidelines on infectious waste management in developing countries, with due consideration to regional specifications and effective and affordable methods for the evaluation and neutralization of hospital hazardous waste within the context of a district health and sanitation effort.
(5) To identify institutions which may be called upon to collaborate with the WHO in developing these guidelines.

The meeting discussed the health and environmental implications and various technical aspects of hospital waste management. The WHO guidelines on hospital waste management in developing countries are being prepared, based on this meeting's discussions.

Activities in the Western Pacific Region

The WHO, through its Regional Office for the Western Pacific and the Environmental Health Centre (EHC), has collaborated with some member states in the management of hospital waste.

In Malaysia in 1988, the EHC collaborated with the Ministry of Health in conducting a hospital waste management survey and preparing preliminary guidelines. As mentioned

earlier, the ministry subsequently prepared a master plan for hospital waste management. As part of the effort to implement the plan, in 1993 the EHC will again collaborate with the ministry to develop a training programme and materials for personnel involved in the new hospital waste management scheme.

In Guam, the WHO collaborated with the Department of Public Health and Social Services in 1990, to develop a training programme on the disposal of medical and toxic wastes in hospitals and other health facilities. The EHC carried out a hazardous waste inventory survey in eleven Pacific island countries and areas in 1992, where hospital waste management practices were also assessed. In 1993, the EHC will collaborate with the Department of Health, Government of Papua New Guinea, in assessing hospital waste management practices in the country and preparing guidelines for the management of hospital wastes.

In Cambodia, the EHC collaborated with the Ministry of Health in 1992, to assess the situation in hospitals and health facilities regarding water supply, sanitation, and SWM. The study found the existing facilities and services in very poor condition.

ISSUES AND APPROACHES

Awareness of Problems

The proper management of hospital wastes has become a hot issue in many developed and rapidly developing countries in the Western Pacific Region, in connection with some incidents of acquired immunodeficiency syndrome (AIDS) and hepatitis B infections which were suspected to have resulted from the mismanagement of medical waste at hospitals. In many developing countries, the public lacks awareness of potential hazards posed by medical waste, making it difficult for government authorities to initiate serious action.

In addition to the technical guidelines for hospital waste management in developing countries being prepared by the WHO, educational materials may be developed for use by small health care institutions and the general public to raise their awareness of health and environmental hazards posed by inadequate management of hospital waste.

Legislation and Waste Management Practices

In developed countries, water and air pollution control and solid and hazardous waste management laws are in place, and guidelines/manuals on medical waste management have been prepared, based on these laws. In these countries, adequate waste management facilities and systems are also available to incorporate the management of medical waste.

Most developing countries in the region, however, do not have comprehensive pollution control and waste management regulations, and neither municipal nor industrial waste management activities are well controlled.

When developing a hospital waste management system for a country or a region, consideration should be given to legislative provisions and municipal and industrial waste management practices. Facilities and services for hospital waste management should be provided that are compatible with the legislation and waste management practices.

Incinerators

Incineration is usually regarded as the most appropriate treatment technology for medical waste. It is particularly effective for cytotoxic and various plastic wastes, provided that the incinerator operates at above 1,000°C and is installed with pollution control equipment.

Construction of an appropriate incinerator is generally expensive and its operation requires well-trained personnel and adequate maintenance. In many developing countries, the capital and human resources for incinerators are often not available, and thus other alternatives need to be considered.

In some cases, use of existing incinerators for other purposes is suggested. For instance, a hazardous waste incinerator can be used. But, such an incinerator is not available in most developing countries. Alternatively, cement kilns can be used. However, their operation in most developing countries is not well controlled. Therefore, use of existing incinerators in developing countries is not very promising.

When funds are available, economies of scale favour a centralized incineration facility rather than on-site incineration. Malaysia and the Philippines are adopting a centralized incineration scheme for this reason. However, the centralized scheme requires reliable systems of waste segregation and collection at medical institutions and transportation to the centralized incinerator facility.

Practical Options for Developing Countries

Despite financial and technical difficulties associated with incinerators in developing countries, they are still the choice of technology, where feasible. In fact, the governments of Malaysia and the Philippines consider them essential. Where incineration is not feasible, other practical treatment and disposal options for medical waste need to be considered.

Waste minimization and segregation of medical waste at source are required in almost all waste management systems and should be included in any plan. Disinfection and autoclaving of infectious waste are often feasible in developing countries. The burying of toxic medical waste securely at a properly selected location in a municipal landfill site or near the hospital may be possible in developing countries if adequate procedures are provided in the form of guidelines. These are some management options which may be possible in developing countries.

Privatization

Hospital waste management could be provided by private companies under contractual arrangements with the municipality when it is regarded as part of the municipal SWM, or with hospitals when it comes under the jurisdiction of hazardous waste management regulations. Provided that contracts are carefully written and the contractor's performance is supervised, monitored, and controlled with legislative support, the privatization of hospital waste management is a viable option and probably a more cost-effective solution. It is also important that competitive companies do exist to bid for the contractual work, and that systems of reporting/documentation and spot checks are provided.

The privatization of hospital waste management is being seriously considered in Malaysia and the Philippines, where centralized incinerators are planned to cater for wastes from a number of hospitals and other health care institutions in urban areas.

However, in developing countries, such as those in the Pacific islands, where hospitals and health care institutions are dispersed, the privatization of hospital waste management alone would not be economically feasible as the demand for services is limited. In such cases, the scope of privatization may be expanded to include the management of other hazardous industrial or domestic wastes.

A problem faced by developing countries is the lack of competitive local companies to undertake the hospital waste management services. The training of local management personnel and operators will be necessary in the long run. Initially, however, foreign expertise should be provided.

CONCLUSIONS

The management of hospital wastes is not a new problem, but it has been given a new focus because of recent concern over health risks associated with potential viral infections (e.g., HIV and hepatitis) and environmental impacts due to improper handling of infectious and chemical wastes. This concern has turned into an outcry in some industrialized countries, and it is rising in many developing countries.

The situations, resources, and constraints of hospital waste management differ from one country to another, even among developing countries. Some developing countries in the Western Pacific Region, such as Malaysia, Papua New Guinea, and the Philippines, have taken serious steps towards developing more effective hospital waste management systems through the formulation of action/master plans, preparation of technical guidelines, and training of the personnel concerned.

In order to support these countries' initiatives and disseminate the information and experiences gained from these efforts to other developing countries, WHO plans to organize future activities, such as regional workshops.

COMMENT

TAN HOO

The Environmental Health Centre (EHC) of the World Health Organization (WHO) in Kuala Lumpur has over the years carried out many projects, contributing greatly to the improvement of the environmental health sector in the Asian-Pacific Region. The work of Hisashi Ogawa on hospital waste management is an example of such positive input.

In his article, Ogawa presents an assessment of the current status of hospital waste management in the region. He also highlights some pertinent issues confronting this sector. As the developed nations are generally well equipped to deal with their problems, it is perhaps more important to deliberate on some of the issues faced by the developing countries.

Generally, most developing countries are confronted with three basic problems, not only in hospital waste management but in almost all sectoral development. These are lack of **money**, trained **manpower**, and managerial as well as technical **skills**. Moreover, hospital waste management is not given much priority in the developing countries, compared with other sectors which have greater bearing on economic development. Therefore, while one should strive to direct more attention (and funding) to hospital waste management, it is important to maximize the effectiveness and efficiency of whatever resources are made available to this sector. A large dose of human ingenuity and innovation is needed to achieve such an objective under the constraints stated above.

It is a well-established fact that the cost of hospital waste management is proportional to the volume of waste generated, and it is much more costly to manage clinical than nonclinical waste. It is therefore logical for Ogawa to recommend waste minimization and segregation. A recent survey conducted in Malaysia shows that both total hospital and clinical waste generation rates increase with the level of specialist services offered in a hospital. The rates vary from 1.4 to 2.4 and 0.3 to 0.8 kg per occupied bed/day, respectively. Moreover, the survey shows that between 65 and 80 per cent of hospital waste is in fact no different from municipal waste, and therefore can be managed as such. However, once the wastes are allowed to be mixed, the mixture has to be dealt with as hazardous clinical waste, as it has become contaminated with the same health risks as clinical waste. Therefore, to contain both health risk and cost of hospital waste management, it is imperative that proper segregation of waste at source be carried out.

Waste minimization and segregation are very much part of the housekeeping component of hospital waste management. They are also closely linked with a hospital's basic medical and administrative policies. Thus, the involvement of both hospital staff

associated with waste generation (e.g., nurses, doctors, lab staff, and others) and hospital administration is vital for the success of such an effort. Moreover, the housekeeping aspect of hospital waste management is at the beginning of the hospital waste management chain. Its strength and weakness will affect all the downstream activities and above all the overall cost of hospital waste management. Therefore, it should not be overlooked.

There is an increasing number of human immunodeficiency virus (HIV) and hepatitis infections resulting from accidents involving the handling of clinical wastes (predominantly caused by infectious sharps). Therefore, one should not lose sight of the nosocomial and occupational health aspects of hospital waste management, which again are largely associated with housekeeping. The incidence of such infections should in fact be used to increase awareness of the health workers, the public, and decision makers on the importance of having a proper hospital waste management system.

Ogawa rightly points out that there is great variation in the nature and magnitude of hospital waste management problems different countries face. At the same time there is also a vast disparity in resources available for hospital waste management in different countries in the region. Thus, it is not possible nor practical to have one best hospital waste management model which is both suitable and affordable, and which has the ability to meet the needs of all the developing countries in the region.

Perhaps, the only way to deal with the situation is to help the relevant staff of each country to master thoroughly the basic hospital waste management principles and leave it to human ingenuity to innovate a hospital waste management system suitable to each country's needs, given its available resources. Along the way, interaction among countries to learn from each other's successes and failures through appropriate international forums, such as those planned by the EHC, would be of great help. Hopefully, in time, each country will be able to establish and implement a systematic action plan with appropriate programmes and strategies to ensure continuous improvement of the hospital waste management sector, from a low-level technology and low-performance standards to a higher-level technology and better performance, as more resources become available.

In this modern world, with rapidly changing technology, newer and more sophisticated equipment and machines (such as medical incinerators) are available to improve hospital waste management effectiveness and efficiency. However, funds for technology costs and resources are not always available. The question is: While medical incinerators may be ideal, should one have to wait until resources are available to buy such technology before attempting to make any improvements?

The answer obviously has to be no, as any attempt towards improvement is a positive step, and any improvement achieved is a step closer towards the goal of establishing an effective and efficient hospital waste management system. Therefore, the search for appropriate and affordable technology and a hospital waste management system to meet one's needs should be an unceasing task. If the medical incinerator is beyond reach, controlled landfill is definitely better than open dumping, and sanitary landfill is even better than controlled landfill. What cannot be landfilled is usually small in quantity (e.g., radioactive and cytotoxic wastes) and, once segregated, the solution for their disposal becomes easier and an interim solution can often be worked out with the supplier of such materials.

A hospital waste management system established for the public sector is but half a

system needed by a country. The total volume of medical waste generated by private health care facilities and general practitioners can be quite significant and tends to increase rapidly as a country progresses. Therefore, a national hospital waste management system has to make provisions for the private-sector's needs. Without such a provision, it would be difficult, if not impossible, to enforce any legal regulations on the private sector for the proper management and disposal of medical wastes.

In many developing countries, it may not be economically viable for a commercial medical wastes disposal service to be established to serve the private sector alone. However, such a service may be possible in some countries by combining both public- and private-sector efforts so as to rely on the economies of scale. In such a case, the privatization of hospital waste management could be feasible. However, as Ogawa points out, success in privatization requires careful planning and preparation, as well as diligent monitoring and control. In fact, should one harbour any hope of achieving cost-effectiveness in the process, the existence of a national hospital waste management plan may be considered as a prerequisite for privatization.

From the information given by Ogawa, it is clear that proper hospital waste management systems are lacking in many developing countries in the region. The same situation probably exists in other parts of the world. Thus, the urgent task at hand is for these countries to build up their own capability to establish and manage a hospital waste management system best suited to their needs and which is sustainable with the resources available. For this purpose, the highest priority should be given to building up their human resources. While no one will deny the benefit of learning from the experience and advanced technology of the developed nations, developing countries have much to gain and learn from one another. After all, many of the hospital waste management problems and constraints faced by the developing nations are similar. It is hoped that with perseverance and some help from international agencies and bilateral organizations, rapid progress can be made in this sector in the developing countries.

HAZARDOUS WASTE MANAGEMENT IN THE PHILIPPINES: A CASE STUDY OF METRO CEBU

MARIA VICTORIA FERNANDEZ-RICAÑA

INTRODUCTION

Prior to 1986, the now-defunct National Pollution Control Commission (NPCC) was the government agency responsible for the monitoring and control of water and air pollution. The central office was in Manila with field offices in the regions to implement and enforce pollution control laws. The NPCC field office for Region VII (Central Visayas covering the provinces of Cebu, Negros Oriental, Bohol and Siquijor) was established in Cebu City. By this time, industrial development in the Philippines had already made great strides to the extent that a vast array of toxic and hazardous wastes were entering the environment. Although there were existing criteria on air and water quality, as well as emission and effluent standards, a systematic programme to monitor the importation, manufacture, treatment, and disposal of hazardous waste had not been institutionalized. However, there was existing legislation dealing with hazardous chemicals in food and drugs, fertilizers, and pesticides but water quality control, which was handled and implemented by as many as ten agencies (as shown in table 1), did not deal with the subject of toxic and hazardous wastes.

The pollution control regulations contained a chapter dealing with the control and regulation of hazardous waste. However, these were general guidelines only and were not implemented until the late 1980s when, internationally, problems arising from mismanagement of hazardous waste were becoming environmental issues of great concern, and locally, attempts to bring hazardous waste into the country for disposal were increasingly becoming a threat. In September 1986, the NPCC created an *ad hoc* Division of Solid and Toxic Wastes Management for the purpose of implementing article 2, chapter IV of the *1978 NPCC Rules and Regulations*, specifically aimed at the prevention and control of pollution from solid, toxic, and hazardous wastes. The first step undertaken by the division was collection and evaluation of existing data from postal questionnaires on the distribution of waste at all known waste generators in the country. The survey form was supposed to provide information on the quantity of waste produced, composition and characteristics of the waste, mode of transport, and method of disposal. The survey did not get a favourable response from industry.

In March 1987, the NPCC came up with the "Interim Implementing Guidelines for the Handling and Management of Solid, Toxic, and Hazardous Wastes". It required all establishments that generate solid, toxic, and hazardous wastes to register with the NPCC

TABLE 1. LEGISLATION RELATING TO CHEMICAL SAFETY AND HAZARDOUS WASTE MANAGEMENT/IMPLEMENTING AGENCIES

Legislation (Implementing agencies)	Area of Concern
Food, Drugs, and Cosmetics Act, 1963 (Bureau of Food and Drugs)	For the safety and good quality supply of food, drugs, and cosmetics
Pollution Control Law, 1976 (Laguna Lake Development Authority; the then National Pollution Control Commission, which is now the Environmental Management Bureau of the Department of Environment and Natural Resources)	For the prevention, abatement, and control of pollution
Dangerous Drugs Act, 1972 (Dangerous Drug Board; Philippine Constabulary- Integrated National Police Narcotics Command)	For the control of importation, sale, and manufacture of prohibited drugs
Code of Sanitation, 1972 (Department of Health)	For industrial hygiene
Occupational Health and Safety Code, 1974 (Department of Labor and Employment)	For safety, health standards, and working conditions
Marine Pollution Decree, 1976 (National Operation Center on Oil Pollution: Philippine Coast Guard)	For prevention and control of marine pollution
Presidential Decree 1144, 1977 (Fertilizer and Pesticides Authority)	For importation, manufacture, repacking, sale, use, and distribution of fertilizer and other agricultural chemicals
Philippine Environment Code, 1977 (DENR)	Environmental management policies and quality standards

as waste generators. The guidelines were partially imposed as a response to the growing concern of both the industry and the community for the proper management of hazardous waste, and the lack of trained personnel especially in the regional offices. Even the government itself recognized this constraint. It was realized that there was a real need for another law that would cover all aspects of hazardous waste management.

After 1986, the new government felt a need for a new and revitalized agency to cope with the worsening situation not only of air and water pollution but also of hazardous waste. The reorganization of the Department of Natural Resources in 1988 into the Department of Environment and Natural Resources (DENR) witnessed the abolition of the NPCC and the National Environmental Protection Council (NEPC), and the creation of an Environmental Management Bureau (EMB) as one of the six staff bureaus of the DENR. The newly reorganized DENR mandated the EMB to draft a bill for submission to the House of Representatives and to formulate rules and regulations on solid and hazardous wastes. *Republic Act (RA) 6969*, known as the *Toxic Substance and Hazardous and Nuclear Waste Control Act of 1990*, grants broad regulatory powers to the DENR. Unlike many other environmental statutes, which focus primarily on waste and discharges ("end of pipe" controls), the act covers the importation, manufacture, processing, handling, storage, transportation, sale, distribution, use, and disposal of all unregulated chemical substances and mixtures that present unreasonable risk and/or injury to health or the environment. It also prohibits the entry, even in transit, as well as the keeping or storage and disposal of hazardous and nuclear wastes into the country for whatever purpose. An Interagency

Technical Advisory Group, chaired by the EMB and composed of different government agencies, industry, and nongovernmental organizations (NGOs), drafted the implementing rules and regulations as required by the statute.

At the moment, the volume, locations, characteristics, or proper handling methods of the chemicals and chemical compounds explicitly covered in the legislation are not known. The legislation is yet to be implemented by the regional offices, and a rudimentary survey has still to be undertaken.

ORGANIZATION AND FUNCTIONS OF THE EMB AND ITS REGIONAL OFFICES

The principal agency for urban and industrial environmental management is the DENR. The EMB is used by the DENR management to influence environmental policies and actions. It establishes rules and regulations, formulates legislation, and also has at its disposal the setting of environmental standards and imposing conditions on permits for air and water discharges. The EMB provides staff support for the Pollution Adjudication Board (PAB), a quasi-judicial body chaired by the Secretary of Environment and Natural Resources, empowered to issue cease and desist orders, assess fines and penalties, and consider compliance schedules.

The central office of the DENR is located in Manila. It maintains regional offices in each of the country's thirteen administrative regions, which implement the laws, policies, plans, programmes, projects, and rules and regulations of the department. A regional office is headed by a regional executive director who is assisted by five regional technical directors each for forestry, land management, mines and geosciences, environment and protected areas, and ecosystems research.

The Environmental Management and Protected Areas Services (EMPAS) in the regions implement all the legislation, programmes, and policies on the environment and pollution control.

A CASE STUDY OF METRO CEBU

History, General Economic Activity, and Current Trends

Before the arrival of Spanish colonizers in 1521, Sugbu (former name of Cebu) had already established trading links with China, ports of Southeast Asia, and other areas of the Philippine Archipelago.

The colonizers, impressed by the size and wealth of the island's port, decided to build their first settlement, lay the foundations of Spanish rule, and sow the seeds of Christianity in this island which later permeated every facet of Filipino life throughout the archipelago.

Cebu City, the capital of Cebu Province, is the oldest city in the Philippines. After the 1940s, Cebu emerged as a major entrepôt serving the Visayas and Mindanao. Cebu Island has one of the fastest growing economies in the area. It is geographically situated at the centre of the Philippine Archipelago (580 km south of Manila), and is the only major island in the country which enjoys an economic growth rate surpassing that of the nation as a whole.

Metro Cebu, the centre of economic activities of Cebu Province, lies on the central eastern portion of the island. It is comprised of three cities (Mandaue, Lapulapu, and Cebu) and seven municipalities (Naga, Minglanilla, Talisay, Cordova, Consolacion, Liloan, and Compostela) with a total land area of 710 km^2. As a major metropolis third only to Metro Manila and Davao, Metro Cebu performs vital development functions in terms of contributing to the national economic recovery, promoting the strategy of decentralization, and focusing on regional industrialization and modernization. Metro Cebu, with its extensive trade and industry is developing wider links through the presence of its international airport and seaport. Sister city agreements have been signed to promote trade and cultural cooperation between Cebu and other cities of the world to enhance mutual assistance and promote friendly ties among the citizens.

Cebu is the seat of the regional government for the Central Visayas and there are a total of eighty-one national government agencies operating in the city. Of this number, thirteen are regional offices; fifty-eight are regional bureaus and commissions; four are government banks; and six are military commands. Recently, an extension office of the President or the Malacañang of the South was opened in Cebu to serve the Visayas and Mindanao.

Population Growth and Distribution

The population, which grew at a rate of 4.5 per cent between 1970 and 1980, is clustered in the narrow coastal plains. Massive capital investment is programmed for the industrialization of Metro Cebu since it does not have a rich agricultural base, thus, the attractiveness of this metropolis will be further enhanced and its growth rate maintained well into the foreseeable future.

Based on the National Census and Statistics Office estimates, the 1990 population of the metropolitan area was 1,274,345 — almost half the total population of the province. Table 2 shows the population distribution per city and municipality in Metro Cebu, the land area, and population density.

TABLE 2. LAND AREA AND POPULATION DENSITY

Area	Population			Land Area (km^2)	Density*		
	1990	1980	1970		1990	1980	1970
Cebu City	610,417	490,281	347,116	280.9	2,173	1,745	1,235
Lapulapu City	146,194	98,723	69,268	58.1	2,516	1,699	1,192
Mandaue City	180,285	110,590	58,579	11.7	15,409	9,452	5,006
Compostela	22,006	17,504	13,931	53.9	408	324	258
Consolacion	41,270	27,454	17,602	32.6	1,266	842	539
Cordova	22,331	16,455	12,538	11.7	1,908	1,406	1,071
Liloan	42,287	30,196	22,495	52.1	811	579	431
Minglanilla	50,875	38,504	28,880	65.6	775	587	440
Naga	60,425	45,831	35,043	79.9	756	573	438
Talisay	97,955	69,720	47,787	86.4	1,133	806	553
TOTAL	**1,274,045**	**945,258**	**653,239**	**732.9**			

Note: * People per km^2.

In 1973, Mactan Island was linked to the main island with the opening of the Mandaue-Lapulapu Bridge. In 1978, Cebu's only industrial estate, the Mactan Export Processing Zone (MEPZ), was created adjacent to the country's second international airport and near to Cebu Harbour. This accounts for the rapid growth of Lapulapu and Cordova.

Land and Resource Use

The municipal and city governments are empowered to enact zoning regulations to attain desirable patterns of land use. The Housing and Land Use Regulatory Board (HLURB) bases its approval of developments upon existing municipal plans. It may issue a waiver of the master plan if a resolution requesting a change is adopted by the Municipal Council and approved by the Mayor.

Cebu's limited natural resources and their present state of degradation have constrained authorities to adopt a developmental strategy that is not dependent upon agriculture.

In common with other Philippine urban centres, Cebu City has no land-use zoning. Residential areas are scattered throughout the city and are built adjacent to industrial sites. Commercial establishments are situated wherever owners feel they have a market for goods and services. The centre of this elongated structure is the central business district (CBD) of downtown Cebu. The CBD exhibits an extremely complex mix of activities accounting for 40 per cent of total metropolitan employment.

Small- and medium-scale industries were relocated to Mandaue City, while export-oriented industries and multinationals were located in the MEPZ. The *poblacion* or outer municipalities act as service centres for outlying agricultural and fishing communities. Nonurban land in Metro Cebu accounts for more than 90 per cent of total land area. This rural land is devoted to agriculture and forestry purposes. Recently, some agricultural land has been declared nonproductive and converted to residential subdivisions. Most rural areas are mountainous and subject to excessive soil erosion. Squatter settlements proliferate on any unoccupied land, including river banks.

Metro Cebu Development Project (MCDP) has earmarked seven reclamation projects to expand and fully optimize land utilization. MCDP is the project implementing arm for Metro Cebu which coordinates with local governments, the National Economic and Development Authority (NEDA), Regional Development Council (RDC), and HLURB.

Manufacturing Industries

Cebu's economy is primarily comprised of micro cottage and small enterprises. This sector of small businesses is the backbone of Cebu's economy. The export sector is primarily dependent on these enterprises for the manufacture of export quality Philippine handicrafts.

The Department of Trade and Industry (DTI), the provincial government, NEDA, and RDC, are promoting the development of light engineering, plastics, and packaging industries in Cebu for direct export or support industries to export firms. The MEPZ is Metro Cebu's prime showcase of nontraditional export-oriented growth. In 1986, there were only eight firms operating in the MEPZ. As of August 1991, the industrial estate has taken in a total of forty-one firms manufacturing a wide variety of goods and services. This growing activity is a microcosm of the rapid economic development taking place in Cebu.

The existing firms are engaged in the labour-intensive manufacture and assembly of different goods ranging from garments to electronic products. Enterprises in the area are export-oriented and predominantly multinational corporations. In 1990, MEPZ continued to register the largest positive trade balance among the four export processing zones in the country.

Types of industries. Wood products industry, principally rattan furniture-manufacturing, stone and shellcraft, and livestock industry (prawn industry included) are the three major types of industries in Metro Cebu (see table 3). Metal foundry and metal finishing, which includes electroplating and galvanizing, with forty-two businesses, total only 5 per cent. Note that there are many small-scale manufacturing and service industries dispersed around Metro Cebu that are not registered under the DENR. And from the business permit files of the different municipalities and cities in Metro Cebu, roughly 9 per cent, which are unregistered, are believed to be handling toxic and hazardous substances. Most of these factories and shops are concentrated in Cebu City and the Mandaue City area. Moreover, there are sixteen hospitals in the Metro Cebu area which are mostly situated in Cebu City.

Environmental Problems and Solid and Toxic Wastes in Metro Cebu

Rapid industrial expansion, especially of the small- and medium-sized industries, has increased the threat to the environmental quality of Metro Cebu. Increasing waste generation is associated with urbanization itself. As urban life-styles are adopted, and disposable income increases, refuse generation increases correspondingly.

There are currently no facilities that can be classified as sanitary landfills. About 60 per cent of the solid waste and residue in Metro Cebu, after the recyclable and reusable materials have been removed by households and neighbourhood scavengers, is actually transported to open dumps. The remaining 40 per cent remains uncollected. The uncollected fraction may be burned, buried, or composted by households, but it may also remain in the streets in the *esteros*, canals, or river systems that cut through the city. With the onset of the rainy season, these materials, along with septic tank effluent are washed out to sea. Even after the material reaches the open dumps, materials slough into the water or contribute to air pollution as a result of smoldering fires.

While each individual household may discard only small amounts of hazardous materials, the total amount of discarded domestic waste containing hazardous materials is large. Materials such as fluorescent lamps, flashlight batteries, paints, medicines, solvents, used oils, empty containers for pesticides and insecticides, medicines, beauty aids, and even household smoke alarms containing radioactive substances are commonly discarded along with normal household waste.

Since adequate disposal facilities are not available for industrial and hazardous wastes, they are dumped together with household waste.

Hospital waste. The handling and disposal of medical waste is a special problem due to the highly infectious nature of some materials. Current law requires hospitals to install, maintain, and use specialized incinerators to treat the materials. Most of the hospitals in the area are in violation of this law.

Industrial toxic and hazardous wastes. At present, there is no secure landfill for the disposal of industrial solid waste. Based on an initial survey conducted by EMPAS Region VII and the Project for Industrial Pollution Control funded by the German Agency for Technical

TABLE 3. INDUSTRY TYPES IN METRO CEBU (DENR-REGISTERED ONLY)

Industry Type	Total Number
Wood products industry (rattan dominated)	135
Livestock (including prawn)	115
Shellcraft and stonecraft	113
Meat, sea products, and fruit processing	60
Milling	54
Foundry, casting, and metal finishing	42
Lumber milling	34
Rubber and related industry	23
Cement, concrete, and gypsum	21
Plastic and synthetic products	15
Fashion accessories	14
Baked products	14
Equipment and engine repair	13
Industrial gas	13
Coconut oil processing	12
Ceramics and glass	8
Mineral ore processing	8
Chemical repacking	7
Power generators	7
Beverage	7
Semiconductors, wire harnesses, and related industry	6
Fertilizer	5
Sugar, confectioneries	5
Bulk depot (petrol)	4
Laundry and cleaning	4
Cotton and garments	4
Battery manufacturing	2
Cartons and paper	2
Dairy products	1
Unclassified	32
Other sources	
Unregistered (from business permits) believed to be handling hazardous toxic substances only	94
Unregistered (from newspaper)	2
Unregistered (Philippine Electroplaters Association-Cebu Chapter members)	31
Hospitals	16

Cooperation (GTZ), the following are the industrial toxic and hazardous wastes in Metro Cebu:

(1) Heavy metal-bearing wastes. The wastewater containing hexavalent chromium, cyanide, zinc, nickel, copper, and iron from the galvanizing industries and small-scale electroplating shops is discharged directly into the sewers, land depressions, or rivers without proper treatment. For small electroplaters, the scum removed from the plating baths is discarded together with household garbage. The salammoniac slag from galvanizing operations, contains ammonium chloride, zinc, tin, and lead, and is also discarded freely along with household waste. For the multinational semiconductor and electroplating industries, the heavy metal sludge from wastewater treatment facilities is collected in drums lined with polyethylene, then stored temporarily on company premises. The solder dross, solid waste from solder-dipping operations containing tin and lead, is sold back to vendors, or stored on company premises. It might end up with normal garbage.

(2) Inorganic cyanides are used by the electroplaters.

(3) Polychlorinated biphenyls (PCBs). Banned, little information currently exists on intractable organics. They have been imported with purchased transformers and capacitors during the period from 1955 to 1970.

(4) Waste oils. Petroleum-based waste oil from gasoline stations, power generators, ship repair industries, and automobile and engine repair shops is recycled, or collected and sold as cheap boiler and foundry fuel. Petrol depots often retrieve waste oil from gasoline stations and store it in tanks within their premises. Spillages find their way into sewers. Contaminated materials during cleaning are thrown directly into the garbage. Used mineral oil, used as transformer oil as a substitute for PCBs, is filtered and recycled, or sold to printing press shops, or utilized as an antitermite treatment for wood.

(5) Petroleum-based cleaners, paints, varnish, and solvents are either recycled or discarded. Painting and polishing are major finishing operations in the wood, stone, rattan, and metal industries. The paint or varnish sludge from their water curtains or spray painting booths are fed into boilers or discarded. For the top ten rattan manufacturers in Metro Cebu, 4,500 barrels of coating materials are wasted per year.

(6) Oil dispersants. Used during oil spillages by ship repair operators.

(7) Waste dyes originate from fashion accessory shops, textile shoe manufacturers, and the bleaching of blue denim jeans, though produced in relatively small quantities.

(8) Pesticides, chlorinated hydrocarbons, and related chemicals are not locally produced but there is evidence of regular imports. The top ten rattan exporters claimed that seventy drums of these chemicals are consumed monthly for rattan poles treatment.

(9) There is also evidence of imports of acids, alkalis, and oxidizing and reducing agents.

(10) Used car batteries. The acidic electrolyte is allowed to settle, then the clarified solution is used to replenish the "dead electrolyte" of used batteries. The dead electrolyte is directly discharged into the ground or into the sewers. The settled lead sulfate and the damaged lead plates are collected and sold to middlemen who ship them to car battery manufacturers in Manila for recovery. The lead-contaminated polyvinyl chloride (PVC) separators find their way into the garbage.

Recycling. The present household/scavenging system is efficient. Separation begins in the household and continues through a succession of professional scavengers who operate around the neighbourhood trash heaps and in the dump sites themselves. Most often, empty bottles and paper are bought directly by scavengers from households. Glass, metal of all kinds, rubber, hemp, nylon cordage, and a considerable amount of paper, cardboard, and polyethylene plastic are removed and carried to middlemen who then transport them to enterprises that specialize in recycling and reusing one particular kind of material.

A number of private waste management contractors serve the industrial sector who periodically haul the industrial solid by-products and residues from the factory sites. The contractor, in fact, buys these materials from the manufacturing company for a price based on the contractor's estimate of the value of the reusable material he will be able to recover. The waste that is found to be technologically or economically unusable is taken to a dump. Since hazardous and toxic materials such as PCBs, lead solder slags, and asbestos waste often have little or no market resale value, they often end up in the dump where they pose a health threat to the scavengers.

Companies with very low quantities of recyclable materials pay contractors to haul their waste to dump sites. This data, in tabulated form with additional information, is contained in table 4.

Solid Waste Management (SWM)

While DENR-EMPAS is responsible for the management and control of industrial waste, the local government is responsible for providing SWM services. There is a statutory precedent for the Department of Public Works and Highways (DPWH) to construct sanitary landfills, and authority for the Department of Health to provide guidelines and technical assistance during all phases of SWM.

About one half of the households in Cebu City are served by garbage collection services. Door-to-door collection is the mode of collection in the majority of high-income and middle-income neighbourhoods, while among the low-income neighbourhoods, households bring their garbage to the trucks for collection. Households not reached by garbage collection resort to other garbage disposal practices such as burning, burying, or composting.

The Department of Public Services is responsible for collection and handling of solid waste in Cebu City. In the past, the city administration gave the responsibility to a private contractor who had simply dumped the waste at a limited site near Barangay Pasil adjacent to Cebu City. The *barangay* was comprised mostly of squatters and the presence of a dump site nearby made life untenable. Solid waste disposal remained at a substandard level until the city government imposed penal provisions at which time the contractor withdrew. Waste disposal was then undertaken by the city government itself with a collection fleet which began with ten open trucks and gradually increased to fifteen. The open dump site at Barangay Pasil was closed in 1979 and incorporated in a new project for Slum Improvement and Resettlement (SIR).

A new site was established in an area approximately 8 km from the CBD in Barangay Inayawan. It is located on the coastal plane and is currently being extended to the tidal zone of the Cebu Straits. Disposal was originally envisioned as a sanitary landfill system but, due to scarcity of funds, the high cost of recovery materials, and a lack of proper equipment,

TABLE 4. SOURCES OF SELECTED TYPES OF INDUSTRIAL WASTE IN METRO CEBU

Waste Type	Source of Waste	Forms of Waste	Discharge Method	Scale	Number
Metal-Bearing Waste					
Lead/tin- bearing					
Small battery shops	Lead plates, battery solution	Solid, in solution	Sewer/garbage/recovered	Small	Many
Electronic manufacturing and assembly	Soldering, electroplating	Solid, vapour	Garbage/atmosphere	Medium	3
Wire harness	Soldering	Solid, vapour	Garbage/atmosphere	Medium	3
Gasoline-fueled engine	Combustion engine	Vapour	Atmosphere	Large	Many
Chromium-bearing					
Electroplating	Treatment plant, spills, rinsings	Solid, in solution	Sewer/garbage/recovered	Small/Medium	40
Zinc galvanizing	Chrome spills, rinsings	Solution	Sewer	Medium	2
Copper/nickel/zinc/iron-bearing					
Electroplating	Treatment plant, spills, rinsings	Solid, in solution	Sewer/garbage/recovered	Small/Medium	40
Electronic board etching	Etching waste	Solution	Sewer	Small	
Metalware	Pickling waste	Sludge, in solution	Sewer/treated	Medium	2
Machine shops	Machining	Solid	Recovered	Small/Medium	Many
Other metal-bearing waste					
Painting	Washing (brush, spray, eqpts.)	Sludge	Sewer	Small/Medium	Many
Photo processing	Processing-solution waste	Liquid	Sewer	Small	Many
Cyanide-Bearing Waste					
Electroplating	Spills, rinsings	Solution	Sewer/treated	Small/Medium	40
Pesticides and Related Chemical Waste					
Rattan	Pesticide application waste	Liquid	Sewer	Medium/Small	135

TABLE 4 (Continued)

Waste Type	Source of Waste	Forms of Waste	Discharge Method	Scale	Number
Waste Oils					
Equipment/engine repair	Change oil, cleaning, spills	Liquid	Recovered/sewer	Medium/Small	Many
Ship repair	Change oil, cleaning, spills	Liquid	Recovered/sewer/dispersed	Medium/Small	6
Power generators	Change oil (including transformer oil), cleaning	Liquid	Recovered/sewer	Medium/Small	7
Power stations	Change oil, cleaning, spills	Liquid	Recovered/sewer	Small	Many
Petrol depots (new oil)	Spills	Liquid	Recovered/dispersed	Large	4
Petroleum-Based Cleaners/Dispersants Waste (Volatile or nonvolatile, halogenated or not)					
Equipment/engine repair	Paint removers, degreasers	Liquid	Sewer/collected	Small/Medium	Many
Ship repair	Paint removers, degreasers, oil dispersants	Liquid	Sewer/collected	Small/Medium	6
Foam factory and related factories	Equipment cleaning	Liquid	Sewer	Medium	2
Power generators	Equipment cleaning	Liquid	Sewer/collected	Medium	7
Paints, Varnishes, and Related Chemical Waste					
Wood finishing (e.g., rattan)	Spray/brush painting	Solid, liquid	Garbage/recovered/sewer	Small/Medium	135
Metal finishing (e.g., auto spray)	Spray/brush painting	Solid, liquid	Garbage/recovered/sewer	Small/Medium/Large	Many
Formulators/blenders	Spills	Liquid	Recovered/sewer	Small/Medium	1
Waste Dyes					
Shoe factories	Dyeing waste	Liquid	Sewer/treated	Medium	1
Bleaching/industry services	Bleaching waste	Liquid	Sewer/treated	Small/Medium	4
Fashion accessories/garments	Dyeing waste	Liquid	Sewer/treated	Small/Medium	16
Printing press	Equipment cleaning waste	Liquid	Sewer	Small/Medium	Many
Other Waste					
Hospitals	Contaminated materials, liquids	Solid, liquid	Incinerated, garbage, sewer	Medium	16

the city had to revert to the open dumping system which is still in effect.

Under a loan from the Government of Japan, the present open dump site for Cebu City in Inayawan will be converted into a sanitary landfill project through funding by the Overseas Economic and Cooperation Fund (OECF). This will be undertaken by the DPWH, the city government, and the Regional Development Council through the MCDP. Through this funding, Cebu City has been able to buy forty-six compactor trucks for garbage collection.

An environmental impact statement (EIS) for the proposed project in Inayawan has been prepared and submitted to the EMB for evaluation. It is also proposed that an incinerator will be established at this site for hospital waste only. The municipalities of Metro Cebu do not have their own disposal facilities. Constituents have to dispose of their waste in their own backyards by burying, burning, or composting.

Nongovernmental Organizations

A growing number of NGOs are showing interest in environmental concerns in response to perceived deforestation problems and damaged stream ecosystems. The Cebu Chamber of Commerce and Industry, Rotary Clubs, and professional organizations such as the Philippine Institute of Chemical Engineers-Cebu Chapter, in Cebu have a growing interest in urban and industrial affairs. The Pollution Control Association of the Philippines-Cebu, whose members are involved in industry, are very active in promoting industrial pollution control and management. Environmental surveys are also being actively promoted.

Industrial Waste Management in Metro Cebu

The implementing rules and regulations for *RA 6969* have been published this year and will be implemented by DENR regional offices. An industrial survey is being undertaken by the DENR-EMPAS Region VII with technical assistance for industrial pollution control being rendered by the GTZ.

The Phil-German Project on Industrial Pollution Control, Cebu

This project is being implemented by the DENR-EMPAS Region VII office, with funding from the Government of Germany through the GTZ. The project covers only Metro Cebu and focuses on industrial waste. The objective is to promote industrial pollution control and to create the necessary conditions for the environmentally-friendly disposal of toxic and hazardous wastes in Metro Cebu.

The project has two phases and will extend for five years. The first phase involves the laying out of baseline information for the proper management and handling of toxic and hazardous wastes and the general foundations for the design and operation of the treatment facility. The second phase involves the design and construction of the treatment facility.

In translating the objectives into a methodology, the following components were identified:

(1) Training courses for the DENR-EMPAS Region VII staff. The training courses on pollution control and industrial waste management are designed to strengthen institutional capability. Local training is also designed to involve NGOs, industry, educational institutions, local governments, and other line agencies, to promote awareness and instill a collaborative approach to urban and industrial environmental manage-

ment.

(2) Ecological profile for Metro Cebu. As a tool for environmental planning and impact assessment, an ecological profile will be developed for Metro Cebu. A data bank based on electronic data processing (EDP) and a geographic information system (GIS) are also being set up, which will combine the data on industrial sources of pollution with data on ecological systems.

The data from industries are collected through surveys, inventories/audits on hazardous chemicals and waste, and samplings of wastewater and sludge.

The survey of ecological systems will examine the conditions of groundwater and its sensitivity to pollution. The data will include soil type/characteristics, geology and topography, distance of groundwater from surface, and velocity and direction of groundwater flow. Data maps will be included in the GIS component. A sampling plan for surface and groundwater will be developed.

(3) Establishment of an environmental laboratory. The University of San Carlos Water Laboratory has been upgraded and supplied with laboratory equipment to enable it to handle environmental analyses including a wide range of toxic and hazardous substances. Environmental samples will be analysed for heavy metals, cyanides, hydrocarbons, and volatile and nonvolatile chlorinated hydrocarbons.

(4) Establishment of a pollution advisory service within the Cebu Chamber of Commerce and Industry. Pollution control and environmental management are not only the tasks of the supervising authority, but also for the waste generators. As the lack of knowledge and technology is more pronounced in the small- and medium-scale industries, more emphasis on consulting and advisory services will be placed on these groups. Large-scale industries can avail themselves of this service. One-on-one training, seminars, brochures, and bulletins will be utilized in this service.

(5) Dissemination of information on problems of toxic and hazardous wastes. A public awareness campaign will be conducted to disseminate information on environmental problems and solutions, and to promote environmental consciousness among the public. Environmental videotapes will be shown to students in schools and to interested citizens' groups. An environmental forum is being organized for city and municipal planners, educational institutions, NGOs, and various industries and the local media will be utilized for the campaign through both print and broadcast.

HAZARDOUS WASTE MANAGEMENT IN JAPAN

REIJI HITSUMOTO

INTRODUCTION

The background to hazardous waste management in Japan is different from that of developing countries. For instance, in Japan there is no problem with scavengers. The main reasons for hazardous waste control in Japan are to prevent accidents during collection, transport, and treatment, and illegal practices by law violators, and to protect the environment from pollution due to illegal dumping and improper treatment. Although treatment facilities for hazardous waste are provided at a certain level, there are some persistent issues that need to be tackled.

In Japan, the management of hazardous waste, other than radioactive waste, is regulated by the *Waste Management and Public Cleansing Law*, which in this article will hereinafter be referred to as the *Waste Management Law*. The current *Waste Management Law* was amended in October 1991, after a twenty-year interval, and has been enforced since July 1992. The amended law is aimed at controlling the amount of waste generation, promoting waste separation, and adopting a broad concept of hazardous waste. Although the former law regulated toxic waste, such as mercury, lead, hexavalent chromium, cyanide, cadmium, and arsenic, the concepts of "infectious" waste and "explosives" were not legally defined. The management of hazardous waste which was not regulated by law, was controlled by guidelines and administrative orders (*gyousei sidou*). The unabated incidences of explosives accidents at waste incineration plants, accidents concerning medical waste, the effects of asbestos on human health, and potential environmental risk of waste acid and waste alkali in effluents required strengthening of the *Waste Management Law* to prevent further damage by toxic waste. Thus, a broader concept of hazardous waste was introduced into the new law.

The issues in Japan now are related to the reduction and proper control of waste, especially industrial waste. Since the volume of industrial waste generated is considerably more than that of domestic waste, the parties concerned should make greater efforts to reduce industrial waste.

This article will first explain the current state of hazardous waste management in Japan, which is undergoing a process of trying to achieve the goals outlined in the new law.

HISTORY OF WASTE MANAGEMENT IN JAPAN

In 1900, the *Filth Elimination Law* was enacted. The history of Japan's *Waste Management Law* is outlined in table 1. Since 1954, filth in urban areas had been mainly under the jurisdiction of the *Public Cleansing Law*. The volume and composition of waste changed as the economy expanded and the standard of living rose. This created a need to radically improve the waste management system. Rapid progress in sanitary engineering has helped improve waste management.

In 1970, the *Public Cleansing Law* was fully amended and updated to deal with the prevailing conditions of waste generation, and emphasized the responsibility of the industrial waste generator as proper waste manager. The amended law was the *Waste Management Law*, which was enforced in September 1971. Subsequent amendments to the *Waste Management Law* in June 1976, were drawn up to strengthen the regulation of industrial waste management and to secure proper disposal of waste from enterprises. In 1983, the *Waste Management Law* was further amended with the introduction of the *Jokaso Law* (private sewerage system law).

In October 1991, the *Waste Management Law* was again amended to introduce the concept of "hazardous" waste, to promote recycling, and to strengthen the enterprises' responsibility. The present law was enforced in July 1992. In addition to these enactments and amendments, there are guidelines for asbestos, demolition, dioxin, and infectious waste management. Administrative guidance (in terms of administrative orders from the national agencies) is provided to regulate the management of hazardous substances such as organochloric compounds (e.g., polychlorinated biphenyl (PCB) and trichloroethylene).

TABLE 1. HISTORY OF THE *WASTE MANAGEMENT LAW*

1900	Enactment of *Filth Elimination Law*
1954	Enactment of *Public Cleansing Law*
1970	Enactment of *Wastes Disposal and Public Cleansing Law*
1976	Amendment of *Wastes Disposal and Public Cleansing Law* (to strengthen control of industrial waste management)
1983	Amendment of *Wastes Disposal and Public Cleansing Law*, following enactment of *Jokaso Law* [private sewerage system law]
1991	Amendment of *Wastes Disposal and Public Cleansing Law* (to strengthen control of hazardous waste management and to promote reduction of waste, etc.)
July 1992	Enforcement of amended *Wastes Disposal and Public Cleansing Law*

DEFINITION OF HAZARDOUS WASTE

The *Waste Management Law* defines waste as useless material or filth which is in solid or liquid state. Waste is classified into two categories: domestic waste and industrial waste. Radioactive waste is regulated by a different law. Industrial waste is defined as waste which is generated from industrial activity, and there are nineteen such categories (see table 2). Domestic waste is waste which does not fall under any of these industrial waste categories. The industrial waste categories include ash (cinder), sludge, waste oil, waste acid, waste alkali, waste plastics, waste paper, waste wood, waste fibre, animal and plant residues, waste rubber, waste metal, waste glass and ceramics, slag, demolition waste, livestock excrement, livestock carcasses, dusts, and treatment residues from industrial waste. Wastes that do not fall under these categories, but which are nevertheless generated within industrial premises, are not defined as industrial waste under the *Waste Management Law* and the pertinent administrative order.

There are three categories of domestic waste and five categories of industrial waste which have corrosive, explosive, infectious, and toxic characteristics, and are considered hazardous. These hazardous wastes are potentially dangerous to human health and the environment.

Hazardous wastes are listed in table 3. Hazardous wastes from domestic sources include discarded air-conditioners, televisions, and microwave ovens (which are equipped with PCB components), dust generated from municipal waste incineration plants, and infectious waste. Hazardous industrial wastes consist of waste oil, waste acid (pH<2.0), waste alkali (pH>12.5), infectious waste, and toxic industrial waste. Toxic industrial waste consists of PCB-polluted substances, asbestos, toxic sludge, and others.

A doctor's assessment is needed to determine whether a particular type of waste is infectious. Standards for classifying toxic wastes are listed in table 4. Common hazardous elements and compounds are mercury, cadmium, lead, organic phosphorous compounds, arsenic, hexavalent chromium, cyanide compounds, PCB, trichloroethylene, and tetrachloroethylene. These standards apply to waste disposed of in landfills. If industrial wastes do not meet these standards, they are allowed to be disposed of only in specific landfill sites which have been designed and constructed for that purpose. Such wastes are assessed by means of a leaching test. The leaching test measures the degree of solubility of hazardous elements or compounds into pH-adjusted water. The waste sample mixture in the water is shaken for six hours. The ranges of pH are 5.8 to 6.3 in the case of reclaimed land, and 7.8 to 8.3 in the case of reclaimed sea. These pH ranges reflect ambient conditions. Standards are also set for ocean dumping, but will not be covered here because of their complexity.

The categories of hazardous waste in Japan are narrower than those defined by the Basel Convention (see tables 5a and 5b). Japan's crisis management system is the reason for the difference in what constitutes a hazard. The Government of Japan is focusing on and strongly regulating hazardous substances. This perspective is reflected in the limitations imposed on industries concerning hazardous waste. Another reason is the regulatory system of laws. The system of regulations includes other laws, such as the *Fire Defense Law*, the *Poisonous and Deleterious Substances Control Law*, and the *Law Concerning the Examination and Regulation of Manufacture of Chemical Substances*.

TABLE 2. TYPES OF WASTE

Domestic Waste	Waste other than industrial waste	
	Kind	Designated industry or waste
Industrial waste (waste generated from industrial activity)	ashes (cinders)	
	sludge	
	waste oil	
	waste acid	
	waste alkali	
	waste plastics	
	waste paper	pulping, paper making, paper processing, newspaper, bookbinding, and printed-material processing industry, waste paper coated with PCB
	waste wood	construction industry (only from the removal of structures), timber or woodenware manufacturing, pulp manufacturing, wholesalers of imported timber
	waste fibres	textile industry (waste natural fibres)
	animal/plant residues	food, pharmaceuticals, or spices manufacturing
	waste rubber	waste natural rubber
	waste metal	
	waste pieces of glass and ceramics	
	slag	
	demolition wastes	
	livestock excrement	livestock industry
	livestock carcasses	livestock industry
	dusts	particulate matter collected by dust collectors installed at smoke generating facilities and sludge/waste oil incineration facilities
	residues not covered by these eighteen groups, generated when the above specified industrial wastes were treated	

TABLE 3. HAZARDOUS WASTE AS DEFINED BY JAPAN'S *WASTE MANAGEMENT LAW* (Explosive, poisonous, or infectious waste which is hazardous to health and/or the environment)

Hazardous Domestic Waste	Waste air-conditioners, televisions, and microwave-ovens with PCB parts Dust generated from domestic waste incineration plants Infectious waste
Hazardous Industrial Waste	Waste oil Waste acid (pH <2.0), Waste alkali (pH >12.5) Infectious waste Toxic waste: • PCB-polluted substances • Asbestos • Waste trichloroethylene • Waste tetrachlorethylene • Sludge, slag, ash, dust, waste acid, waste alkali which contain toxic elements and/or compounds 1/

Note: 1/ Toxic elements and compounds are listed in table 4.

TABLE 4. JUDGMENT STANDARDS FOR TOXIC ELEMENTS AND COMPOUNDS FOR LANDFILL DISPOSAL

Substances	Judgment Standards (mg/1)
Alkali mercury compounds	not detectable
Mercury and its compounds	not over 0.005
Cadmium and its compounds	0.3
Lead and its compounds	3.0
Organic phosphorous compounds	1.0
Hexavalent chromium compounds	1.5
Arsenic and its compounds	1.5
Cyanide Compounds	1.0
PCB	0.003
Trichloroethylene	0.3
Tetrachloroethylene	0.1

TABLE 5a. BASEL CONVENTION CATEGORIES OF WASTE FOR CONTROLLING THE TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND THEIR DISPOSAL

Waste stream:

Y1	Clinical wastes from medical care in hospitals, medical centres, and clinics
Y2	Wastes from the production and preparation of pharmaceutical products
Y3	Waste pharmaceuticals, drugs, and medicines
Y4	Wastes from the production, formulation, and use of biocides and phytopharmaceuticals
Y5	Wastes from the manufacture, formulation, and use of wood-preserving chemicals
Y6	Wastes from the production, formulation, and use of organic solvents
Y7	Wastes from heat treatment and tempering operations containing cyanides
Y8	Waste mineral oils unfit for their originally intended use
Y9	Waste oils/water, hydrocarbons/water mixtures, emulsions
Y10	Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs), polychlorinated terphenyls (PCTs), and/or polybrominated biphenyls (PBBs)
Y11	Waste tarry residues arising from refining, distillation, and any pyrolytic treatment
Y12	Waste from production, formulation, and use of inks, dyes, pigments, paints, lacquers, varnish
Y13	Waste from production, formulation, and use of resins, latex, plasticizers, glues/adhesives
Y14	Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new, and whose effects on man and/or the environment are not known
Y15	Wastes of an explosive nature not subject to other legislation
Y16	Wastes from production, formulation, and use of photographic chemicals and processing materials
Y17	Waste resulting from surface treatment of metals and plastics
Y18	Residues arising from industrial waste disposal operations

Waste having as constituents:

Y19	Metal carbonyls
Y20	Beryllium; beryllium compounds
Y21	Hexavalent chromium compounds
Y22	Copper compounds
Y23	Zinc compounds
Y24	Arsenic; arsenic compounds
Y25	Selenium; selenium compounds
Y26	Cadmium; cadmium compounds
Y27	Antimony; antimony compounds
Y28	Tellurium; tellurium compounds
Y29	Mercury; mercury compounds
Y30	Thallium; thallium compounds
Y31	Lead; lead compounds
Y32	Inorganic fluorine compounds, excluding calcium fluoride
Y33	Inorganic cyanides
Y34	Acidic solutions or acids in solid form
Y35	Basic solution or bases in solid form
Y36	Asbestos (dust and fibres)
Y37	Organic phosphorous compounds
Y38	Organic cyanides
Y39	Phenols; phenol compounds, including chlorophenols
Y40	Ethers
Y41	Halogenated organic solvents
Y42	Organic solvents, excluding halogenated solvents
Y43	Any congenor of polychlorinated dibenzo-furan
Y44	Any congenor of polychlorinated dibenzo-p-dioxin
Y45	Organohalogen compounds other than substances referred to in this annex (Eq. Y39, Y41, Y42, Y43, Y44)

TABLE 5b. BASEL CONVENTION LIST OF HAZARDOUS CHARACTERISTICS FOR CONTROLLING THE TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES

H1	Explosives
H3	Flammable liquids
H4.1	Flammable solids
H4.2	Substances or wastes liable to spontaneous combustion
H4.3	Substances or wastes which, in contact with water, emit flammable gases
H5.1	Oxidizing
H5.2	Organic Peroxides
H6.1	Poisonous (Acute)
H6.2	Infectious substances
H8	Corrosives
H10	Liberation of toxic gases in contact with air or water
H11	Toxic (Delayed or chronic)
H12	Ecotoxic
H13	Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above.

ORGANIZATION FOR WASTE REGULATION AND MANAGEMENT

The responsibilities of stakeholders are listed in table 6. People have to cooperate with the national and local governments by controlling the volume of waste generated, separating waste, accelerating recycling, and self-treatment and disposal. The responsibility for proper treatment and disposal of waste generated by industrial or business activities lies with the enterprise itself. With regard to the various government levels, the municipal governments are responsible for motivating residents to reduce the volume of waste and efficiently managing the waste disposal facilities. Prefectural governments have to provide technical and financial assistance to municipal governments, and take necessary measures for securing the proper disposal of industrial waste. The national government has to collect and use information concerning waste management, develop the waste treatment and disposal technology, and provide technical and financial assistance to local governments. The changes in people's life-styles and production processes, and the resulting diversification of waste characteristics suggest the need for the national government's commitment to the development of proper technologies. All levels of government should enlighten the people and enterprises. The enterprises' responsibility is especially important in hazardous waste management.

Under the Japanese administrative system, there has been a devolution of power from the national to the local governments, particularly in waste management. For example, almost all authority concerned with industrial waste management is held by the prefectural governor and the designated city mayor. It is the duty of the prefectural governor to plan for industrial waste management.

While it is best for the waste generator to treat the waste in its own premises, a large amount of waste is being transported all over Japan for several reasons. While domestic waste is mainly disposed of by the municipal government, industrial waste is often disposed of through a contractor. An industrial waste generator contracts out the disposal

TABLE 6. DUTIES OF CONCERNED PARTIES

Citizens	Cooperation with national and local governments in restricting the volume of waste they discharge, in using recycled products, and discharging waste separately
Private enterprises	Proper disposal of their own waste generated from their activities, and assessment of their product from a waste management viewpoint
Municipal Governments	Motivation of citizens on reduction of domestic waste, and efficient management of domestic waste disposal
Prefectural Governments	Technical assistance to municipal governments, supervision, and countermeasures against industrial waste management
National Government	Collection of information, development of technology, and technical and financial assistance to municipal governments
All levels of government	Motivation of people and enterprises

of waste to a contractor who is permitted to operate under the *Waste Management Law*. Because industrial waste is transported across municipal and prefectural boundaries, local government supervision is necessary. Any contractor who undertakes waste treatment and disposal has to obtain a license from the prefectural governor or the designated city mayor who has jurisdiction over that area. In the case of waste collection and transportation, he/she has to obtain such a license from the governors or designated mayors who have jurisdiction over the areas where waste is both loaded and unloaded. Local governments make sure that proper waste treatment and disposal are carried out by means of spot inspections of the activities of waste generators or enterprises and the waste management contractors, as well as by making actual checks on the state of storage, treatment, and disposal, and on the treated and disposed waste and records. Local governments require enterprises and contractors to submit their reports concerning waste management once a year for checking. However, the reports are voluminous and perfect control is impossible. Basically, waste generators themselves are required to monitor whether their contractor is properly carrying out his/her duties.

WASTE GENERATION RATES

Although a broader concept of hazardous waste has been recently adopted, there is still no data available on the volume of hazardous waste generated based on the newly delineated categories. Data on infectious waste is released by the Ministry of Health and Welfare (MOHW). According to a survey (see table 7), the amount of infectious waste generated by medical institutions is 354 tons/day, which amounts to just over 129,000 tons annually. Although data on the volume of toxic waste is gathered by each local government, the data is not published. It is estimated that the proportion of hazardous waste from industrial waste is bigger than the amount of domestic waste itself. Therefore, it appears that private enterprises have a bigger responsibility in hazardous waste management.

TABLE 7. AMOUNT OF INFECTIOUS MEDICAL WASTE GENERATED

Source	Amount generated (ton/day)
Hospitals	330
Clinics	10
Hygiene institutions	14

Source: Information is based on a 1988 survey conducted by the Ministry of Health and Welfare.

The total amount of waste generated is listed in table 8. The amount of waste generated annually is 352 million tons, with industrial waste accounting for 312 million tons and domestic waste 40 million tons. The amount of industrial waste is about eight times as much as that of domestic waste. The biggest category of industrial waste consists of sludge, with 113 million tons, followed by livestock excrement, with 62 million tons. Toxic waste is included in sludge, slag, waste acid, waste alkali, dust, waste oil, and ash.

TABLE 8. WASTE GENERATED IN JAPAN

Unit: 10^3 ton/year

Kind of Waste	Amount generated (per cent)	
Domestic waste Total (1987 FY)	39,590	(100)
Industrial waste Total (1985 FY)	312,271	(100)
sludge	112,821	(36)
livestock excrement	62,462	(20)
demolition waste	48,948	(16)
slag	41,649	(13)
waste metal	8,877	(3)
waste wood	8,058	(3)
dusts	6,224	(2)
waste acid and waste alkali	4,320	(1)
waste pieces of glass and ceramics	3,910	(1)
waste oil	3,672	(1)
others	11,330	(4)

Source: Information is based on a survey conducted by the MOHW.

From the viewpoint of waste generated, enterprises are obliged to do a pre-assessment of the product or container when disposed of, develop the technology for proper waste treatment, provide information on the product and/or resulting wastes after use, and cooperate with governments in reducing waste volume and in taking countermeasures against waste which is difficult to dispose of properly. Municipal governments can ask enterprises to cooperate in disposing of such waste. The prefectural governor and the designated city mayor can issue orders to the hazardous waste generators and demand that a waste disposal plan be drafted and implemented.

WASTE MANAGEMENT SYSTEM

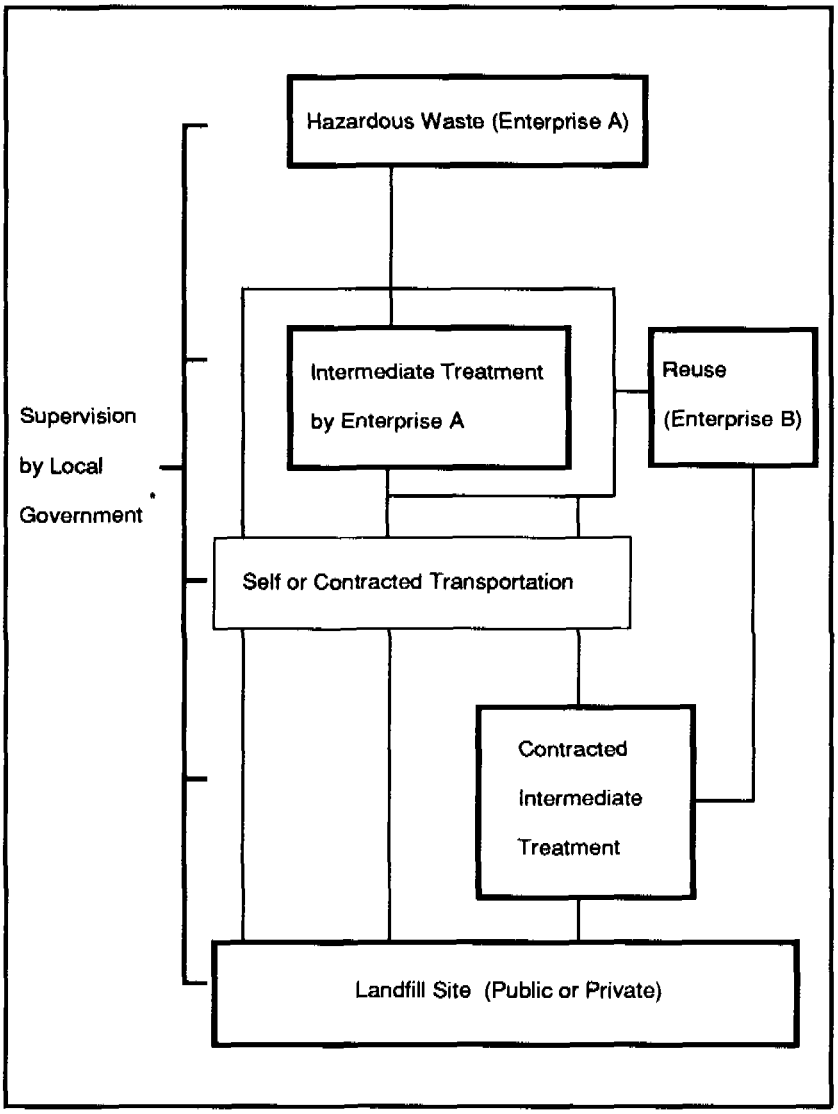
An outline of the hazardous waste management system in Japan is shown in figure 1. Hazardous waste is disposed of by the waste generator and/or contractor. The waste disposal system consists of collection, transportation, intermediate treatment, and final disposal. The purpose of intermediate treatment is to meet the standards regarding waste composition and to reduce its effects on the environment. Intermediate treatment is accomplished by stabilization, volume reduction, recycling, and neutralization. Hazardous waste is treated to a certain degree by these processes and should meet the disposal standard, after which it is discharged into the designated site.

Toxic waste is treated by chemical method to detoxify it. Such method, except for the treatment of cyanide compounds, PCB, trichloroethylene, and tetrachloroethylene, in effect, changes the water solubility of the toxic substance by changing it into a different chemical form, such as sulfides. Infectious waste is incinerated to kill the infection. Asbestos waste is disposed of at a designated disposal site after melting by heating or by packing it in a container made out of a double-layered waterproof material. Products containing PCB are stored by the responsible person or company. Waste oil is recycled or incinerated. Waste acid and waste alkali are neutralized, incinerated, or recycled. An outline of the standards for hazardous waste treatment and disposal is shown in table 9.

These basic standards are designed to prevent scattering and spillage of waste, bad odours, vibration, noise, and damage to the environment and human health. Hazardous waste shall not be stored at any location between generation site and disposal site, except with proper reshipment procedures. Infectious waste has to be collected and transported in tightly-sealed cases which are equipped with special devices to facilitate handling and storage and are strong enough to resist damage. Toxic waste has to be disposed of at an anti-hazardous landfill site (secure landfill). Landfills containing waste oil, waste acid, waste alkali, and infectious waste are prohibited. The generator of hazardous waste must employ a manager who has completed a training course authorized by the MOHW, or who has the equivalent qualifications.

In Japan, the trend in industrial waste management is towards the commissioning of treatment and disposal services. Although waste generators should treat and dispose of their waste themselves, the commissioning of treatment and disposal services is a result of economic considerations, and currently a larger percentage of waste is treated and disposed of in this manner. The waste generator can contract out only to a contractor licensed by the prefectural governor or the designated city mayor, as specified in the written contract.

Figure 1. Chart on Hazardous Industrial Waste Management in Japan



Note: * Prefectural governor or designated city mayor.

The qualification standards for contractors to obtain a license are listed in table 10. The following persons cannot obtain a license for waste management: an incompetent or bankrupt person, any person who has been imprisoned or meted out severe punishment within the last five years, a person who has violated environmental laws and has been fined or meted out severe punishment within the last five years, or a person whose license has been canceled within the last five years. The license is for a one-year period for domestic waste, and for a five-year period for industrial waste. It must be emphasized that the ability to manage waste properly is the most important consideration in the issuance of a license.

TABLE 9. STANDARDS FOR HAZARDOUS WASTE TREATMENT AND DISPOSAL

- The collection, transportation, and disposal of hazardous waste shall be carried out in a manner that such waste does not scatter or give rise to bad odours, vibration, and noise, and should be ensured such that the environment and human health are protected. Hazardous waste has to be collected and transported separately from the other wastes.
- The collector/transporter has to bring a document containing information about the waste or attach a label identifying the waste.
- Infectious waste has to be collected and transported in tightly-sealed cases which are strong enough to resist damage.
- Hazardous waste shall not be stored at any location between generation site and disposal site, except with proper reshipment procedures. Reshipment has to be done in a designated area, without mixing hazardous waste with other waste.

O The industrial waste generator (enterprise) must store hazardous wastes properly.

- Treatment/recycling of hazardous waste has to be done by way of removing the potential of infection or damage to human health and the environment.

O Hazardous industrial waste that has not undergone intermediate treatment has to be disposed of at an anti-hazardous type landfill site (secure landfill).

- An anti-hazardous type landfill site is one which is isolated from public waters and underground water. Waste acid, waste alkali, waste oil, and infectious waste shall not be disposed of at any type of landfill site. Asbestos must be disposed of at a designated area in the landfill site after packing it in double-layered waterproof material or melting it.

Note: O = only for industrial waste.

TABLE 10. QUALIFICATION STANDARDS FOR OBTAINING A CONTRACTOR'S LICENSE

A contractor's license cannot be issued to the following persons:

- Those who are incompetent
- Those who are bankrupt
- Those who have been imprisoned or have undergone severe punishment within the last five years
- Those who have been punished with a fine or more severely within the last five years for violating environmental laws. The specific laws are: *Waste Management Law, Jokaso Law [private sewerage system law] , Air Pollution Control Law, Marine Pollution Prevention Law, Water Pollution Control Law, Noise Regulation Law, Vibration Regulation Law,* and *Offensive Odour Control* Law
- Those whose license has been canceled within the last five years

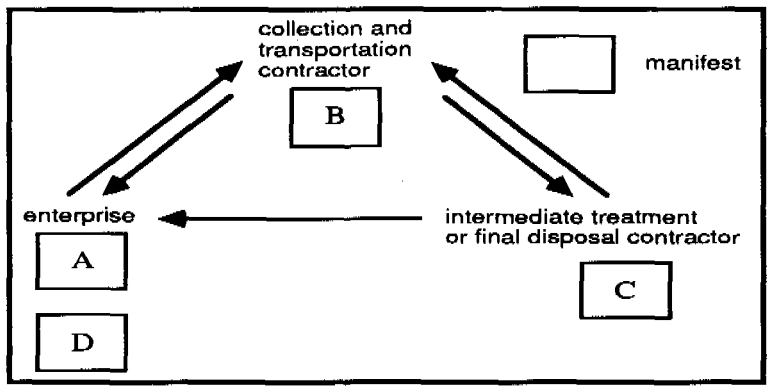
The merit of a contractual system seems to be the efficiency in waste management that can be achieved through economies of scale and the application of appropriate treatment and disposal technology. Although waste treatment and disposal are undertaken by other parties, by law the generator is responsible for waste management. Thus, the issue is who should check whether the contractor has adopted proper procedures for the treatment and disposal of waste; the waste generator cannot perfectly perform this task. As a result, the contractor has a wide range of unsupervised prerogatives. Some contractors illegally, carelessly, or loosely manage the waste, because it has no economic value. For this reason, the manifest system was introduced in the *Waste Management Law* amended in 1992.

An outline of the manifest system is shown in figure 2. The manifest forms are in quadruplicate, and are used one at a time, according to the kind of waste being dealt with. The hazardous waste generator notes down the necessary data and details on the first page and delivers it to the transportation contractor. The transportation contractor checks the items specified and the waste to the transported. If both are correct, the transportation contractor signs on the first page and returns the first page to the waste generator. The transportation contractor transfers the waste along with the manifest to another contractor for intermediate treatment and final disposal. The treatment and disposal contractor checks the items and waste mentioned therein. If both are correct, the treatment and disposal contractor signs on the second page of the manifest and returns the second page to the transportation contractor. The intermediate treatment and final disposal contractor returns the fourth page of the manifest to the waste generator after finishing treatment and disposal, while keeping the third page for his own records. The waste generator checks the first and last pages and confirms whether treatment and disposal were properly done. The waste generator has to keep both pages. If the last page is not returned to a waste generator within sixty days, the waste generator has to trace and confirm the status of waste treatment and disposal. The waste generator who has contracted out the disposal services must report the matter to the prefectural governor or designated city mayor concerned once a year. The governor or mayor advises the hazardous waste generator on the proper use of the manifest. This manifest system is based on the trust put on the contractor by the waste generator that treatment and disposal have been carried out as reported in the manifest. Should there be some extreme cases of false statements, the best way for the waste generator to confirm the report is to check the waste in question on-site. In addition to the own-disposal and contractual system of industrial waste treatment and disposal, the municipal and/or prefectural governments are permitted by the *Waste Management Law* to accept the waste if it poses no negative effects on the municipal waste management system.

WASTE TREATMENT AND DISPOSAL FACILITIES

Facilities for treatment and disposal of hazardous waste are already provided at a certain level, such as incineration plants for waste oil, neutralization plants for waste acid and alkali, concrete solidifying plants for sludge containing toxic substances, decomposition plants for cyanide compounds contained in sludge, waste acid, waste alkali, and special landfill sites. Toxic compounds, such as cyanide compounds, trichloroethylene, and

Figure 2. The Manifest System



tetrachloroethylene are decomposed by thermal method. Heavy metals, such as lead and cadmium, are recovered, for example, by chlorination-volatilization method, or treated by chemical stabilization method (concrete solidifying method).

The chlorination-volatilization method of heavy metal removal is based on the theory that chlorinated heavy metals are more volatile than heavy metals. The advantage of this method is the removal and recovery of heavy metals from waste. On the other hand, the concrete solidifying method is based on the theory that the heavy metals (hydroxide/sulfide) have less solubility than the ions. Heavy metals are stabilized according to this theory and solidified with concrete. If these intermediate treatments are not conducted, toxic waste has to be disposed of at special landfill sites which are isolated from public waters and underground water sources. The structure of this kind of disposal site is illustrated in figure 3. As this anti-hazardous type of landfill site is a permanent storage site, stringent management and control measures are needed to prevent accidents when the site is filled.

Although infectious waste is best dealt with in the generation site, it is usually brought outside and incinerated by a contractor. A remarkable treatment method of infectious waste is treatment by electric furnace used in steel production. This method can treat infectious waste at high temperatures and, since the amount of infectious waste is negligible compared with the amount of scrap metal, infectious waste can be perfectly treated. Syringe needles can be used as a raw material, and only nonhazardous glass remains in the slag. This electric furnace treatment is almost an ideal method.

Prior to installing or upgrading waste treatment facilities, permission is needed from the prefectural or the designated city government to plan for capacity levels beyond those listed in table 11, in accordance with the *Waste Management Law*. Landfills are divided into three types: anti-hazardous type, stable type, and controlled type. These three types are shown in figure 3. The use of each landfill site is restricted to the waste it is designed to handle. These facilities have to be technically managed by a person with enough knowledge and experience, or who has passed a qualifying examination administered by the minister.

A waste disposal centre has been recently established. The minister can designate a private corporation to provide an areawide waste disposal facility at each prefecture. The

Figure 3. Structures of Landfill Sites

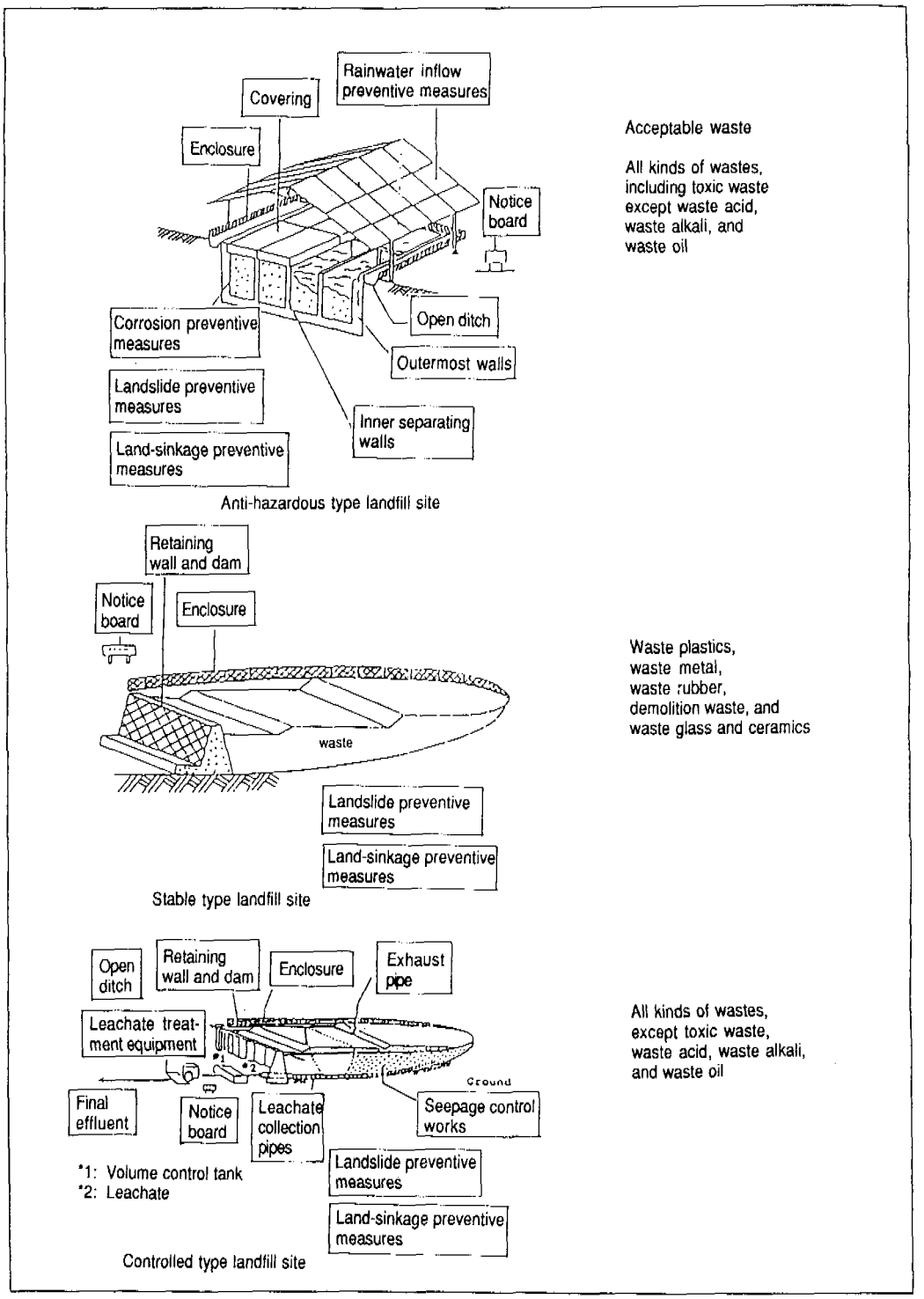


TABLE 11. WASTE TREATMENT FACILITIES

KIND OF FACILITY	CAPACITY
Dehydrating plant for sludge	Over 10 m^3/day
Drying plant for sludge (solar drying plant for sludge)	Over 10 m^3/day (over 100 m^2)
Incineration plant for sludge	Over 5 m^3/day
Oil separating plant for waste oil	Over 10 m^3/day
Incineration plant for waste oil	Over 1 m^3/day
Neutralizing plant for waste acid or waste alkali	Over 50 m^3/day
Crushing plant for waste plastics	Over 5 tons/day
Incineration plant for waste plastics	Over 0.1 ton/day
Concrete solidifying plant for sludge containing toxic substances	—
Calcination plant for sludge containing mercury compounds	—
Decomposition plant for cyanide compounds contained in sludge, waste acid, waste alkali	—
Incineration plant for waste PCBs, PCB-polluted substances, or PCB-treated substances	—
Cleaning plant for PCB-polluted substances	—
Anti-hazardous type landfill site (for toxic waste)	—
Stable type landfill site (for waste plastics, waste rubber, waste metal, waste glass and ceramics, and demolition waste)	3,000 m^2 or over
Control-type landfill site (for others)	1,000 m^2 or over

minister also guides and supervises the contractor. The types of business activities include disposal of hazardous waste and construction of waste disposal facilities. The funds contributed by corporations and subsidies provided by the national government are used to finance these facilities. The waste disposal centre is expected to play an active role in solving the problems of securing a disposal site and proper treatment and disposal in the future.

PUNISHMENT FOR IMPROPER OR ILLEGAL DISPOSAL

Illegal dumping of all kinds of waste is prohibited. Those found guilty of illegally dumping waste are sentenced to one year imprisonment and hard labour, or assessed a maximum fine of 1 million yen (approximately US$8,100). In cases of a contracting business operating without a license or establishing a waste treatment and disposal facility without permission from the local government, punishment is more severe, i.e., a maximum of three years' imprisonment and hard labour, or a fine of 3 million yen (approximately US$24,300). At present, violation of environmental laws consists of illegal dumping of waste, especially demolition waste. If there is a likelihood of environmental pollution due to illegal dumping or improper treatment of hazardous waste, the prefectural governor or the designated city mayor can order the violator to rehabilitate that area to its original unpolluted state. The prefectural governor or the designated city mayor can also order enterprises or contractors to improve their treatment and disposal facilities when these are in poor condition. While the authorities usually have such powers, they seldom use them; administrative guidance is more frequently employed.

Punishment and fines are not the objective, but the means to secure proper waste management. Administrative authorities do not strictly use these powers, but rather try to encourage proper waste management through a softer approach. However, the authorities' strong power is sometimes necessary.

ADVANTAGES AND DISADVANTAGES OF HAZARDOUS WASTE MANAGEMENT IN JAPAN

What is the ideal hazardous waste management system? How does the hazardous waste management system in Japan compare with the ideal system? The ideal system may be described as follows:

(1) First and foremost, the hazardous waste generated is minimized, if it cannot be eliminated. It should be reduced as much as possible by means of improved production processes, recycling into raw materials, and substitution with nonhazardous products.
(2) The above waste has to be stored and transported separately from other wastes that need to be recycled and/or treated efficiently. Industrial waste generators are able to reuse and treat hazardous waste, as they are aware of their contents and have the resources and technical capability to use and treat them.
(3) Hazardous properties have to be reduced as much as possible before discharging them into the site.

(4) Waste disposal has to be done at whatever sites possible, and where environmental pollution control countermeasures are provided.

The issue of waste management should be tackled not only from the perspective of waste, but also by considering the waste generation process. People's life-styles and awareness which determine product demand, and production processes which provide the product, are important in solving waste management problems.

Current good practices and those practices in hazardous waste management in Japan, which need improvement are listed in table 12. Good practices include provision of treatment facility, administrative control by spot inspection, and obligatory reporting from enterprises, some recycling systems of hazardous waste, prohibition from producing PCB and products containing PCB, and so forth. A regulatory system has already been established.

There is a need to increase the waste generator's level of awareness. The waste generator has the responsibility for proper waste management. However, waste is usually treated and disposed of at another place, while the emission of gas and liquid effluent is treated at the site of generation. Some wastes are illegally disposed of because the waste management system is not operating properly. The reasons for this are as follows:

(1) Waste is carelessly disposed of because the waste material has no economic value.
(2) Waste generators and enterprises want to dispose of their wastes cheaply, so that contractors are forced to adapt, sometimes performing below standards.
(3) Contractors give priority to profit, and awareness for conserving the environment sometimes is given secondary importance.
(4) Recently, the industrial waste disposal business is a target for private investment and, in some cases, gangster syndicates have taken up the business.
(5) The chemical form of the elements in the residues generated by the treatment of hazardous wastes is affected by environmental changes.

Citizens do not seem very concerned with hazardous waste management at present. The system of contracting is a form of partnership. Hazardous waste management problems in Japan cannot be resolved through partnerships alone. However, partnerships among the various producers and consumers are necessary. Moreover, it is important for enterprises to find innovative ways of reusing waste as a raw material.

CONCLUSION

Since treatment and disposal facilities are already available, generating the awareness of the parties concerned remains to be a major hazardous waste management issue in Japan. Illegal or improper disposal still occurs. Strict regulation and a strong incentive system are needed to secure the proper disposal of hazardous waste. The reduction of waste is an urgent issue in waste management in Japan, where land for waste disposal is limited. In the future, Japan will have to consider the reduction of hazardous waste generation and promote the utilization of hazardous waste as a raw material. Japan must think about hazardous waste issues, not only from the viewpoint of waste management, but also from the viewpoint of controlling the generation processes. In addition to end-of-pipe treatment, it is important to also emphasize and promote the concept of cleaner production.[1]

TABLE 12. HAZARDOUS WASTE MANAGEMENT IN JAPAN

(Currently in Good Practice)

- Treatment facilities have already been provided at a certain level.
- Administrative controls by spot inspection and obligatory reporting are being done by enterprises.
- Some kinds of recycling systems exist for hazardous waste (hexavalent chromium, waste acid, etc.)
- Some amount of mercury is being recovered by contracting companies (hazardous substances should be recovered as much as possible).
- Production of PCB and products containing PCB are prohibited. Existing PCB-containing products (transformers and condensers) are controlled by registering them with the Ministry of International Trade and Industry (MITI) and inspected by the local government.
- Self-treatment system of hazardous wasfe is practiced, for example, infectious waste treatment by a medical association.
- Regulation system for hazardous waste has already been arranged.

(State to be Improved)

- As environmentalists have pointed out, environmental change, such as acid rain, affects the resulting residue from treatment of hazardous waste where chemical form is changed.
- Waste generators/enterprises have a low level of awareness on the proper treatment of their own waste due to the contracting disposal system for hazardous waste, while treatment of gas emissions and liquid effluent is done on-site.
- As waste management system is not operating well, some wastes are illegally disposed of. The reasons are as follows:

(1) Waste can be easily or carelessly disposed of because it has no economic value.
(2) Waste generators/enterprises want to dispose of their wastes cheaply, so contractors are forced to adapt, sometimes performing below standard.
(3) Contractors make profit as their priority. Sometimes awareness of conserving the environment diminishes. Given this background, citizens tend to rely on the public rather than the private sector to dispose of wastes. Construction of disposal sites by the third sector, which consists of the public and private sectors, is increasing.
(4) Recently, the industrial waste disposal business has attracted private investment. In some cases, gang syndicates have taken up the business. Considering this problem, qualification standards have been amended. Offenders of some laws cannot obtain a contracting business license for five years.

NOTE

1/ According to Kirsten Oldenburg, Senior Consultant, Industry and Environment Programme Activity Centre of the United Nations Environment Programme:

> Cleaner production means the continuous application of an integrated preventive environmental strategy to processes and products so as to reduce risks to humans and the environment. For processes, this means conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and waste before they leave a process. For products, cleaner production means to reduce impacts along the entire product life cycle, from raw material extraction to disposal after reuse. Cleaner production is achieved by applying know-how, by improving technology, and/or by changing management attitudes.

COMMENT

NG WUN JERN

Reiji Hitsumoto provides an overview of the hazardous waste management experience in Japan. He discusses the waste management history, definition of hazardous waste, waste generation rates, regulations, punishments for infringements, treatment and disposal facilities, and the advantages and disadvantages of Japan's hazardous waste management system.

Granted the differences in socioeconomic backgrounds, East and Southeast Asian countries can nevertheless learn from the Japanese experience. This is because the objectives of hazardous waste management are not vastly different from country to country. The value of the Japanese experience to its neighbours would be in providing indicators for achievements in hazardous waste management, the methodologies involved, and the pitfalls to avoid.

Hitsumoto succeeds in providing an overview of hazardous waste management in Japan. Regrettably, in so doing, he necessarily had to limit the depth of his discussions. It would have been useful for readers from countries now attempting to formulate hazardous waste management regulations to have information on the rationale behind the Japanese regulations and standards. For instance, although the categories of hazardous waste defined by Japan's *Waste Management Law* identify fewer items, compared with the Basel Convention list referred to by Hitsumoto, the former would have, nevertheless, allowed considerable latitude for interpretation by law enforcers and, unfortunately also, by potential violators. A discussion of the Japanese experience on this would have been instructive.

Coordination among government bodies involved in managing hazardous waste can often be difficult. In the Japanese approach, almost all authority in relation to industrial waste management is in the hands of the prefectural governors and the designated city mayors. The former also has the duty to formulate the waste management plan. This suggests a high level of autonomy among prefectures. Such a condition can exist in many countries in the region. The efforts and successes of the Japanese in coordinating the activities of various prefectures to avoid, for instance, duplication of facilities, are therefore important indicators.

Such facilities would have included incinerators and protected landfills. Properly designed and operated facilities are an expensive undertaking. Hitsumoto, unfortunately, did not discuss the cost issue. It may nevertheless be presumed that the costs for effective hazardous waste management are unlikely to be low. This is likely to be more so if

individual waste generators are to set up their own treatment facilities. Costs may in fact be the single most important impediment to the effective operation of a hazardous waste management programme. To resolve the issue concerning high costs, generators may resort to off-site treatment using licensed contractors. Off-site treatment would naturally involve transporting the wastes. However, Hitsumoto points to the obvious failure of waste management systems where there is no manifest system. The manifest system itself did not appear to have completely resolved the problem, as Hitsumoto noted that current violations of environmental laws frequently consist of illegal waste dumping. A record of such cases over a number of years would have given an excellent indication of the effectiveness of education and enforcement programmes, if any.

While the economic advantages of using a common or shared facility to treat hazardous waste are not in question, the social difficulties encountered in such an undertaking can be large. This may best be summed up in the phrase, "not in my own backyard" or the NIMBY syndrome. Already, strong public opposition to proposed sites for hazardous waste treatment facilities has been noted in parts of Southeast Asia. The concerns of the lay person to the possibilities of leaks and contamination are not easily allayed, and the Japanese experience in handling public opinion would be invaluable. It may well be that in the future, because of the difficulties involved in resolving the NIMBY syndrome, interest may be spurred in the development of *in situ* treatment methods and mobile units for treatment and disposal, notwithstanding their relative lack of economic attractiveness, compared to common or shared facilities.

In situ methods are often based on standard waste treatment technologies and include surfactant washing, grouting, immobilization, thermal fusion, ground freezing, volatilization, photodegradation, and microbial application. The feasibility of a particular method is contingent on site geology and hydrology, as well as soil and waste characteristics. Implementation of the technologies associated with these methods is generally still in the developmental stage, with the possible exception of biotreatment methods (e.g., application of selected microbes in spill site cleanups). Genetically altered microorganisms selected for their ability to detoxify chemicals are being vigorously researched, and this is likely to facilitate application of biotreatment methods in the future.

The cradle-to-grave concept places ultimate financial responsibility for any remedial action following improper disposal of hazardous waste on the waste generator or owner. While this would certainly allow the enforcement process to proceed with greater assurance, it may also bias the use of treatment facilities and development of technologies. In the future, increasing quantities of hazardous waste may be expected to be redirected to incineration plants as a result of reluctance to or restrictions on disposal in landfills and lagoons. This would impose a strain on existing incineration facilities.

Although Hitsumoto does mention that Japan's *Waste Management Law of 1991* also aimed at controlling waste generation, he does not elaborate on this. With increasingly stringent laws and escalating costs associated with proper and improper control and management of toxic materials, the industrial sector is likely to adopt a new position. Waste minimization may become economically more attractive with a progressive departure from the "end-of-pipe" treatment and management methods. East and Southeast Asian countries have much to learn from the Japanese experience and its successes in legislation aimed at encouraging such a move.

PART III:
PARTNERSHIPS IN SOLID WASTE DISPOSAL

IMPROVEMENT OF WASTE DISPOSAL SITES USING THE SEMIAEROBIC RECIRCULATORY SYSTEM: A CASE STUDY OF SEBERANG PERAI, PENANG

NOOR HISHAM BIN RAMLY

The state of Penang in Malaysia is composed of Penang Island and Seberang Perai on the mainland of Peninsular Malaysia. The area of Seberang Perai is 73,841 km^2 and comes under the administration of the *Majlis Perbandaran Seberang Perai (MPSP)*. The municipal council's administration covers a population which reached 600,000 in 1993. Seberang Perai is divided into three districts and fifty-three *mukims* (regions). The *MPSP*'s administrative area includes both urban and rural districts. Townships and towns in Seberang Perai are Butterworth, Bukit Mertajam, Nibong Tebal, Sungai Bakap, Simpang Ampat, Kepala Batas, and Seberang Jaya. (See figure 1.)

DISPOSAL OF SOLID WASTE IN *MPSP*

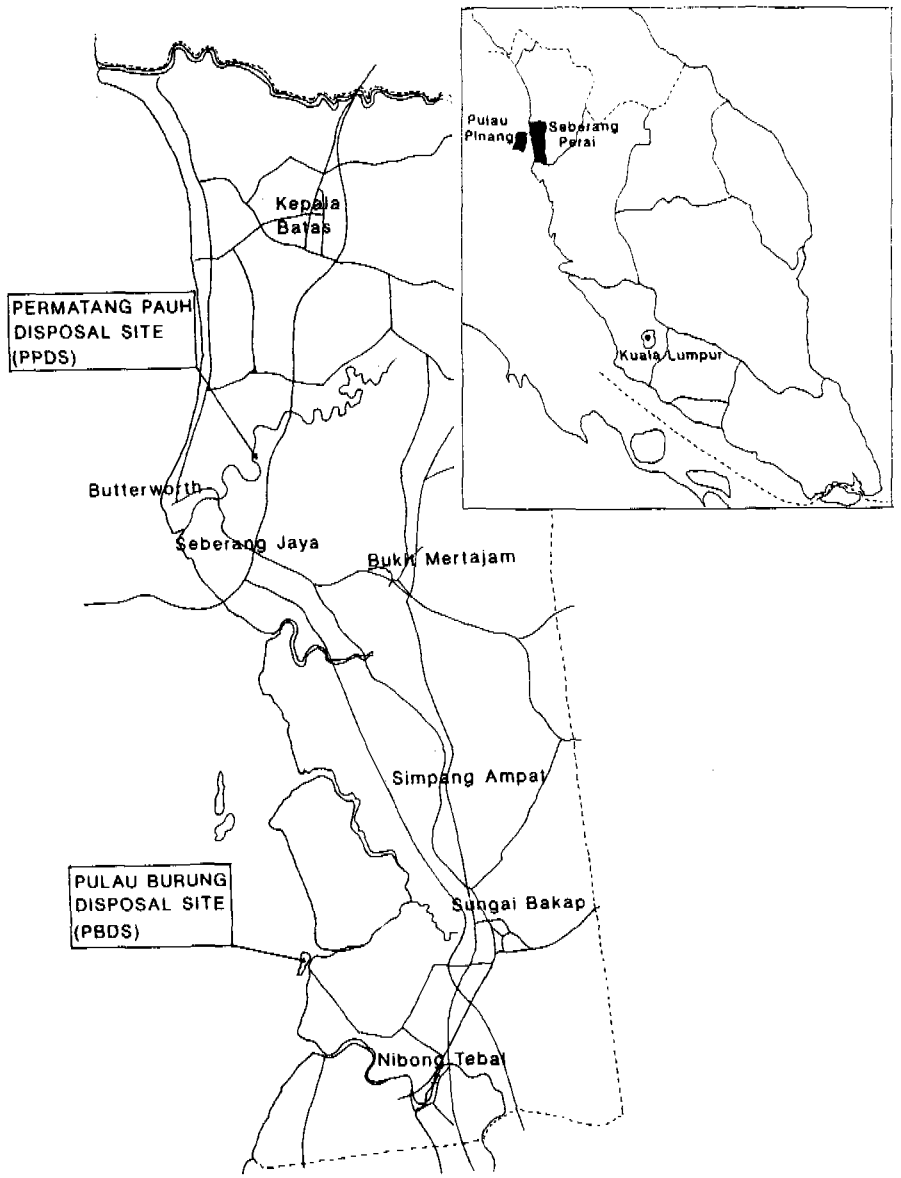
Prior to 1989, all solid waste disposal in Seberang Perai was conducted through landfilling in low-lying marshlands at the Permatang Pauh Disposal Site (PPDS) and Pulau Burung Disposal Site (PBDS). Both sites used the open dumping method, causing various environmental problems such as fires and bad odours in their vicinities, not to mention potential public health hazards. *MPSP* landfill sites were constantly burning and emitting smoke for more than six months every year. Frequently, such unpleasant scenes were reported in the daily press.

In response to public concern regarding the unsatisfactory conditions of the existing dumps, a master plan was drawn up with the assistance of the Japan International Co-operation Agency (JICA) and the Ministry of Housing and Local Government, Government of Malaysia. The master plan for Seberang Perai was ready for implementation by 1988. This plan included all aspects of solid waste management (SWM) in addition to the improvement of the solid waste disposal system.

An acceptable alternative to the open dumping practice is the sanitary landfill. The alternative involves the planning and application of sound engineering principles and construction techniques. Sanitary landfilling is an engineered method of disposing of solid waste on land by spreading it in thin layers, followed by a process designed to reduce the waste to the smallest practical volume. Finally, it is covered with soil after each working day in a manner that seals it from insects and rodents.

From 1989 to 1991, *MPSP* has upgraded the disposal sites from open dumps to Sanitary Landfill Level III in PPDS and Sanitary Landfill Level II in PBDS. Level III

Figure 1. Waste Disposal Sites in Seberang Perai



sanitary disposal systems are the most basic improvement of a sanitary landfill.

The sanitary landfill in PPDS was designed using the semiaerobic concept. This concept was developed in Japan and is claimed to be more efficient than an anaerobic landfill in terms of leachate, biochemical oxygen demand (BOD), and chemical oxygen demand (COD) reductions. This technique of landfilling could reduce the BOD level of leachate to around 1,500 mg/litre after one year of operation, whereas the leachate from an anaerobic landfill under similar conditions has a BOD of around 40,000 mg/litre.

Leachate from the PPDS landfill was collected in an integrated collection system connected to a retention ditch. The leachate in the retention ditch is aerated and then recirculated to the landfill through the gas-venting facilities and collection pipes. A 600 mm diameter concrete pipe was chosen for the collection pipes. The v-cut pipes are packed with stones through which the recirculated leachate trickles. The packed stones serve as an aerobic system and as a medium for microorganisms. They act in the same way as a trickling filter used in wastewater treatment plants.

Sanitary Landfill

The aim of the SWM system is to immediately remove solid waste from the urban community, reduce its volume, and dispose of it in a hygienic manner. Land disposal is a management option. The need for land disposal can be reduced through reuse, recycling, resource recovery of waste materials, and other disposal methods such as incineration and composting. Nevertheless, land disposal of residues is necessary in all solid waste disposal systems. The appropriate land disposal practice should be hygienic through proper containment of the waste and use of the natural metabolic function to stabilize the waste conversion to humus.

Waste stabilization begins after it is dumped in the landfill, but the process is very slow and may continue for years after closure of the landfill area.

The major objections to sanitary landfills are the initial costs for design and construction, difficulties in site selection, and increasing concern for recovery of useful materials disposed.

The advantages of a properly designed and operated landfill can be listed as follows:

(1) The site should be aesthetically pleasing. Measures to improve the aesthetics of the sanitary landfill site include screening the roads and nearby residences by construction of berms, tree-planting, or other landscaping techniques such as construction of an attractive entrance with good roads and easily understood signs.

    On the site, aesthetics can be improved by litter control, principally by the use of fencing to deflect the wind and control the scattering of paper and plastic material. Such littering as does occur should be tidied mechanically or by hand.

(2) Flies and mosquitoes are best controlled by covering the solid waste daily and by the elimination of any open stagnant water, such as that being stored for recycling of the leachate from the retention pond.

(3) Rats are perennial problems at open dumps, but the use of soil cover, which ensures that all the food waste is buried, can eliminate the problem at a sanitary landfill.

(4) Birds can be a nuisance or even cause severe problems with low-flying aircraft if the landfill is located near an airport. Sound systems and traps have been used to discourage birds at such landfill sites.

(5) Odours are best controlled by maintaining a soil cover, as well as by adequate compacting. Daily soil cover also forms cells which will reduce the ability of fires to spread to other locations within the landfill.
(6) Scavenging is the uncontrolled sorting of waste material to recover useful items, as contrasted to salvaging, which is the controlled separation of recoverable items. While recycling may be desirable, the scavenging of materials from a sanitary landfill is usually prohibited. Professional scavengers have been injured, sometimes fatally, while sorting through the waste dumping sites.
(7) Even more important for the protection of public health and the environment is the control of gas generated by the decomposition of solid waste and of leachate formed as water migrates through the solid waste attracting a variety of biological and chemical contaminants. The gas generated is vented and dispersed if the volume is small and burnt if it poses a fire hazard. In large sanitary landfills the gas can be recovered and used for fuel.

CHANGE IN WASTE PROPERTIES-DECOMPOSITION

After solid waste is deposited in a landfill, physical, chemical, and biological processes alter the condition of the waste.

In general, a landfill will undergo three different biological decomposition stages with different bacterial types predominating at each stage, as shown in figure 2.

The rate of decomposition of waste and the chemical characteristics of leachate will depend on the composition of the waste and the conditions within the landfill such as the presence of voids which sustain the aerobic condition and stimulate the recirculation of leachate.

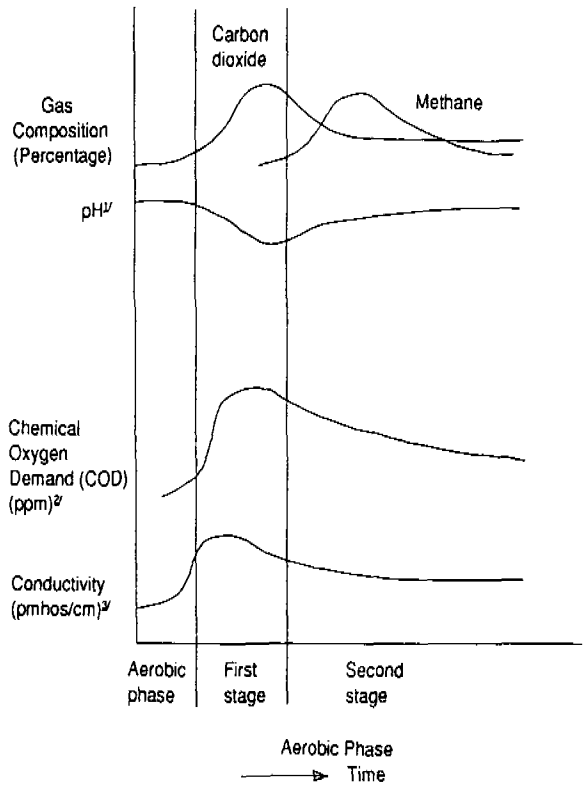
Solid waste initially decomposes aerobically, with carbon dioxide, water, and nitrate as the main decomposition by-products. As oxygen is used up, facultative and anaerobic microorganisms predominate. These bacteria produce volatile acids, carbon dioxide, and methane gas.

The organic acids reduce the pH level to 4 or 5, which in turn solubilizes some inorganic materials in the landfill. Methane-producing bacteria have a slow growth rate so little methane is produced during this period. The first anaerobic stage is characterized by low pH, high volatile acid production, high COD, and low methane production.

Over time, the methane-producing bacteria become more predominant. These bacteria reduce the volatile acids to methane and carbon dioxide, resulting in a rise in pH to more neutral values (7-8) and a fall in the COD. The ratio of methane to carbon dioxide depends not only on the activity of methane-forming microorganisms, but also on the nature of the organic components of the waste. For example, anaerobic decomposition of cellulosic components results in almost equal amounts of methane and carbon dioxide; protein and fats produce more methane than carbon dioxide.

During the process of decomposition, BOD decreases more rapidly than COD, because it is more easily biodegradable in waste, whereas the COD includes almost all organic substances including those which are nonbiodegradable. The biodegradable organic substances are attacked by a variety of bacteria at the beginning of the landfill process.

Figure 2. Phases of Solid Waste Decomposition



Source: Cited in Phil O'Leary and Bernin Tansel, "Land Disposal of Solid Waste: Protecting Health and Environment," *Waste Age* (Published by the University of Wisconsin Landfill Course) (March 1986).

Notes: 1/ Hydrogen Ion Concentration.
2/ Parts per million.
3/ One trillionth part of an mho (measure of conductivity).
If methane formers are killed by the volatile fatty acid, the pH will continue dropping and the anaerobic stage with full bloom methane production will never pick up.

Factors Affecting Decomposition

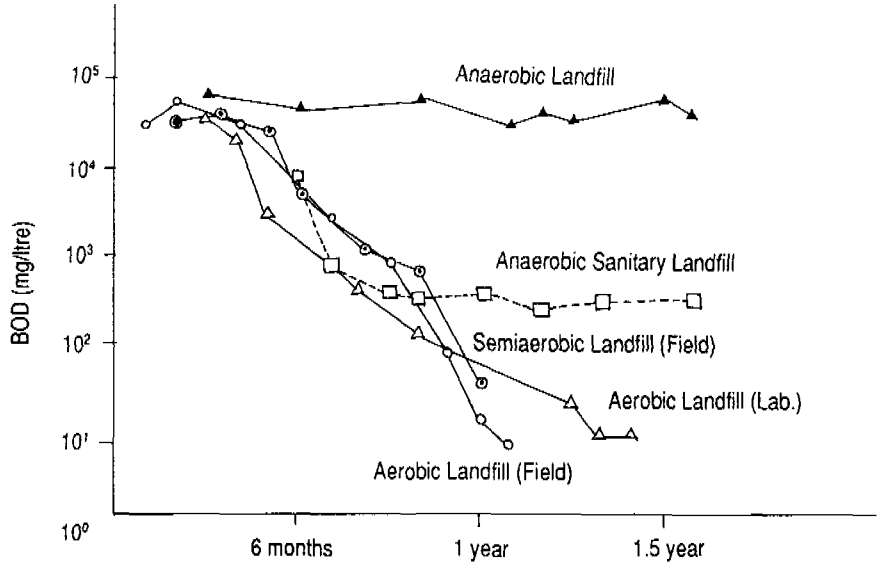
Major environmental factors which affect the rate and extent of the biochemical decomposition in the landfill are moisture, temperature, soil cover, and its permeability to water, rainfall, the degree of the waste's resistance to bacterial attack, and the extent of solid waste processing prior to landfilling.

Moisture is an essential factor for bacterial survival. An ideal moisture content is one that approaches saturation. Low moisture is a limiting factor for the biological reaction if it drops below 55 to 60 per cent.

SEMIAEROBIC LANDFILL

It has been found that solid waste decomposes rapidly if air is applied and the aerobic bacteria is predominant. BOD reduction in aerobic reactions is faster than in anaerobic reactions as shown in figure 3.

Figure 3. Change in the BOD Concentration of Leachate by Landfill Type



Landfills of the aerobic type are extremely costly to construct and due to the equipment and power required to supply the air, operation is rather impractical. On the other hand, a semiaerobic landfill is easy to construct and maintain and provides a viable alternative to the aerobic and anaerobic landfills.

Advantages of the Semiaerobic Landfill

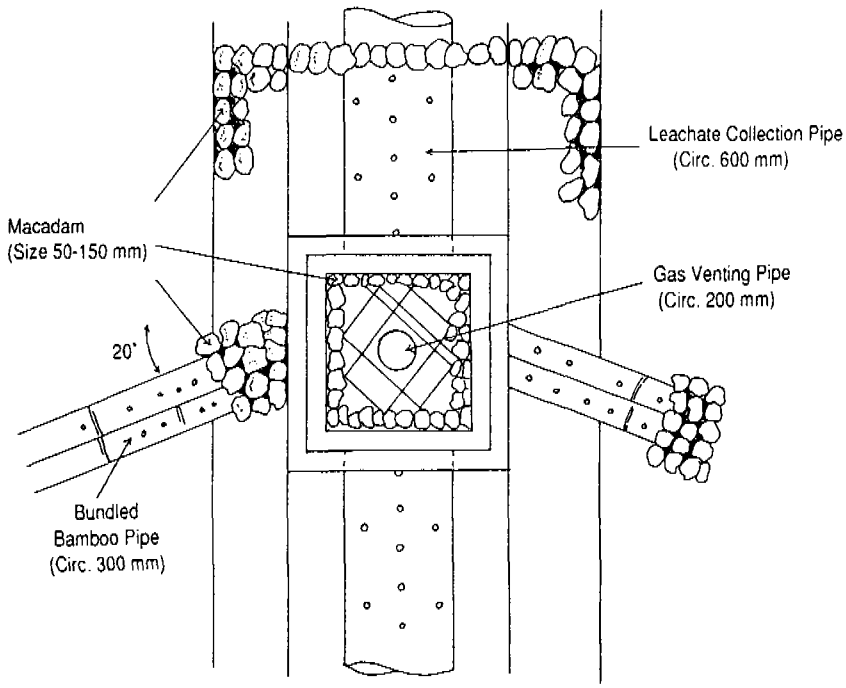
The semiaerobic landfill may have a combination of pump pit and leachate collection facility, or it may simply utilize the leachate collection pipes and natural ventilation processes.

Perforated leachate collection pipes draw in a large amount of air and oxygen is supplied to microorganisms by natural air convection (see figure 4). The waste can be stabilized biochemically through aerobic fermentation.

The semiaerobic landfill also plays an important role in preventing leachate seepage into the groundwater. Additional advantages of the semiaerobic landfill are as follows:

(1) The leachate is less problematic than in an anaerobic landfill type;
(2) The production of hazardous gases such as chlorine (CH_4) and hydrogen sulphide (H_2S) can be reduced;
(3) The solid waste is more quickly stabilized than in an anaerobic landfill;
(4) The groundwater pollution by leachate can be reduced; and
(5) Operation can be maintained at low cost.

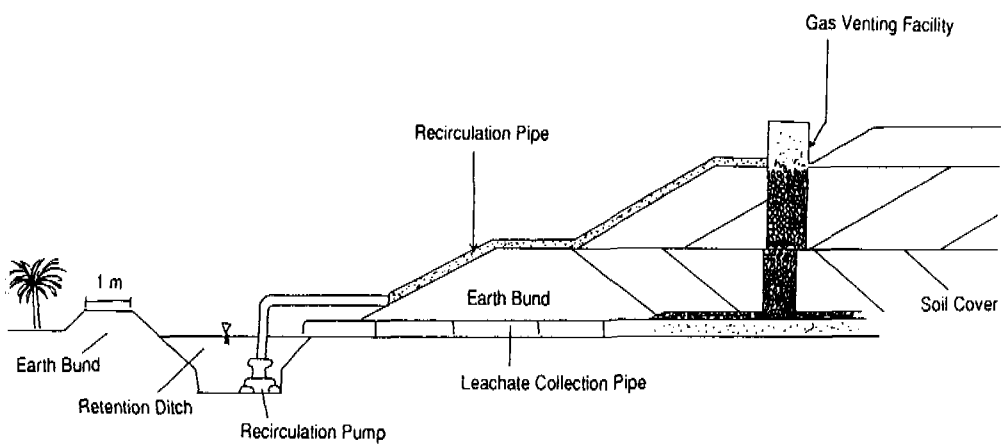
Figure 4. Gas Venting Facility and Leachate Collection Pipe (From above)



RECIRCULATORY SEMIAEROBIC LANDFILLS

Semiaerobic landfills incorporate a leachate recirculation process and are called recirculatory semiaerobic landfills. The schematic diagram of the system is represented in figure 5.

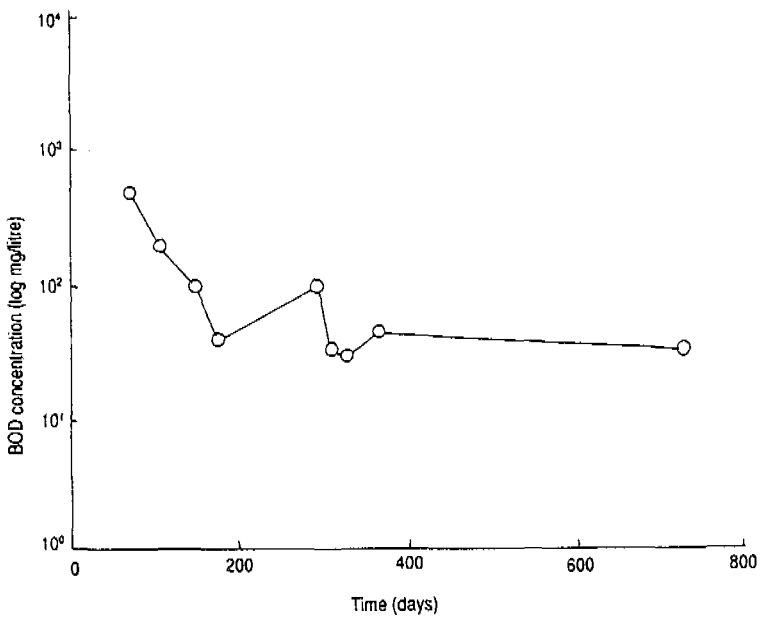
Figure 5. Countermeasures for Leachate (Recirculatory Semiaerobic Landfill Type)



The main functions of the recirculatory semiaerobic landfill are to decrease the amount of leachate; enhance the decomposition of waste; and improve the leachate quality. The methods of recirculating the leachate are the horizontal recirculation method which decreases the amount of leachate through evaporation, and the vertical recirculation method which enhances the decomposition of solid waste due to the introduction of air into the landfill.

Field experiments on the recirculatory semiaerobic landfill using the vertical method have shown that the leachate quality has improved. The initial BOD concentration of 1,200 mg/litre decreased to 200 mg/litre in 100 days, to 50 mg/litre in 175 days, and to 30-40 mg/litre in two years as shown in figure 6.

Figure 6. Change in the Leachate BOD Concentration with Recirculation in Semiaerobic Sanitary Landfill



Leachate Quality at the Recirculatory Semiaerobic Sanitary Landfill in PPDS

Two separate studies were conducted on the leachate quality at the PPDS. The first study was conducted by the Universiti Pertanian Malaysia while the second was conducted by Fukuoka University (Japan). The results of the two studies exhibit slight variations in composition, as shown in table 1.

Analysis of both studies show that the leachate generated at PPDS is of the medium- to low-strength type, with an average COD and BOD of around 1,000 mg/litre and 185 mg/litre, respectively.

This indicates that the recirculatory semiaerobic landfills perform well in Malaysian conditions. Although the landfill is of relatively recent construction, the third phase began being filled about two years ago, the leachate generated by the landfill has reached a stable quality.

TABLE 1. LEACHATE QUALITY AT PPDS

Component	Universiti Pertanian Malaysia	Fukuoka University (Japan)	Government Effluent Standard**
Temperature	27.9	28.0	40
pH	8.0	8.2	6.0-9.0
BOD	180	190	20-50
COD	1,285	975	50-100
Nitrates (NO3-N)	13.0	15.0	-
Iron (Fe) ppm	11.0	6.0	1.0-5.0
Chromium (Cr) ppm	0.39	ND***	0.05
Cesium (Ce) ppm	NT****	1,529	-
Magnesium (Mg) ppm	180	NT	0.2-1.0
Calcium (Ca) ppm	790	NT	-
Sodium (Na) ppm	1,410	NT	-
Lead (Pb) ppm	0.32	NT	0.1-0.5
Zinc (Zn) ppm	0.67	NT	1.0

Notes: * PPDS leachate quality concentration in mg/litre, except pH and temperature.
** Effluent standards for effluents discharged into rivers according to Malaysian law.
*** ND = Not detected.
**** NT = Not tested.

While the BOD and COD have been reduced considerably compared to anaerobic sanitary landfill, the leachate impurities are still higher than the government discharge standard. Therefore it is recommended that the leachate is treated further before being discharged into the adjacent river.

PROPOSED FURTHER TREATMENT OF LEACHATE AT PPDS

Y. Matsufuji in his recent visit to Seberang Perai proposed further treatment for the leachate at PPDS using a physical treatment system as shown in figure 7. The treatment system consists of a filter bed and an absorption bed. The filter bed is made of local materials such as waste coconut fibres and charcoal sticks, while the absorption bed consists of coconut fibres and charcoal dust.

An experimental physical treatment system was constructed at the PPDS as shown in figure 8. An analysis of the leachate quality following treatment showed that the COD could be reduced to as low as 78 mg/litre as shown in table 2.

Encouraged by the results of the experiment, the Municipal Council of Seberang Perai now plans to construct a prototype leachate treatment facility at PPDS. The schematic diagram of the prototype is shown in figure 9.

Figure 7. Physical Treatment System for Leachate Using Waste Materials

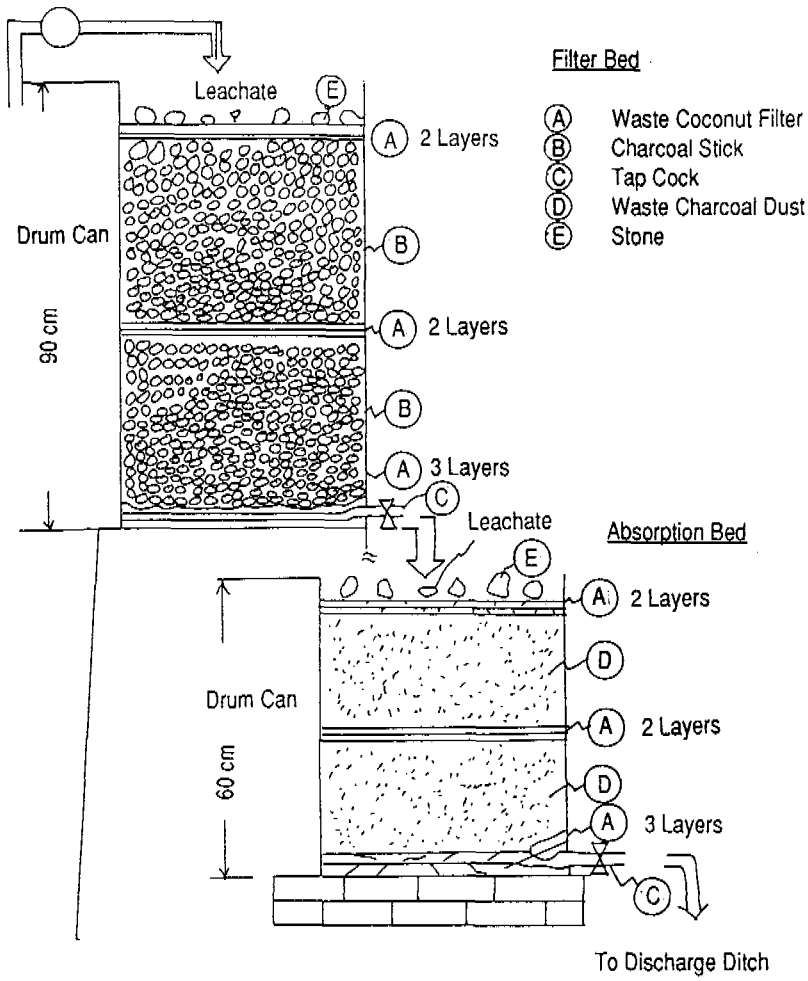


TABLE 2. LEACHATE QUALITY AT PPDS AFTER PHYSICAL TREATMENT

Sample	Retention Time (days)	COD		Nitrogen as Ammonia (NH4+-N)		pH
		Concentration (mg/litre)	Removal Rate (per cent)	Concentration (mg/litre)	Removal Rate (per cent)	
A	-	650	-	550	-	8.2
B	1	618	4.9	500	9.1	8.2
	4	650	0	500	9.1	8.0
C	1	78	87.4	200	60.0	9.4
	4	130	80.0	70	87.3	9.4

Notes: Sample A — Leachate from retention pond.
Sample B — Effluent from charcoal stick filtration bed.
Sample C — Effluent from charcoal dust absorption bed.

Figure 8. Recirculatory Semiaerobic Landfill System with Leachate Treatment Facilities

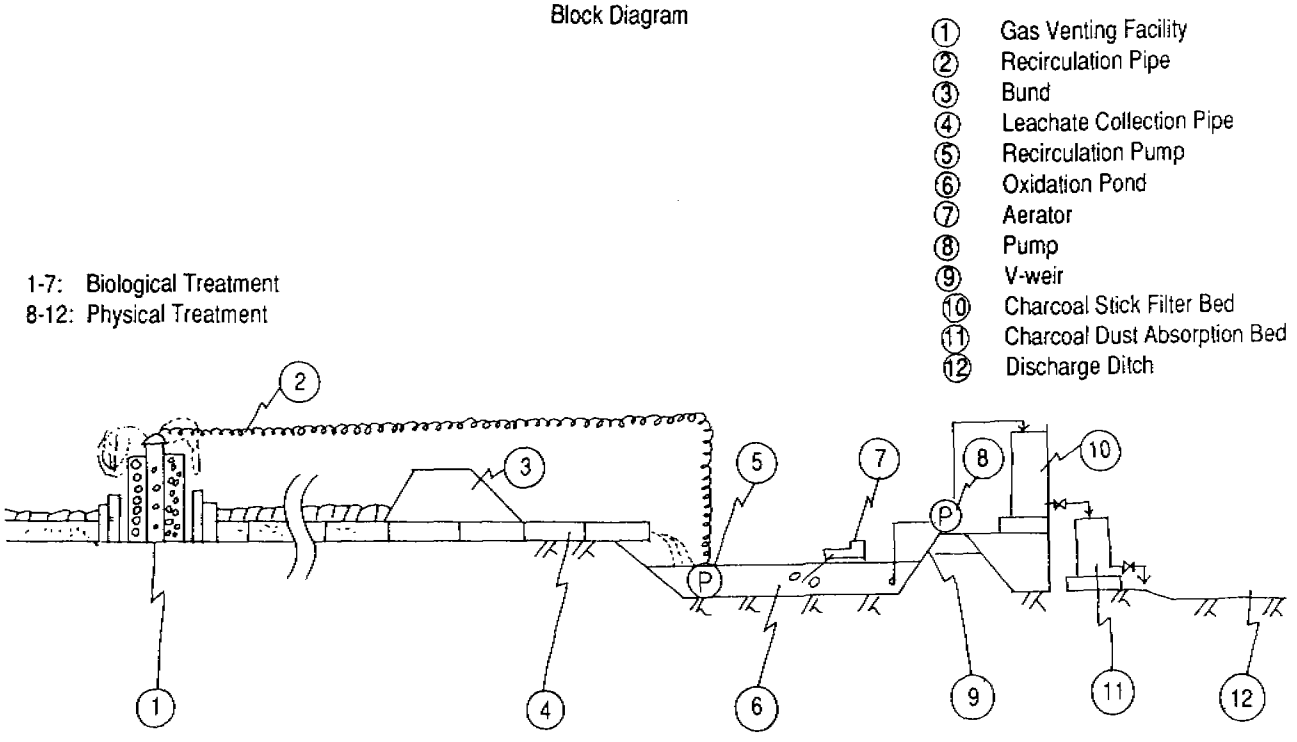
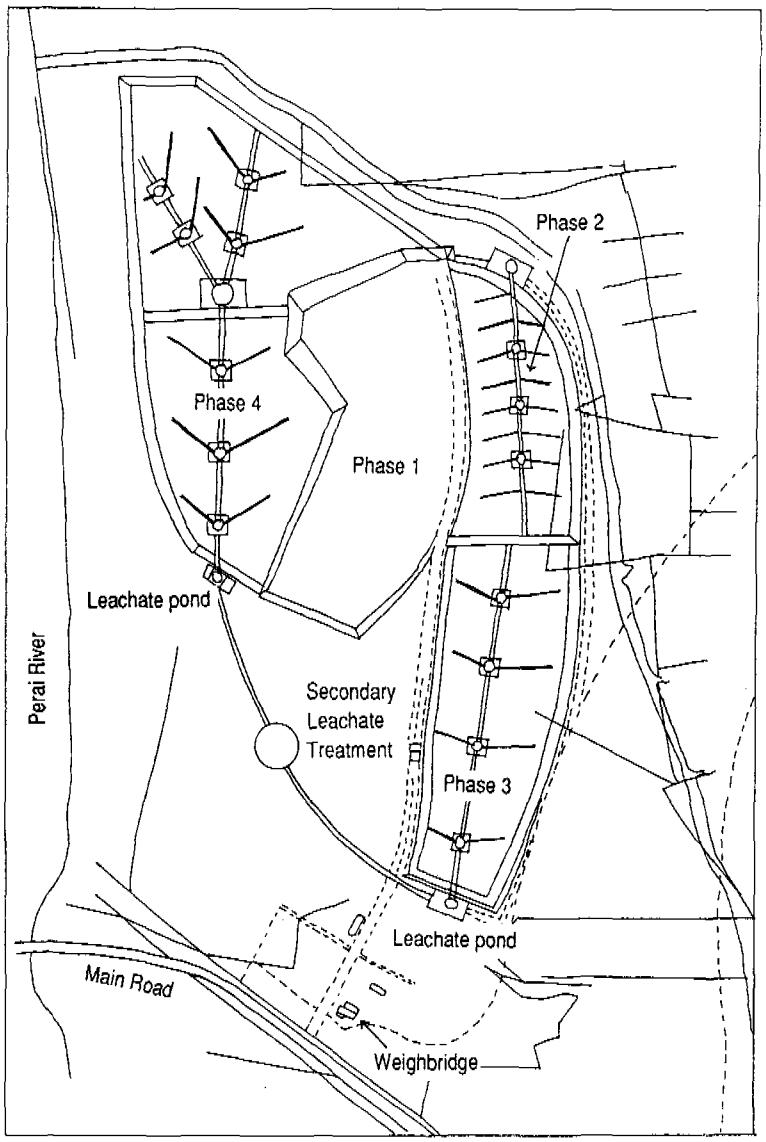


Figure 9. Proposed Layout of Sampah Ampang Semiaerobic Landfill



CONCLUSION

The ability of the *MPSP* to construct and manage a sanitary landfill demonstrates the development of an improved solid waste disposal method which the other local authorities in Malaysia could adopt, using their technical expertise. Financial constraints should not be a barrier to such adoption. Improvements made at the *MPSP* landfill have shown that technical and financial constraints can be overcome by phasing the implementation process. Suitable designs, using local materials and construction methods, can be used.

The analysis of the leachate quality at the MPSP landfill has indicated that the recirculatory semiaerobic sanitary landfill performs well in Malaysian conditions.

Further treatment of the leachate is necessary and can be carried out within the resources of the local authorities using the physical treatment system consisting of local materials such as waste coconut fibre and charcoal sticks and dust.

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IMPROVEMENT OF DISPOSAL SITES IN MALAYSIA

ZAMAN HURI BIN ZULKIFLI

INTRODUCTION

Of all the environmental control sectors, solid waste disposal has generally received the least professional attention in rapidly developing countries, such as in Southeast Asian countries. Municipal solid waste must be collected with reasonable efficiency if cities are not to be inundated with refuse. Yet, once collected, these wastes are often tipped indiscriminately on the nearest available land without any concern for environmental damage. Scavenging of dump sites is common in poorer countries and, although this leads to an informal system of recycling, the people relying on this for their existence are normally in a poor state of health. The adverse environmental impacts of uncontrolled tipping sites also include offensive sights due to lack of cover and windblown debris; public health risks due to flies, rats, and other vectors; air pollution from gases, odours, smoke, and fumes at landfill sites; surface and groundwater pollution from leachate; and danger of gas explosions in nearby landfill premises.

At the present stage of development in the Southeast Asian countries, it is no longer acceptable to continue with solid waste disposal practices which are aesthetically objectionable and a potential hazard to public health and safety. The disposal of municipal solid waste is a major component of environmental management which needs urgent attention in many countries.

LOCAL GOVERNMENT IN MALAYSIA

There are three tiers of government in Malaysia, namely, the federal (sovereign national), state (quasi-sovereign), and local (infra-sovereign). Local government is subject to the state government, i.e., all local authorities are under the exclusive jurisdiction of the state government (except the Federal Territory, where the national capital, Kuala Lumpur, is located). Local government is autonomous to the extent of the autonomy granted to it by the state government. It is also a separate legal entity with the power to sue and to be sued, to make contracts, and to own property.

Malaysia's local government is confined to local affairs. According to the *Local Government Act of 1976*, the statutory functions of a local authority are: sanitary and cleansing services (garbage collection, drain cleansing, street sweeping, and grass

cutting); conservancy and sewage disposal; cleanliness and beautification; playing fields, parks, and open spaces; control of markets, hawkers, and obnoxious trades; preparation of structure and local plans; controlling the construction of roads, drains, and buildings; maintaining abattoirs, cemeteries, and public latrines; preserving public health and public safety; and abating nuisances. It is charged with the obligatory functions of providing housing for the poor, health services and clinics, community halls and libraries, urban transport services, electricity and gas supply, and fire-fighting services, and creating jobs through commerce and industry.

There are ninety-five local authorities in Peninsular Malaysia, of which two are city councils (state administrative centres), fourteen are municipal councils (urban centres, excluding state capitals), and seventy are district councils (rural-based). Municipal councils have a population exceeding 100,000 and a revenue of over M$5 million. They are characterized as centres of administration needing urban services more than infrastructure.

STATUS OF MUNICIPAL WASTE DISPOSAL IN MALAYSIA

Based on information gathered in December 1992, there are approximately 187 municipal disposal sites in Peninsular Malaysia. Municipal councils have an average of 1.3 disposal sites, while district councils have an average of 2.2 disposal sites. Presently, the final disposal sites of the local authorities in Peninsular Malaysia are in town vicinities, and no kind of transfer operations has been practiced.

Table 1 indicates that almost 80 per cent of the municipal councils have one disposal site, while approximately 55 per cent of the district councils have more than one disposal site. This means that in bigger towns or cities, availability of land for the purpose of waste disposal is a major issue, especially in urbanized and densely-populated areas. In extreme cases, there are situations where the local authorities were asked to close down a disposal site to give way to other types of development.

TABLE 1. NUMBER OF DISPOSAL SITES IN LOCAL AUTHORITIES

Number of disposal sites	Municipal/City Councils		District Councils	
	Number	Percentage	Number	Percentage
1	12	75	35	44
2	3	19	19	24
3	0	0	17	22
4	1	6	4	5
5	0	0	0	0
6	0	0	4	5
TOTAL	16	100	79	100

Note: Data above refer only to West Malaysia (as of December 1992).

In contrast to more urbanized areas, land is easily available in small councils, such as district councils. However, the site locations are scattered. Furthermore, it is uneconomical to have one disposal site serve several smaller towns within a district, where distances between collection centres are far.

Table 2 summarizes the most common disposal practices in the local authorities. In small local authorities, open dumping is the most common practice, with the usual problems of odours, flies, and litter. Few district councils use daily cover to minimize such problems, however, most of the open dumps are in anaerobic condition, without any leachate control and gas venting facilities to protect the groundwater and air from contamination. The majority of municipal councils have adopted controlled tipping or sanitary landfill, as opposed to open dumping. Even though no proper environmental control facilities are fully provided, monitoring and control of dumping operations can be seen at most of the sites. Solid waste which is covered by soil is sprayed with chemicals to prevent the breeding of vectors and rodents. Proper access roads, fencing facilities, weighbridges, site offices, and other facilities have been made available at the sites.

TABLE 2. CURRENT DISPOSAL PRACTICE

Disposal Practice	Municipal/City Councils		District Councils	
	Number of Disposal Sites	Percentage	Number of Disposal Sites	Percentage
Open Dumping	3	14	110	66
Controlled Tipping	18	82	56	34
Sanitary Landfill	1	4	0	0
TOTAL	22	100	166	100

Note: Data above refer only to West Malaysia (as of December 1992).

As shown in tables 3 and 4, 50 per cent of the municipal councils have areas larger than 10 ha. Bigger areas are required to accommodate hundreds of tons of waste produced daily by commercial establishments, industries, housing estates, and institutions in big cities. However, most such facilities have remaining capacities of less than five years. Most district councils have areas of less than 10 ha, with remaining capacities of between ten and fifteen years. In addition to these two factors, a survey conducted in 1990, indicated that a majority of disposal sites are located in either swampy areas or flat ground without any cover materials available near or at the sites.

TABLE 3. TOTAL AREA OF DISPOSAL SITES

Area (ha)	Municipal/City Councils		District Councils	
	Number	Percentage	Number	Percentage
<5	2	13	50	63
5.1-10	5	31	17	21
10.1-15	1	6	6	8
>15	8	50	6	8
TOTAL	16	100	79	100

Note: Data above refer only to West Malaysia (as of December 1992).

TABLE 4. TOTAL LIFE SPAN OF DISPOSAL SITES

Total Life Span (Years)	Municipal/City Councils		District Councils	
	Number	Percentage	Number	Percentage
>14	1	6	14	18
10-14	2	13	31	40
5-9	3	19	17	21
<5	10	62	17	21
TOTAL	16	100	79	100

Note: Data above refer only to West Malaysia (as of December 1992).

Recently, more and more local authorities are attempting to plan for better landfills which are properly designed and managed. A disposal site provided by the Seberang Perai Municipal Council was upgraded from open dumping to a sanitary landfill system where a recirculatory semiaerobic system was adopted. This is due to the fact that pollution caused by improper waste disposal is becoming a major threat to the surroundings and the public. In addition, remedies and improvements for better disposal sites have been advocated in recent solid waste management (SWM) policies formulated by the Department of Environment. *Environmental Quality (Prescribed Activities for Environmental Impact Assessment) Order 1987* was enforced in April 1988, after which date it became mandatory for all local authorities to carry out an environmental impact assessment (EIA) of the municipal waste disposal facility construction projects.

STRATEGIES FOR IMPROVEMENT

Many factors have to be carefully considered and studied prior to any decisions to further rectify the existing situation at the disposal sites. Many local authorities in developing countries, including Malaysia, have limited resources in terms of money, manpower, and equipment. In some smaller councils in Malaysia, a technician is responsible for all technical matters in the council areas. In some cases, qualified personnel in the respective field are not available. This deficiency makes implementation of any improvement plan difficult. In addition to internal constraints and complications, growing public awareness, concern, and sensitivity, especially in the location, operation, and maintenance of disposal sites, are other factors which have to be taken into account at an early stage in the improvement plan.

Based on the above constraints and limitations, the Government of Malaysia formulated a programme and an action plan in 1988, on the improvement of disposal sites. The objective of this programme is to dispose of all solid waste in a proper and efficient manner so as not to pollute the environment, and at the same time to provide a model for landfill sites for neighbouring municipalities.

Realizing the weakness in almost all local authorities, in terms of financial and technical know-how, the Ministry of Housing and Local Government has decided that conversion of open dumping to a sanitary landfill system should be done in stages. The improvement target levels are as follows:

Level 1: Controlled tipping
Level 2: Sanitary landfill with bund and daily cover
Level 3: Sanitary landfill with leachate recirculation
Level 4: Sanitary landfill with leachate treatment

The aim is that in a few more years all local authorities will have at least achieved the Level 3 sanitary landfill system. In order to achieve the above target, the government has developed an intergovernmental approach in the formulation of strategies for implementation. The implementation plan includes the following:

Continuous Training of Local Authority Personnel. The Ministry of Housing and Local Government conducts training courses for local authority personnel on the design and operation of sanitary landfill systems. The participants are exposed to basic concepts of sanitary landfill facilities, methods of design and operation, and proper environmental monitoring. Since December 1992, five training courses on this subject have been conducted, covering almost 95 per cent of the local authorities in Malaysia. The courses have been jointly organized by the National Institute of Public Administration (INTAN).

Financial and Technical Assistance. Under the *Sixth Malaysia Plan (1990-95)*, M$22.5 million were allocated to develop forty-five sanitary landfill sites. This amount will assist the local authorities in financing the capital cost of sanitary landfill projects (see figure 1). The cost will also include the purchase of weighbridges, topographical surveys, EIA studies, and construction of sanitary landfills. The ministry will try to get more funds in the next plan to improve other sites. It is also helping with the design and tender documentation, especially for smaller municipalities. Presently, twenty sanitary landfill projects are under construction.

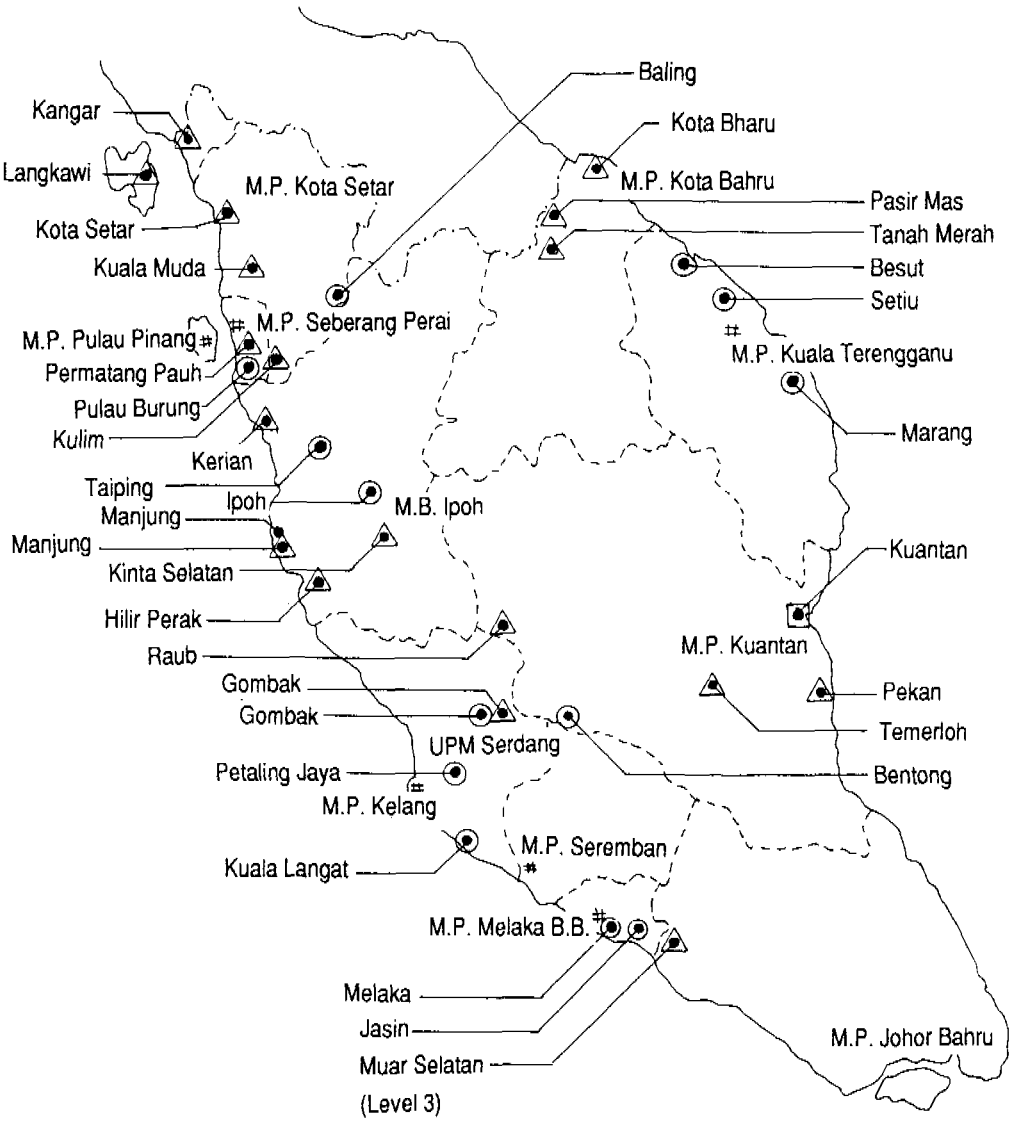
Technical Committee for Site Selection. Locating new sites for waste disposal is the most critical stage in planning for SWM. Any changes in site location after final decisions have been made, will adversely affect the entire planning process. Therefore every factor must be taken into account in the process of determining the most suitable sites for waste disposal. Items which are considered to be the most important and critical are as follows: the possibility of land acquisition; getting neighbours' consensus; compatibility with the regional development plan; economic feasibility; and environmental acceptability.

In order to undertake the above tasks, a site selection committee is formed, comprised of personnel who are familiar with state policy, especially on land matters. The committee consists of the following bodies:

(1) **The State Government.** Town and Country Planning Department; the Land and Mines Department; and the Regional Office of the Department of Environment.
(2) **The Local Government.** The Health Department; the Engineering Department; and the Town and Planning Department.
(3) **Other Members.** The Public Works Department; the Drainage and Irrigation Department; and others, as required.

To date, states such as Penang, Perlis, Perak, Selangor, Pahang, and Trengganu have organized site selection committees. These committees screen potential sites, including existing sites, in accordance with the factors described above. Priority is given to existing sites because they do not involve any land acquisition process, and thus save time and money. After a series of meetings and discussions, the committees decide on the most suitable sites for sanitary landfill development.

Figure 1. Implementation of Sanitary Landfill Project, 1991-93



In the case of new sites, EIA studies must be conducted, as required by the *Environmental Quality (Prescribed Activities) for EIA Order 1987.* Guidelines for the implementation of EIA were prepared by the Department of Environment to assist the project proponent in preparing the study report. In 1992, fourteen new sites were identified for sanitary landfill development. The Ministry of Housing and Local Government has hired consultants to undertake these studies, and EIA studies for three sites have been completed and submitted to the Department of Environment for review.

Promotion of Regional Disposal. One of the components of Malaysia's national policy on SWM is the promotion of a regional approach to municipal waste disposal. In areas where very limited land is available due to rapid urbanization and economic growth, a regional disposal site is highly recommended. The main advantage in having regional disposal sites is to save in their construction, operation, and maintenance costs. However, careful planning has to be done at the initial stage to ensure successful implementation of the project.

The *Klang Valley Environmental Improvement Plan (KVEIP)* studies conducted in 1987, recommended a regional approach to solid waste disposal for the Klang Valley region. The region is comprised of the Federal Territory of Kuala Lumpur and five major districts in Selangor, namely, Gombak, Petaling, Klang, Ampang Jaya, and part of Hulu Langat. The region had a population of 3.1 million in 1990, and is projected to increase to 3.7 million by 1995. It covers an area of 2,842 km^2, and is a centre of fast economic growth in Malaysia.

To cope with the ever-increasing waste generation, coupled with the limited land available, the report has recommended a regional approach to waste disposal, including transfer stations. In addition to this, most of the existing disposal sites in the region have an average remaining life span of two to three years, and are located in the vicinity of the towns and cities.

Based on the report's recommendations, the State Government of Selangor has taken a leading role in implementing the project. A committee was formed at the state level to prepare a plan and monitor its implementation. The committee is comprised of the Selangor State Government, the Ministry of Housing and Local Government, the Department of Environment, the State Economic Planning Unit, Town and Country Planning, and the local authorities of Klang Valley. In 1992, the committee decided that the project should be privatized due to the high capital investment and operational costs incurred by the project. With privatization, the consortium will charge the local authorities a tipping fee. Waste collected by the local authorities will be transported to transfer stations or directly to the disposal sites, depending on the distance. Three disposal sites and five transfer stations were proposed to be built in stages in accordance with the report's recommendations. The Ministry of Housing and Local Government has agreed to undertake the EIA, and studies were already completed for two sites in Rawang and Puchong, and submitted to the Department of Environment for review.

Proposals from various consortia were received, and evaluations were made, based on the financial and technical proposals submitted. Since December 1992, no final decisions have been made on an acceptable proposal.

CONCLUSION

The preceding exposition showed that it is possible for a country such as Malaysia to make a significant change in the disposal of solid waste. An open dump with its appurtenant odour and smoke problems due to open burning can be converted to a sanitary landfill. The disposal of solid waste has considerably become complex not only because of an increasing volume of waste, but also because of the changing characteristics of waste and uncertainty regarding the effects of leachate in surface and groundwater. This is why the current pilot work on improving leachate quality is being continued in the location of the first successful site.

The whole process that transpired in Malaysia is a combination of several important factors: the central government's commitment; sustained bilateral technical assistance; step-by-step technical innovation; attention to cost; and effective liaison between central and local governments. In terms of land-use planning, the sanitary landfill should no longer pose as a reason for the not-in-my-backyard (NIMBY) syndrome.

With growing public concern over environmental issues and the need for a better quality of life, the government institutions at all levels are taking steps to improve the existing system of waste management. Solid waste disposal is becoming a major focus for all concerned, including politicians, individual organizations, the private sector, nongovernmental organizations (NGOs), and others. Even though initial steps were taken by the respective agencies to rectify the situation, participation from various organizations and individuals is very important to ensure effective planning of waste management.

COMMENT

YASUSHI MATSUFUJI

Disposal sites in developing countries are mainly operated as open dumping or controlled tipping. Such action is causing major environmental pollution issues.

As developing countries approach the status of newly industrializing economies (NIEs), annual improvements in living standards and the growth of industrialization will definitely increase the volume of municipal and industrial solid wastes and result in more complex waste composition. In the future, if intermediate treatment technology is adopted, such as recovery of resources, incineration, and others, final disposal sites will be needed.

From this point of view, improvement in existing disposal sites is an important measure to upgrade the level of sanitary landfill. Zaman Huri bin Zulkifli provides a case study of improvement of disposal sites in Malaysia.

In 1988, the Ministry of Housing and Local Government, Government of Malaysia, with assistance from the Japan International Cooperation Agency (JICA), formulated an action plan on solid waste management (SWM) designated as the *National Action Plan for Beautiful and Clean Malaysia (ABC)*. This plan emphasizes the need for a national policy on SWM and is aimed at creating a municipal SWM system that is uniform, cost-effective, environmentally-sound, and socially acceptable throughout Malaysia by the year 2010. Twelve activities under this plan (shown in table 1) have been proposed and implemented to achieve the plan's objectives. A sanitary landfill for all municipal councils involved in the programme is the first priority.

Based on the information provided by Zaman, I am convinced that through its *ABC*, Malaysia has been initiating programmes to improve existing and new landfill sites up to the level of sanitary landfills year by year. Therefore, Malaysia should earnestly seek to pool the public, private, and academic sectors' resources to establish a regional waste management centre in Southeast Asia, under the United Nations, for handling waste problems. To conclude this comment, the SWM problems in developing countries are summarized as follows:

(1) Classification of wastes, management setup, and so forth, are copied blindly from the developed countries. However, in many cases, lack of trained personnel, analytical systems, information processing capability, and financial resources, are reasons why the imported plans are difficult to implement.

(2) Weak environmental monitoring systems have resulted in the actual situation not being fully understood. There is often no inventory of factories which must be equipped with treatment facilities to deal with hazardous effluents, and no record to indicate whether the factories have complied with the law.

TABLE 1. TWELVE *ABC* ACTIVITIES IN MALAYSIA

1.	Institution-building
2.	Interagency and interministerial coordination
3.	Master plans for all municipal councils
4.	Solid waste management (SWM) improvement in district councils
5.	Productivity improvement in refuse collection, coupled with the use of weighbridges
6.	Sanitary landfills for all municipal councils
7.	Establishment of a permanent training system for SWM personnel
8.	Strengthening of SWM enforcement and education
9.	Improvement of equipment management
10.	Careful and successful privatization of SWM services
11.	Development of SWM information systems and the monitoring of ABC performance
12.	Promotion of applied research

(3) Equipment and plants are poorly managed and maintained. There is no organization responsible for training SWM personnel.

(4) It is increasingly difficult to control the rate of waste generation because, in their eagerness to attract foreign firms to participate in the rapid industrialization programme, developing countries may unknowingly accept polluting industries.

(5) Regulations on effluents discharged by factories in developing countries are often only in the formulation stage. In the future, such regulations will become more stringent, thus, the amount of hazardous waste generated will likely increase. Similarly, more stringent air pollution regulations will also increase the amount of hazardous dust generated.

(6) The local authority setup is weak in matters of environmental protection. Regulations to prevent industrial waste from being disposed of at a municipal solid waste landfill site are insufficient. In many cases there are no countermeasures against pollution because the municipal solid waste landfill site has not yet been converted into a sanitary landfill.

(7) The shortage of public funding has brought about the privatization concept, whereby the construction, operation, maintenance, and even financing of facilities are contracted out to a private company. When there is insufficient supervision and guidance from the public sector, there is no guarantee that the facilities will be used.

(8) With the emergence of an advanced information society, awareness of waste problems has become global. In most countries today, securing land for waste treatment facilities is difficult because of the not-in-my-backyard (NIMBY) syndrome.

(9) The situation in most developing countries is such that the waste management problem is not considered part of social development, and development is carried out without consideration of available resources and the environment on a global level.

METROPOLITAN MANILA: ISSUES AND FUTURE PROSPECTS OF SOLID WASTE DISPOSAL

J. SALVADOR T. PASSE, Jr.

In the Philippines, so little attention has been given to the problem of solid waste management (SWM), that it is characterized by inefficiency and inadequacy. As a result, SWM systems cannot cope with the burdens placed upon them.

This is evidenced in the country's national capital region (NCR) popularly referred to as the Metropolitan Manila area. It is composed of four cities and thirteen municipalities occupying an area as large as Singapore, or about 630 km^2. Into this region is squeezed a population of 8.5 million. Being the country's major growth centre, it experiences all the problems that are associated with urbanized areas in developing countries, such as uncontrolled population growth, rapid industrial or commercial development, and inadequacy of basic services.

THE EXISTING SWM SYSTEM IN METRO MANILA

Primary sources of solid waste in Metro Manila as of 1982 were the residential areas which contributed 48.8 per cent of the total waste. Street-swept waste amounted to 18.4 per cent, market waste 12.9 per cent, commercial and industrial waste 11.2 per cent, and institutional waste 5.2 per cent. The remainder was derived from construction and demolition debris and others (see table 1). The average composition of solid waste was made up principally of food waste, paper and cardboard, screenings, plastics, and yard or garden trimmings.

Solid waste is stored at source in various types of containers before it is brought out for collection by the Metro Manila Authority (MMA) trucks or private haulers contracted by the MMA. In affluent communities, plastic refuse bags are finding greater use. Experience with such bags indicates that they are more hygienic and easier to handle. They have also reduced pick-up and collection time and costs.

The MMA is a manager-council type organization with jurisdiction over the delivery of basic services requiring coordination and direction, one of which is SWM (see table 2). Within the MMA is the Environmental Sanitation Center (ESC). The ESC is the implementing arm of the MMA to maintain cleanliness, conduct beautification projects, and carry out garbage collection and disposal.

TABLE 1. TOTAL QUANTITIES AND COMPOSITION OF METRO MANILA MIXED MUNICIPAL SOLID WASTE AS GENERATED IN ONE QUARTER OF 1982

Type of Waste	Residential		Market		Commercial		Industrial		Construction and Demolition		Street Waste		Institutional		Other Waste		Total	
Components	TPD	%	TPD	%	TPD	%	TPD	%	TPD	%	TPD	%	TPD	%	TPD	%	TPD	%
Paper	117.0	9.1	14.6	4.3	33.1	23	30.7	20	-	-	35.0	7.2	27.2	20	-	-	257.6	9.8
Cardboard	49.0	3.8	6.1	1.8	33.1	23	15.3	10	-	-	12.1	2.5	6.8	5	-	-	122.4	4.7
Food and Kitchen Waste	460.5	35.8	240.1	70.6	18.7	13	3.1	2	-	-	90.8	18.7	23.1	17	-	-	836.3	31.7
Textiles	23.7	1.8	-	-	2.2	1.5	2.3	1.5	-	-	6.3	1.3	1.4	1	-	-	35.9	1.3
Rubber and Leather	21.0	1.6	-	-	2.2	1.5	2.3	1.5	-	-	4.4	0.9	-	-	-	-	29.9	1.1
Plastic, Film	67.3	5.2	10.9	3.2	15.8	11	23.0	15	-	-	20.4	4.2	17.7	13	-	-	155.1	5.9
Plastic, Hard	21.4	1.7	1.0	0.3	5.8	4	7.7	5	-	-	4.9	1.0	1.4	1	-	-	42.2	1.6
Yard Waste	126.7	9.9	49.3	14.5	-	-	-	-	-	-	25.3	5.2	-	-	-	-	201.3	7.7
Other Combustible	52.3	4.1	2.0	0.6	10.1	7	38.4	25	5.8	20	10.7	2.2	17.7	13	20.9	35	157.9	6.1
Metal	74.1	5.8	1.0	0.3	13.0	9	18.4	12	-	-	8.3	1.7	13.6	10	-	-	128.4	4.9
Glass	44.4	3.5	1.4	0.4	7.2	5	-	-	-	-	6.3	1.3	12.2	9	-	-	71.5	2.7
Other Noncombustible	38.1	3.0	0.3	0.1	-	-	-	-	23.4	80	18.5	3.8	2.7	2	38.9	65	121.6	4.6
Screenings <10 mm	188.9	14.7	13.3	3.9	-	-	-	-	-	-	242.9	50.0	-	-	-	-	445.1	16.9
Special and Hazardous Waste	-	-	-	-	2.9	2	12.3	8	-	-	-	-	12.2	9	-	-	27.4	1.0
TOTAL	284.4	100.0	340.1	100.0	144.0	100.0	153.4	100.0	29.2	100.0	485.7	100.0	136.0	100.0	59.8	100.0	2,632.8	100.0
Percentage of Total	48.8		12.9		5.5		5.8		1.1		18.4		5.2		2.3		100	

TABLE 2. METRO MANILA REFUSE SPECIFICS (1991)

Population	8.5 million
Households	1.5 million
Waste Generation Rate*	0.5 to 0.6 kg/capita/day
Waste Generated	4,250 to 5,000 tons/day
ESC personnel**	11,000 (including casuals)
ESC Trucks Owned	168 (55 per cent available)
ESC Trucks Contracted	438 (75 per cent available)
Waste Collected by ESC	3,410 tons/day
ESC Open Dump Sites	5
ESC Sanitary Landfills	1 (demonstration scale)
Waste Disposed or Recycled by ESC	3.850 tons/day (77 to 90 per cent)
1991 ESC Annual Expenditure***	765 million pesos
1991 ESC Recurrent Expenditure per ton (without owning costs)	615 pesos/ton 113 pesos/capita/year

Notes: * Waste generation estimates are rough. Without weighbridges at transfer stations and disposal sites, actual quantities of refuse generated and handled cannot be well defined.

** ESC = Environmental Sanitation Center.

*** Expenditure does not include investment cost, debt service or renewal funding for the fleet. Most ESC-owned trucks have been provided through JICA grant. All ESC-contracted trucks are fully depreciated (most are over fifteen years old). If owning costs were included, the above expenditures would be about 25 per cent higher.

In the residential areas, it is common practice for housewives to keep household waste bins inside their houses to avoid loss, only bringing them outside during collection time. Individual waste containers are mainly metal or plastic bins, used supermarket bags, sacks, or cardboard cartons. With the exception of plastic containers such as plastic bags, all are uncovered and poorly maintained. In the case of communal containers, when these are filled to capacity, excess waste is dumped beside the containers. It should be noted that some houses have enough backyard space for garbage pits and composting activities.

Collection is generally carried out by workers who pick up the refuse containers from the houses, street curbs, or at the designated collection points. Street cleaners or sweepers are also employed to collect garbage from public areas, including markets, and deliver these containers which are in turn picked up by collection trucks. As indicated by field investigations, the percentage of the urban population served by collection systems varies from 17 per cent to 70 per cent.

Although collection is reportedly being made daily in some areas, the service is generally inadequate and ineffective, particularly in peripheral and depressed areas. This is further hampered by the inadequate budgetary allocation for collection and the general condition of collection vehicles. Most are old or obsolete while newer ones lack the necessary spare parts. The result is a deficient service which leads to public dissatisfaction and a general feeling of indifference among the people towards SWM.

The deficient collection system consequently results in the burying of uncollected garbage in crude pits in available backyard space or worse, in indiscriminate dumping in vacant lots, roadsides, riverbanks, or in nearby water bodies.

Areas served by the municipal or MMA collection services cover residential houses, commercial or industrial establishments, and institutions in Metro Manila. The slums or squatter settlements are not usually served by the municipal collection services because of narrow access streets and fewer recyclable components of waste. The problem is further compounded when these squatters are living along the riverbanks or on the banks of the *esteros* (canals) which exist in Metro Manila. These areas, familiarly known as "river sides," although formerly cleared of waste by the MMA, are not serviced at present.

More affluent neighbourhoods are served by the municipal or MMA collection trucks. However, subdivisions and various housing estates are not afforded the same services. Problems arise when these estates contain pockets of empty lots where households can dump their refuse, making the surroundings extremely unsightly. Furthermore, professional scavengers who are paid by the subdivision communities to dispose of the waste usually dump it on the nearest riverbank, at the roadside, or in available lots outside the subdivisions.

Related Problems or Issues

Another problem which recently cropped up was the enactment of *Republic Act no. 7160*, otherwise known as the *Local Government Code* of 1991. Among other things, the management and collection of solid waste were devolved to the local government units. This law's primary intent is to provide autonomy to the local government units. However, in the case of the Metro Manila area, the law's intent regarding SWM has been interpreted in various ways.

The MMA is presently beset by problems, most of which stem from its financial status. The MMA's funds come from the contributions of the seventeen local government units within its boundaries. However, recently these local government units have not been rigorously complying with their obligations, which has placed a strain on the MMA's ability to deliver the much-needed basic services. With the enactment of the *Local Government Code*, these local government units found a further excuse not to pay the mandatory contributions which were cut down to half the usual amount.

As of the end of 1992, the majority of local government units have entered into a Memorandum of Agreement with the regional authority whereby henceforth collection and disposal shall be handled by the local government units. The number is expected to increase once the other local government units realize the practicability of the present set-up. However, this practice may further erode the financial and institutional capability of the MMA and possibly lead to more pressing problems in the future.

Resource recovery and recycling is being practiced to some extent at the household level. Organic waste such as food and kitchen waste is being utilized as feed for poultry and domestic animals. Some households operate backyard composting pits and use the resulting compost for garden produce or flowers. Resource recovery is practiced at different levels, from households to the collection crews, and by scavengers or waste pickers at the dump site. Collection crews separate bottles, tin cans, and other recyclables in the rear of the truck — increasing official collection time and affecting collection

efficiency. Dump site scavengers work under harsh conditions to provide additional income for their families. Aside from this, several syndicated junk dealers are in operation attesting to the viability and profitability of the activity.

Current activities of nongovernmental organizations (NGOs) in Metro Manila are concentrated in the area of waste recycling and reuse while some are in the area of advocacy. There are a number of success stories in this field although what is really lacking is a system which is able to replicate these so-called success stories. Further, most NGO activities or projects are fragmented without the benefit of an overall plan or even a framework. Although this has generally been the case, the activities have been of some assistance in helping to resolve some of the problems of SWM in Metro Manila.

THE PROBLEM OF WASTE DISPOSAL

The last functional process in any SWM system is final disposal and it is a "no alternative" option because it is the essential fate of waste that has no further value. In the developing countries, it may also be called the most problematic element as SWM authorities encounter difficulties in siting and operating adequate waste disposal facilities.

In the process of selecting areas for disposal of solid waste, people tend to react negatively as the process is generally associated with open dumping. This is known in Western countries as the not-in-my-backyard (NIMBY) syndrome. However, the same people feel that local authorities should collect and dispose of the waste as it poses health and environmental problems.

A case in point is the City of Caloocan in Metro Manila where the local authorities decided to dispose of waste on one of their properties. Spearheaded by a NGO, people began protesting because the area was bounded by a resettlement area for the urban poor, housing estates, and a medical care institution. Invoking the fact that the site had been designated as an area for priority development (APD) and operation of a dump site would cause environmental degradation in general, the people sought the assistance of concerned government agencies in their objections to the local government plan.

When confronted, the local government presented the original plan, which was to construct a sanitary landfill in the area. However, they could not do so due to the costs involved. The local government used to dump its waste in a neighbouring town, but when charges allegedly increased the decision was made to dump the waste in its own locality. One reason given was that it was government property and that therefore the local authority was free to use it in whichever way it saw fit.

The concerned residents, upon realizing that it was going to be operated as an open dump, not as the planned sanitary landfill, started to gather information to be used in their subsequent actions. Their vigilance paid off as, backed by the investigations of related government agencies, the proposed operations at the site were halted by the courts.

The foregoing is cited to show the difficulties which can be encountered in siting disposal facilities, even when this is considered a management decision, in Metro Manila. As contained in the Metro Manila SWM Plan, two landfills are currently being developed, both of which are outside the metropolis. Current activities in this area have been facilitated through assistance from the World Bank. One landfill is located in the eastern

part of the mountains of San Mateo, Rizal while the other is in Carmona, Cavite (see figure 1). When the residents of these areas learned of the plan, they also vigorously protested over what they saw as plans to dump Metro Manila's waste in their localities. When it was explained to them that these dump sites were going to be developed as sanitary landfills, the impression remained that any waste disposal area would necessarily be a dump site such as the infamous "Smokey Mountain" site in Manila which constituted the city's principal dump site at that time. Obviously, they did not like the idea of another Smokey Mountain in their backyards.

The concern is further aggravated when industrial waste and hazardous waste find their way onto the present dump sites. No monitoring of incoming waste is done by the local governments or the regional authority operating these dumps. The result is a growing movement to close these open dump sites and to operate waste treatment facilities instead.

FUTURE IMPROVEMENTS IN WASTE DISPOSAL

In the face of the onslaught resulting from environmental vigilance, which was evident in the 1980s, the government undertook the necessary measures for SWM. The Department of Environment and Natural Resources (DENR) formulated a memorandum stating that all solid waste disposal projects were henceforth to be covered by the environmental impact assessment (EIA) system.

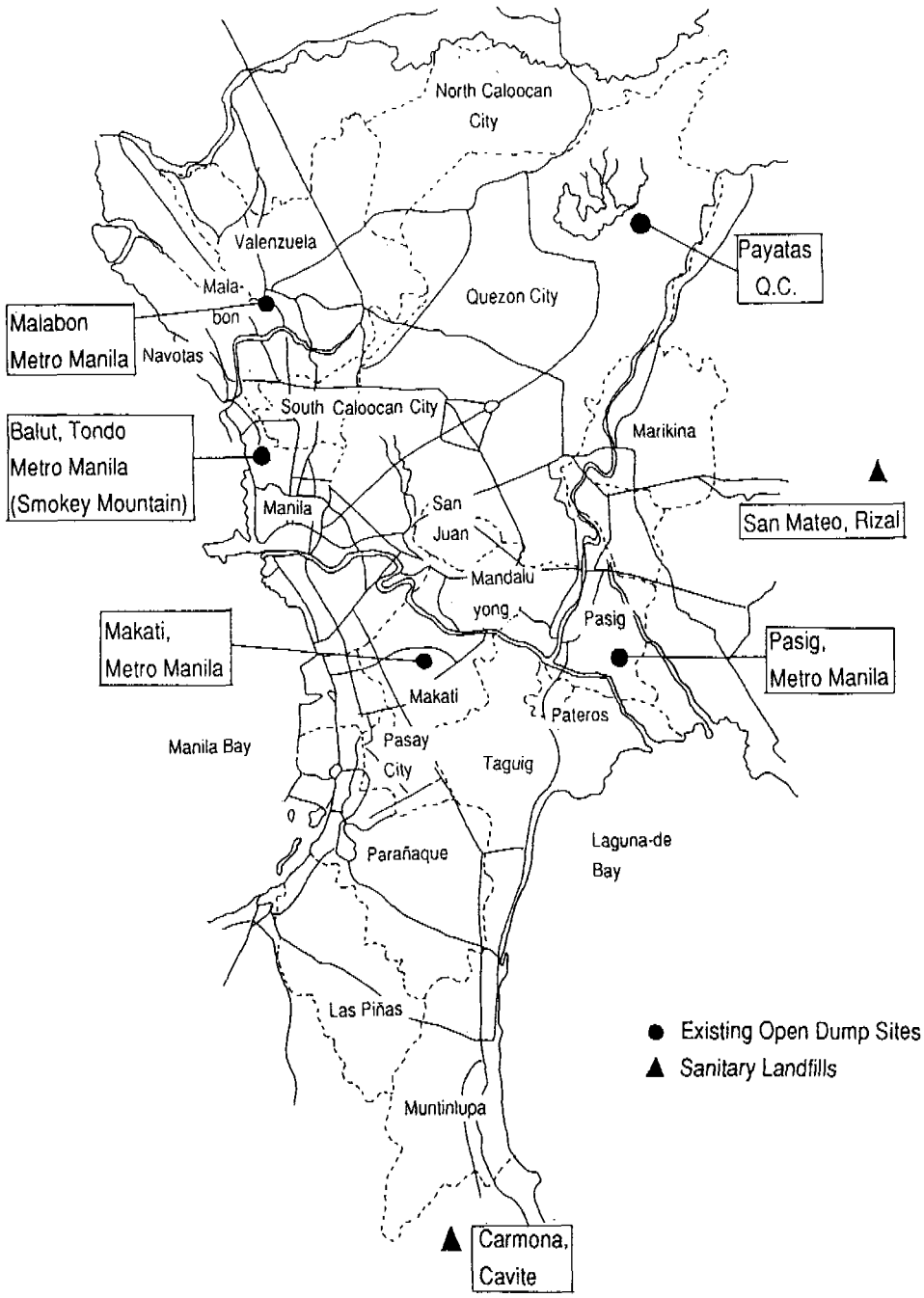
The DENR realizes that waste disposal is an immediate concern, however, the EIA system should ensure that any projects should be environmentally sound.

The sanitary landfill projects in San Mateo, Rizal, and Carmona, Cavite, although government projects, were each required to undergo an EIA. The Smokey Mountain Development Project, another government-initiated project to address the problem of the Metro Manila dump site, Smokey Mountain, was also required to submit an EIA statement. A number of proposals from foreign entities which were submitted to the Presidential Task Force on Waste Management to address the garbage problem in Metro Manila were likewise all required to submit EIAs.

In the area of hazardous waste and hospital waste disposal, there are ongoing activities being undertaken both by the DENR and the Department of Health to address the problem. The concept of operating regional or communal waste treatment and disposal facilities is also gaining ground. Although most of these are government proposals, the private sector is being encouraged to participate in this area. In fact, one privately-managed facility has been built to treat and dispose of hazardous hospital wastes in Metro Manila, although it has yet to begin operations.

The business of solid waste disposal and management is not only the business of government. At most, the government can only regulate, while operation and management can, to a certain extent, be "privatized". The many players and factors involved in SWM indicate an interplay of various concerns and issues that calls for multisectoral approaches and solutions.

Figure 1. Metro Manila: Solid Waste Disposal Sites



COMMENT

ROLAND SCHERTENLEIB

In his article, Salvador Passe is addressing not only the issues related to the disposal of solid waste, but also the other main aspects of solid waste management (SWM) in Manila: collection, resource recovery, and recycling. The article describes mainly the present situation and gives relatively little attention to a discussion of possible or planned approaches to improve this situation.

For a reader who does not know the solid waste situation in Manila from personal experience, it is interesting to note that the problems related to SWM in that city are very similar to those encountered in most cities in the developing countries. In almost all third world cities, five typical problem areas can be identified:

(1) Inadequate coverage of the population to be served;
(2) Operational inefficiencies of municipal solid waste services and management;
(3) Limited utilization of the capacity of the informal and formal private sector in recycling activities;
(4) Final disposal of solid waste; and
(5) The management of (nonindustrial) hazardous waste.

All of these problem areas are related to institutional, financial, and technical issues.

The author mentions that the percentage of the urban population served by collection systems in Manila varies from 17 to 70 per cent. Unfortunately, he does not mention in which areas the percentage is 17 per cent and in which areas it is much higher. However, it is clear that the low-income periurban areas usually make up the unserved population. As it is reported from Manila, the lack of adequate institutional arrangements and the low financial and technical sustainability of existing collection systems are the main reasons why this kind of situation prevails in the urban areas of the developing countries. The waste being generated by the fast-growing cities is more and more beyond the collection capacity and financial means of most municipal administrations. Usually, not even the operation costs of the collection services are covered by adequate fees, and the available funds from the central budget are insufficient to finance adequate levels of service to all segments of the population. However, as long as solid waste collection services are not sustainable in the sense that the beneficiaries are not able or willing to pay for the kind of service offered to them, it is obvious that it will be even more beyond the resources of the municipal administrations to collect the increasing amount of solid waste generated by such cities. Even if the operation of the existing systems can be improved significantly, a large portion of the population will realistically not be served by the municipal services, especially in

low-income areas where there is insufficient pressure on municipalities to provide the services. This has two main consequences for the setting up and operation of a solid waste collection system. First, the costs for the house-to-house collection service usually offered to the middle- and high-income population should be fully covered by fees paid by the beneficiaries; and secondly, the people in low-income communities should assume the responsibility of the municipality with regard to the handling of their garbage, and set up a system appropriate to their economic situation. This can take different forms, i.e., the community or neighbourhood either pays private collectors, from inside or outside the community, or the community members partially or wholly carry out the work themselves. In other words, those who cannot afford to pay in cash will still be provided with SWM services through payment in kind. In most places, low-income communities have proved willing to make some investment in cleaning up streets and improving drainage.

Another typical problem encountered in Manila seems to be the low operational efficiency of the solid waste services operated by the municipality. Although municipalities in developing countries typically expend substantial resources on waste management (often 20 to 30 per cent of municipal operating revenues), there is now overwhelming evidence that, operationally, they tend to do a poor job. This operational inefficiency is due primarily to the ineffective institutional arrangements common to many municipal governments in the developing countries. Several studies have shown that the increased involvement of the private sector in specific SWM activities is a promising approach to improve the low levels of efficiency in existing SWM systems. The fact that SWM in the US, Japan, and in a number of West European countries has been characterized for many years by private sector involvement is another indication that increased privatization, especially of collection services, could help alleviate some of the existing problems in the developing countries, e.g., by improving efficiency and freeing public authorities from day-to-day operations in order for them to devote their attention to policy formulation and regulation as well as support activities. Private sector participation is probably most appropriate in collection activities where the economy of scale is much less important than in the operation of landfills. Privatization, of course, also has serious limitations. It is crucial that private firms who are in charge of solid waste services do not have a monopoly. It is possible, for instance, to divide a city into several collection areas so that different firms have to compete regularly to obtain the service contracts for these different parts of the city. Unfortunately, it is not clear from Passe's article if there have been or if there are any attempts in Manila to better utilize the capacity of the private sector.

Probably the best known solid waste problem of Manila is related to the disposal element. Manila's Smokey Mountain is the notorious evidence for the environmental consequences of inadequate disposal of solid waste. This situation whereby solid waste is disposed of in uncontrolled open dumps is again very typical for most cities in the developing countries. Although the environmental consequences are often quite evident, they are seldom dealt with effectively. Financial and institutional constraints are the main reasons for this situation. If the financing of solid waste collection services poses a problem, the financing of safe disposal of solid waste poses an even greater problem. In addition, since the important physical components of the environment are all public goods, their utilization cannot be controlled simply by market mechanisms. They are usually considered to be free goods in the sense that the supply of clean air, water, and soil is

thought to be much greater than the demand for them to absorb the pollutants. However, this last assumption is certainly no longer true for urban and periurban areas with high population densities. The author points out another serious problem which is strongly related to the current disposal method: the not-in-my-backyard (NIMBY) effect. Mainly due to smoke, odours, dust, and other nuisances from existing dump sites, it is becoming increasingly difficult to find new landfill sites which are acceptable to the public, and which are located at a reasonable distance from the collection area. Recently selected landfill sites in Manila and other large cities, e.g., Jakarta, are located at distances between 20 km and 40 km from the central collection areas. This results in high transfer and transportation costs, as well as the need for additional investments in infrastructure.

In the final section, "future improvements", the author mentions that future SWM projects in Manila have to be covered by the environmental impact assessment (EIA) or the environmental impact statement (EIS) system. Although these new requirements will certainly increase the awareness of existing and potential environmental problems related to SWM activities, I am not convinced that it will automatically lead to an improvement of the present solid waste situation in Manila. Probably more substantial and basic changes are required, especially at the institutional and technical levels. In these comments on Passe's article, I have indicated some possible approaches to improving at least some of the existing SWM problems in Manila.

CONTRIBUTORS

Carl R. Bartone
Senior Environmental Specialist, Urban Development Division, The World Bank, 1818 H Street, N.W., Washington DC 20433, USA

Michael Chiu
Environmental Protection Department, 28th floor, Southorn Centre, 130 Hennessy Road, Wanchai, Hong Kong

Antonio L. Fernandez
Research Associate, United Nations Centre for Regional Development (UNCRD), Nagono 1-47-1, Nakamura-ku, Nagoya 450, Japan

Noor Hisham bin Ramly
Director, Health Services, Province Wellesley Municipal Council, Tingkat 6 and 7, Wisma U.M.N.O., D/A Jalan Datuk Haji Ahmad Said, 12000 Butterworth, Malaysia

Reiji Hitsumoto
Associate Expert, UNCRD, Nagono 1-47-1, Nakamura-ku, Nagoya 450, Japan

Zaman Huri bin Zulkifli
Public Health Engineer, Technical Section, Local Government Sector, Ministry of Housing and Local Government, Block K Paras 4, Pusat Bandar Damansara, Peti Surat 12579, 50782 Kuala Lumpur, Malaysia

Eddy Indrayana
Head, Surabaya Cleansing Department, Jl. Taman Surya No. 1, Surabaya, Indonesia

Ksemsan Suwarnarat
Director, Division of Policy and Integrated Plan, Policy and Planning Department, Bangkok Metropolitan Administration, 173 Dinsor Road, Bangkok 10200, Thailand

Bindu N. Lohani
Assistant Chief, Office of the Environment, Asian Development Bank (ADB), P.O. Box

789, Metro Manila, Philippines

Yasushi Matsufuji
Associate Professor, Faculty of Engineering, Fukuoka University, Nanakuma 8-19-1, Johnan-ku, Fukuoka City 814-01, Japan

Ng Wun Jern
Associate Professor, Department of Civil Engineering, National University of Singapore, 10 Kent Ridge Crescent, Singapore 0511, Republic of Singapore

Hisashi Ogawa
Environmental Systems Engineer, Western Pacific Regional Environmental Health Centre, World Health Organization (EHC/WHO), P.O. 12550, 50782 Kuala Lumpur, Malaysia

E. A. R. Ouano
16 Mundin Street, Doonside 2767, N.S.W., Australia

J. Salvador T. Passe, Jr.
Head, Solid Waste Management Assistance and Development Program, Environmental Management Bureau, Philippine Heart Center Building, 6th floor, East Avenue, Diliman, Quezon City, 3008 Metro Manila, Philippines

M. B. Pescod
Tyne and Wear Professor of Environmental Control Engineering; and Head, Department of Civil Engineering, Cassie Building, University of Newcastle Upon Tyne, New Castle Upon Tyne NE1 7RU, UK

Maria Victoria Fernandez-Ricaña
Project Manager, Philippine-German Project, Industrial Pollution Control Cebu, Department of Environmental and Natural Resources, Greenplains Subdivision, Banilad, Mandaue City, Philippines

Kunitoshi Sakurai
Department of Urban Engineering, Faculty of Engineering, University of Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo 113, Japan

Roland Schertenleib
Director, International Reference Centre for Waste Disposal, Uberlandstrasse 133, CH-8600 Duebendorf, Switzerland

Johan Silas
Laboratory of Human Settlements, Surabaya Institute of Technology (ITS), Kampus ITS Keputih, Surabaya 69265, Indonesia

Kazal Sinha
Technical Director, Local Government Department, Ministry of Housing and Local Government, Block K Paras 4, Pusat Bandar Damansara, Peti Surat 12579, 50782 Kuala Lumpur, Malaysia

Tan Hoo
Chief, Public Health Engineer, G Floor, Block E, Damansara Office Complex, Jalan Dungun, 50490 Kuala Lumpur, Malaysia

Joo-Hwa Tay
Head, Division of Water Resources and Transportation, School of Civil and Structural Engineering, Nanyang Technological University, Nanyang Avenue, Singapore 2263, Republic of Singapore

Watana Luanratana
Chief, Environmental Planning Section, Division of Infrastructure and Environment, Policy and Planning Department, Bangkok Metropolitan Administration, 173 Dinsor Road, Bangkok 10200, Thailand

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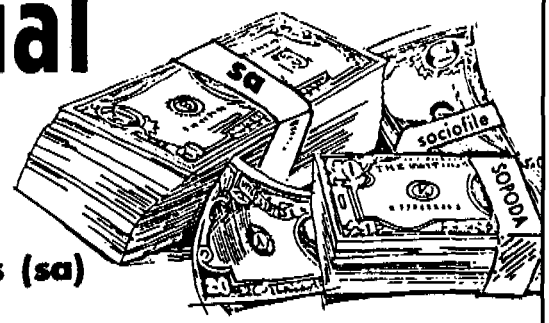

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REGIONAL DEVELOPMENT DIALOGUE

15th Anniversary Issue
Vol. 15, No. 1, Summer 1994

Call for Papers

Papers are invited for *Regional Development Dialogue (RDD)*, 15th Anniversary Issue, Vol. 15, No. 1, Summer 1994. This *RDD* issue will focus on local and regional development and planning issues and trends in relation to the rapidly evolving political, social, economic, environmental, and technological changes and realities at global, national, regional (subnational), and local levels.

Suggested topics for papers include: "Globalization and Regional Development"; "Democratization and Local Autonomy"; and "Sustainable Local and Regional Development".

Concept papers and country case studies dealing with Africa, Eastern Europe and Central Asia, and the Asian newly industrializing countries are due by **1 February 1994**. Authors will be notified of acceptance by 1 March 1994.

Send paper (with an abstract of 250 to 500 words) to:

Hideki Kaji, Director
(Attn. Josefa S. Edralin, *RDD* Coordinator)
United Nations Centre for Regional Development (UNCRD)
Nagono 1-47-1, Nakamura-ku, Nagoya 450
JAPAN

Telephone: (+81-52) 561-9377/9379
Telefax: (+81-52) 561-9375/9458
Telex: J59620 UNCENTRE

REGIONAL DEVELOPMENT DIALOGUE

An International Journal
Focusing on Third World Development Problems

The *Regional Development Dialogue (RDD)* supersedes the *Asian Development Dialogue*, which ceased publication in 1977. It is intended to be interdisciplinary and to focus on current development issues. Its basic objective is to bridge the gap between concept and reality, and policy and practice, in regional development.

The *RDD* is one of the media through which the United Nations Centre for Regional Development (UNCRD) shares its experiences and research findings and generates a dialogue with a wide-ranging audience on various theoretical and applied aspects of regional development. By encouraging debate on critical questions in the field of regional development, the *RDD* hopes to contribute to greater understanding of these issues, and thus ultimately to improvements in regional development policy and planning.

Each issue of the *RDD* deals with a topical theme. The editors welcome suggestions for themes, papers for possible publication, and comments on articles. Readers wishing to comment on material appearing in the *RDD* are encouraged to write to the editors.

The *RDD* is published quarterly, in Spring, Summer, Autumn, and Winter, by UNCRD. Please direct manuscripts, comments on articles, and correspondence to the Editor-in-Chief, *Regional Development Dialogue*, United Nations Centre for Regional Development, Nagono 1-47-1, Nakamura-ku, Nagoya 450, Japan.

Guide to Contributors

Authors and commentators writing for the *RDD* should aim at contributing to the theory and practice of regional development and planning relevant to the third world countries.

While considering their contributions, the authors should keep in view that this journal communicates with a wide audience not only in terms of geographic distribution but also specialization, concern, and professional background. The presentation should be in clear English. While no precise limits are imposed, articles in the range of twenty to thirty typed manuscript pages, double-spaced, are preferred.

The acceptance of an article by the *RDD* implies an understanding by the author(s) that UNCRD will have the sole publication rights over the article; the author(s) should not submit it to any other journal or book for publication; and once published in the *RDD* it will not be reprinted in any other form without prior written permission from UNCRD.

Prospective contributors to the *RDD* are requested to obtain a copy of the "UNCRD Styleguide: Information for Authors" from UNCRD.

ABOUT THE UNCRD

The United Nations Centre for Regional Development was set up in 1971 in pursuance of the terms of ECOSOC resolutions 1086C (XXXIX) and 1141 (XLI) which called for global action to promote regional development, and resolution 1582 (L) that provided guidelines for its establishment. The principal aim of UNCRD is to enhance the capabilities of the developing countries in local and regional (subnational) development and planning. Towards this aim, UNCRD organizes training courses, promotes collaborative research on substantive issues in regional development, extends technical advisory services, serves as a forum for exchange of experiences, and fosters exchange of publications and information on local and regional development and planning.

In 1986, UNCRD reorganized its programmes into seven major operational units. UNCRD also launched a new programme known as its Strategic Assistance Programme. Although the projects focus primarily on research and training, they also include advisory services and information dissemination components.

The seven operational units provide a framework within which UNCRD can identify, design, and manage research and training projects. These units include: (a) Urban Development and Housing Unit (UDHU); (b) Regional Development and Management Unit (RDMU); (c) Environmental Planning and Management Unit (EPMU); (d) Regional Disaster Prevention Unit (RDPU); (e) Information Systems Unit (ISU); (f) Social Development Unit (SDU); and (g) Industrial Development Unit (IDU).

The Strategic Assistance Programme provides support for specific activities in local and regional development and planning that are of demonstrated importance to the developing countries. Current projects include: (a) Development of Training Modules on the Integrated Approach to Disaster Management and Regional/Rural Development Planning in Bangladesh; (b) Transformation of Regional Economies and Modernization of Enterprise and Village Management in China; (c) JIF/UNCRD Joint Training Programme on Regional Development Planning Techniques and Management for Indonesian Local Government Officials; (d) Local-Level Planning and Management in Papua New Guinea; (e) Training Programme on Earthquake Engineering and Disaster Management for Establishing a Building Administration System in the Philippines; (f) Social Forestry and Community Development in Southeast Asia; (g) Local and Regional Development in Eastern and Southern Africa; and (h) Management of Metropolitan Living Environments in Latin America.

For further information, please write to:

The Director
United Nations Centre for Regional Development
Nagono 1-47-1, Nakamura-ku, Nagoya 450, JAPAN

Phone: (+81-52) 561-9377
Fax: (+81-52) 561-9375
Telex: J59620 UNCENTRE
Cable: UNCENTRE NAGOYA
