Chapter 2 Understanding Issues of Assistance in the Solid Waste Sector

The preceding chapter has identified the characteristics of and problems with solid waste management (SWM) in developing countries, summarized donor trends, and reviewed Japan's experience in technical cooperation. This chapter structures specific issues related to SWM there and provides basic information for exploring assistance for capacity development in this sector. Specifically, Section 2-1 reviews such issues systematically and summarized them in charts and matrices. The following sections provide an explanation of each of these issues.

2-1 Issues related to assistance in SWM

Problem analysis through the systematic understanding of the background factors related to solid waste problems takes precedence in examining ways to solve solid waste problems.

This section presents development objective matrices that summarize specific issues in SWM sector to get a general picture in developing countries. This process is designed to systematize development issues so that the matrices can be used as a tool for identifying issues and formulating projects for each user. At present, the socioeconomic aspects should be given special consideration in planning development assistance in this sector in addition to technical aspects, and the roles should be played by different stakeholders.

Here, an "issue" refers to an obstacle that has to be overcome to solve a given solid waste problem. In other words, it is a specific subject for which a recipient is required to develop its capacity. The process of systematizing issues is the process of identifying specific subjects for capacity development support.

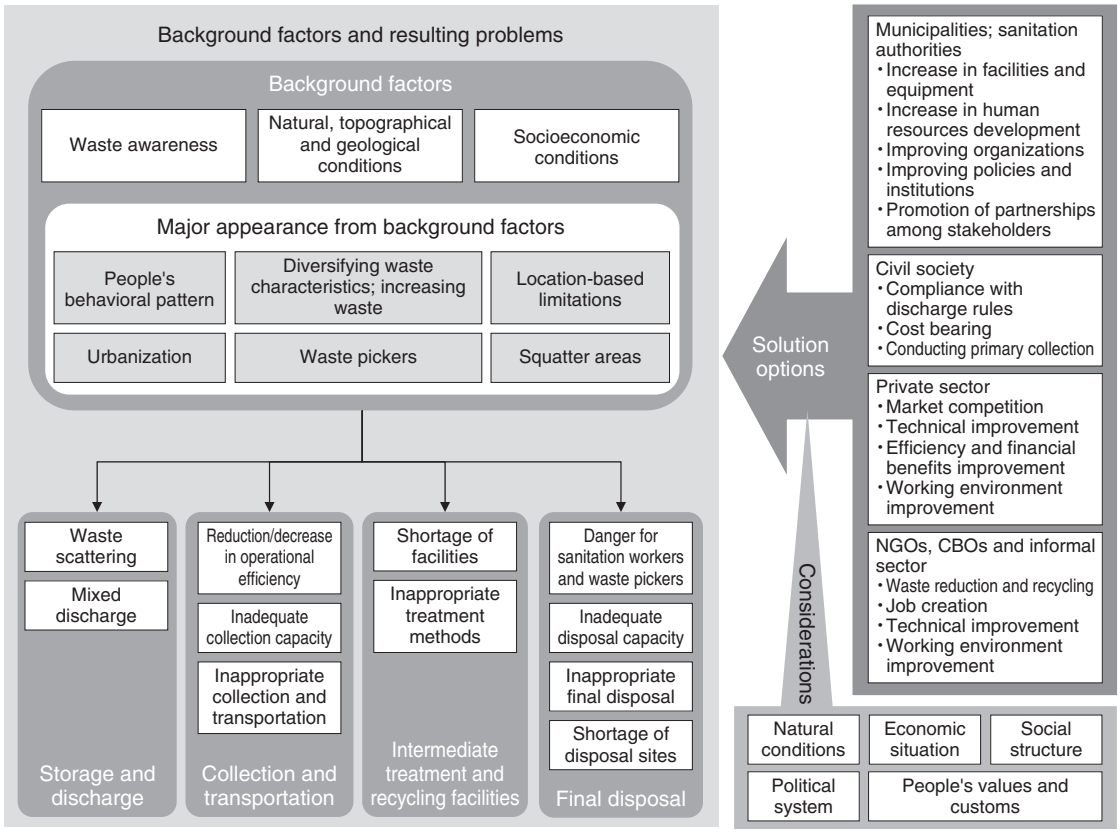
2-1-1 Understanding issues in the solid waste sector

(1) Correlation between issues and methods for their solution

As mentioned in Chapter 1, waste problems reflect society, economy, culture and natural conditions and other factors. These various background factors play a significant role in determining how each problem manifests itself-how each problem occurs, what form it takes, and how far it develops-at each phase of the solid waste management process: storage and discharge, collection, intermediate treatment, and final disposal.

When donors support recipients in developing their capacities to solve these waste problems, it should be noted that stakeholders in capacity building, i.e. entities expected to implement solution options are not limited to local governments as a whole or their departments or sections in charge of SWM. They also include a variety of other stakeholders, such as civil society, the private sector, NGOs, CBOs and the informal sector. Each stakeholder has a role to play by itself or by working with others toward solving waste problems. The specific solution options to be taken should be decided with consideration given to the natural conditions, socioeconomic situations, culture and political system of a given

Figure 2−1 Background Factors, Resulting Problems, and Solution Options in the Solid Waste Sector



Source : Compiled by OTSUKI Noriko

area. In fact, unless these factors are assessed accurately, options for solving waste problems cannot be devised. Nor can capacity development policies based on these options be formulated, or directions for donors' assistance be defined.

Figure 2-1 summarizes background factors, problems and what action should be taken and by whom in relation to solid waste management in a given city. This comprehensive diagram allows for predictive analysis of stakeholders, problems and objectives. It can also serve as a tool to share the understanding of solid waste problems between donors and implementing agencies.

Any developing country city has already some kind of SWM system in place. For each city, such a system has been optimized in the historical and cultural context. Yet the system is now unable to cope with recent changes such as population growth due to urbanization and diversification of wastes under the paradigm of mass production and mass consumption, causing various problems at each level of waste management service. Table 2-1 shows examples of specific problems resulting from background factors and inadequate capacities of municipalities and other stakeholders. Reversely, it is possible to identify capacity development issues to be addressed at each level of SWM service based on these examples.

(2) Roles of each stakeholder in SWM

Understanding of the roles of each stakeholder in SWM is an important element of the process of setting objectives for improving the overall SWM capacity of the entire society.

The primary counterparts in JICA's

Table 2-1 Causal Factors and Specific Examples of Solid Waste Problems in Developing Countries

Problem factors			Problems caused			
			Storage and discharge	Collection and transportation	Intermediate treatment	Final disposal
Background factors	Population, economic level, climate, topography, etc.	• Increases in waste quantities • Changes in waste characteristics • Seasonal variations, floods and other natural disasters • Underdeveloped urban infrastructure • Operational difficulties • Difficulties in procuring sites • Diversification of city residents	• Inappropriate storage and discharge methods for the quantities and characteristics of the wastes • Inappropriate storage and discharge methods inappropriate for lifestyles • Inappropriate storage and discharge methods inappropriate for climatic conditions • Difficulties in establishing collection points	• Traffic congestion due to population growth • Expansion of the areas with poor access to collection service, including squatter areas • Selection of equipment inappropriate for waste quantities and characteristics • Driving difficulties due to flooding • Poor access due to poor road conditions, including steed roads	• Intermediate treatment inappropriate for waste quantities or characteristics • Intermediate treatment inappropriate for climatic conditions • Difficulties in siting treatment facilities	• Environmental impacts of hazardous, infectious and corrosive wastes • Scarcity of landfill sites due to increasing waste quantities • Increases in the amount of leachate due to heavy rain • Difficulties in siting landfills • Pollution of rivers and groundwater due to leachate • Difficulties in procuring cover soil material
Inadequate SWM by municipalities	Social aspects	• Inadequate understanding of waste issues • Unwillingness to cooperate • Gaps between rich and poor • Formation of slum areas • Disintegration of traditional communities	• Inadequate waste reduction • Improper discharge • Waste left uncollected and scattered around collection points (containers, etc.) • Scattering of waste on streets, etc. due to scavenging	• Denial of access to service by low-income earners due to the failure to pay fees • Low social status of collection workers • Scavenging in the collection process (including scavenging by collection workers themselves, which lowers collection efficiency.)	• NIMBY syndrome • Bringing-in of inadequately separated wastes • Intermediate treatment and recycled products unfit for economic activity	• NIMBY syndrome • Scavenging at landfills • Unsanitary and dangerous working environment for waste pickers
	Institutional aspects	• Lack of policy objectives • Lack of appropriate laws, standards or guidelines • Inconclusive decentralization or weak power of municipalities • Inadequate systems concerning organizations in charge of SWM	• Lack of rules on storage and discharge • Inadequate policies or frameworks for waste reduction and source separation • Mixing of industrial waste into municipal waste • Mixing of hazardous wastes into municipal waste	• Illegal dumping • Lack of safety measures for collection workers • Inappropriate contracts with private contractors • Areas without access to collection service	• Local opposition to the proposed siting of facilities • Lack of safety measures for sanitation workers • Inappropriate contracts with private contractors • Environmental impacts	• Lack of safety measures for sanitation workers • Lack of safety measures for waste pickers • Inappropriate contracts with private contractors • Environmental impacts
	Organizational aspects	• Opaque decision-making process • Lack of a shared sense of purpose • Frequent personnel changes • Lack of organizational management capacity • Lack of policy-making capacity • Lack of coordination and partnership with private waste service providers and other organizations	• Inadequate or inappropriate guidance for communities • Waste left uncollected and littered due to irregular discharge	• Inefficient operation • Inadequate supervision • Inadequate planning • Waste left uncollected and littered due to incomplete collection	• Inefficient operation • Inadequate supervision • Inadequate planning	• Inefficient operation • Inadequate supervision • Inadequate planning

Problem factors			Problems caused			
			Storage and discharge	Collection and transportation	Intermediate treatment	Final disposal
Inadequate SWM by municipalities	Financial aspects	• Underdeveloped tax collection system • Low priority for SWM in budget allocation • Lack of financial management capacity • Lack of financial planning in anticipation of equipment renewal, etc. • Inadequate assessment of cost-recovery performance • Inappropriate allocation of collected fees for other purposes than SWM service	• Inadequacy or lack of containers for storage and discharge at collection points • Incomplete collection of waste collection fees	• Insufficient amounts of collected waste collection fees • Inappropriate allocation of collected fees for other purposes than SWM service • Insufficient allocations from the general-account budget of the municipality • Insufficient expenses for equipment and fuel • Insufficient expenses for operating and maintaining equipment • Insufficient expenses for renewing equipment	• Insufficient expenses for operating and maintaining facilities • Low operating rates for facilities • Excessive inventories of recycled products • Mismatches with markets	• Insufficient amounts of collected waste disposal fees • Insufficient allocations from the general-account budget of the municipality • Insufficient expenses for operating and maintaining equipment • Insufficient expenses for renewing equipment • Difficulties in procuring cover soil material
	Technical aspects	• Inadequate skills • Lack of skilled human resources • Inadequate policies for human resources development (HRD) • Inadequate technical information	• Inadequate or inappropriate guidance for communities • Inadequate waste separation	• Insufficient capacity for maintaining equipment • Inadequate planning • Inappropriate collection methods • Inefficiency • Inadequate supervision over private contractors	• Introduction of inappropriate intermediate treatment • Inappropriate operation and maintenance • Inadequate planning • Negative impact on the environment and resultant encouragement of NIMBY opposition • Inadequate supervision over private contractors	• Inappropriate disposal methods • Inappropriate operation and maintenance • Inadequate planning • Negative impact on the environment and resultant encouragement of NIMBY opposition • Inadequate supervision over private contractors

* The left column on "social aspects" is crossed out because each member of the society plays a part in SWM although social aspects serve as background factors for the municipality in question.

Source : Compiled by OTSUKI Noriko

assistance in the solid waste sector are mostly municipality because they are most likely given responsibility and power for solid waste disposal. For this reason, JICA's technical cooperation projects have focused on capacity development support for SWM departments and sections at individual and organizational levels that involves assistance for both 'hard' and 'soft' aspects.

Meanwhile, collaborative relationships between municipalities and all the other stakeholders are essential for such authorities to deliver SWM service appropriately. Figure 2-2 shows desirable relationships among entities that implement solution options in Figure 2-1 and other stakeholders in SWM. This diagram offers hints as to which directions capacity development at each level of society should go, including the option of building partnerships and frameworks between stakeholders.

2-1-2 Development Objectives Matrix in the SWM sector

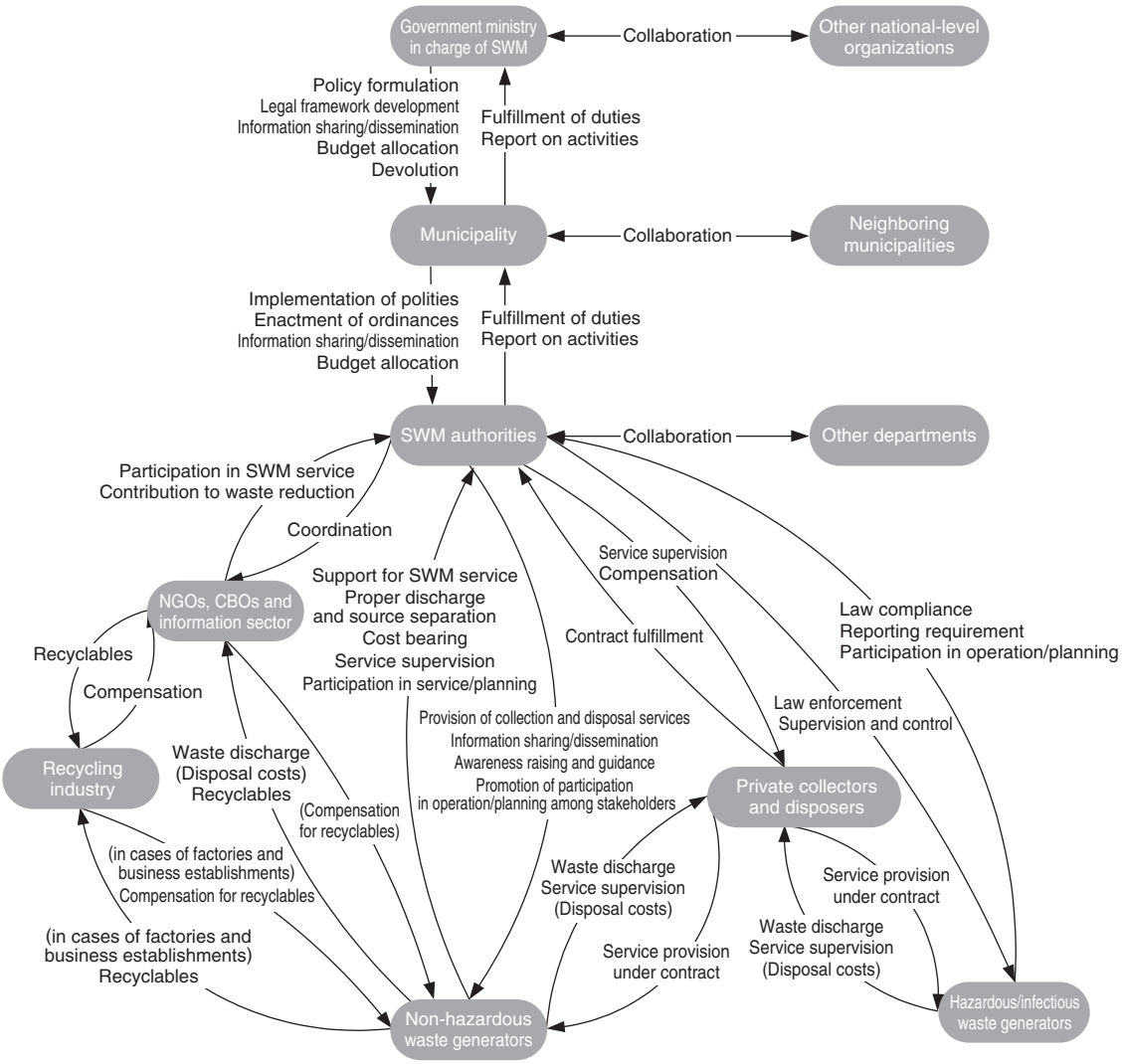
Table 2-2 summarizes development objectives in the SWM sector from different aspects of problem factors (institutional, organizational, social and other aspects) by structuring issues in this sector. This Development Objectives Matrix sets out the improvement of each aspect as Development Objectives, which are broken down into Mid-term Objectives and further to Sub-targets of Mid-term

Objectives. The following sections of this chapter focus on the components of each development objective. At any rate, this chart provides a cross-sectoral picture of what policy or which direction to take in solving problems in SWM (development objectives) in a tree form. The chart can serve as a tool that can be used to identify which objective donors should address according to the capacity of the counterparts. The matrix also offers examples of aid activities. The environmental and public health aspects, especially the management of hazardous and medical wastes are discussed in detail in Section 2-5 since they are deemed to deserve the special attention of donor countries in the developed world because of their extent influence [1].

Table 2-3 structures issues around solid waste management (SWM) components along the waste flow, which plays an important role in SWM. This matrix is useful in identifying which process in the flow has problems and in determining aid components to solve them. Each process in the flow is detailed in Section 2-6.

Integrated input in the form of aid programs calls for the use of both these two matrices to adopt a multifaceted approach.

Figure 2-2 Relationships among different stakeholders in SWM



Source : Compiled by OTSUKI Noriko

[1] Such an objective as "the establishment of SWM with appropriate consideration given to the environmental and public health aspects" are not included. This is because such an objective is deemed to be an outcome goal that will be achieved by fulfilling the two development objectives in Table 2-2.

Table 2-2 Development Objectives Matrix in the Solid Waste Management Sector (Cross-sectoral Issues)

Development Objective	Mid-term Objective	Sub-targets of Mid-term Objectives		Examples of Aid Activities
1. Developing SWM capacity	1-1. Improvement in the institutional aspect	1	Formulating SWM policy	Assessing the current situation and identifying problems; fact-finding survey
				Formulating a SWM plan through a development study
				Information disclosure at the planning phase; support for consensus building among stakeholders; assistance for theintroduction of an appropriate planning process with EIA support, etc.
		2	Development of law and legislation	Clearly defining waste and waste services; clarifying the responsibility for disposal; providing advice on legislation to strengthen the monitoring framework and tighten penalties; developing model laws; supporting waste classification, coding and database development.
		3	Establishing the organization responsible for SWM	Encouraging communication between organizations concerned to codify their roles in official documents
	1-2. Improvement in the organizational aspect	1	Defining job descriptions within organizations	Support in codifying the roles of organizations in official documents and defining the assignment of responsibilities within organizations
				Establishment of appropriate division of duties through support for reviewing contractual relationship between the public and private sectors and revising contract documents
				Support in introducing a permits and licenses system and performance indicators for private business operators; establishment of techniques to control such operators by the training of staff, etc.
		2	Ensuring appropriate personnel distribution in both quality and quantity	Defining the level of expertise required of each department; suggesting performance indicators to meet the need for human resources
				Promoting sanitation service at higher education institutions; securing or reducing human resources through vocational training designed to promote reemployment of workers made redundant
		3	Development of organizational management capacity	Introduction of internal and external auditing systems through support for the introduction of ISO9000s and ISO14000s
				Increasing operational efficiency through support for the development of manuals for various types of operations
				Support for revising wage systems; establishment of evaluation items; fair evaluation of staff performance through support in evaluation implementation
		4	Development of the capacity for cooperation and coordination with other organizations	Support for the establishment of liaison arrangements with other organizations; support in holding committee meetings regularly
				Support for PR using newsletters and the Internet; support for the establishment of information sharing systems
	1-3. Improvement in the financial aspect	1	Ensuring proper financial management	Clarifying SWM costs and expenses based on fact-finding survey on costs of SWM services
				Clarifying the budget and income based on fact-finding survey on the financial status
				Technology transfers related to the development and use of accounting management software
		2	Establishing arrangements for cost recovery (self-finance)	Assessing expenses at municipal, provincial and national levels
				Support for the establishment of a reasonable charge system toward the introduction of a system to collect waste disposal fees; advice on appropriate collection methods and arrangements
				Increasing access to investment financing through the provision of development funds for municipalities with the application of "two-step" loans
		3	Improvement of the balance between income and expenses through cost reductions	Reviewing collection routes; support for the construction of transfer stations; improving collection and transportation efficiency through support for operating efficiency analysis with time-and-motion study
				Support for the introduction of regional waste disposal with the establishment of a broader intermunicipal cooperation framework
				Analysis of cost-saving effects of privatization with an eye to outsourcing SWM services to the private sector or even privatizing SWM

Development Objective	Mid-term Objective	Sub-targets of Mid-term Objectives		Examples of Aid Activities
	1-4. Closer cooperation with the private sector	1	Appropriate promotion of private sector participation	Support for reviewing contractual relationship between the public and private sectors and for revising contract documents
				Recommendations on the scope of outsourcing or privatizing SWM services towards the introduction of such moves
		2	Development of the municipality's capacity to supervise the private sector	Support for reviewing contractual relationship between the public and private sectors and for revising contract documents
				Support in introducing a permit and licensing system and performance indicators for private business operators; establishment of techniques to control such operators through the training of staff, etc.
	1-5. Improvements in the technical aspects	1	Improvement of skills	Support for formulating and implementing HRD plans in combination with training programs
				Developing manuals for collection service and landfill site operation
				Support for establishing internal and external cooperative relations with universities, research institutes, etc.
		2	Development and introduction of appropriate technologies	Promoting technical development by accumulating, promoting and introducing technical expertise and research findings in various countries
				Introduction and optimization of technologies with pilot-scale application and advice
				Promoting the appropriate facility development through support in designing (for better performance), constructing, operating and managing facilities, including transfer of technologies designed to minimize environmental impacts
2. Establishment of a SWM framework suitable for the society	2-1. Appropriate consideration to cultural and social aspects	1	SWM that considers culture and customs	Assessing the current level of public awareness about waste based on opinion polls
				Holding a public hearing for each social group about SWM planning to apply systems that accommodates their cultures and customs
		2	Handling of the informal sector	Establishing operational rules agreed between landfill managers and waste pickers to promote partnership with the informal sector
				Support for registering waste pickers and informal scrap dealers and organizing unions
				Offering alternative livelihoods by providing waste pickers with vocational training
		3	Respect for the consensus building process in SWM	Involving civil society in the planning process through the reflection of the community's opinions received via public hearings and the Internet
				Support for information disclosure, including information on the schedule and actual progress on SWM planning
				Support for organizing a monitoring committee that involves residents and business establishments
	2-2. Encouraging waste generators to participate in the planning of SWM	1	Development of the capacities of CBOs	Promoting the involvement of CBOs through support for information campaigns on the roles of communities in SWM
				Support for community activities with technical guidance on separate collection and sale of recycled items
		2	Promoting the understanding of solid waste problems and issues	Support for developing teaching materials on solid waste
				Support for public awareness raising through information campaigns, including preparation of campaign leaflets
				Support for information campaigns designed to make the public familiar with legislation for SWM with focus on raising the awareness of generators of wastes (including hazardous andmedical wastes) about their responsibility
				Raising public awareness through support for developing tools for guidance and publicity materials regarding hazardous and medical wastes, including their effects on human health and the environment, characteristics of their properties and how to handle them
				Support for the establishment of a framework to provide consultations on the telephone or Internet and other information on how to reduce store and discharge waste properly
				Teaching how to develop publicity tools; developing the ability to guide the residents through OJT that includes public hearings
				Promoting awareness building for waste service providers, strengthening the collector's capacity for implementing SWM so as to be trusted by the beneficiaries

Source : Compiled by MURATA Takuya and OTSUKI Noriko

Table 2-3 Development Objectives Structured Around SWM Components

Components	Subcomponents	Elements of subcomponents	Descriptions and examples of items to be improved
Ensuring proper generation, storage and discharge	Raising public awareness about SWM	Improving solid waste education	Promoting the understanding of waste streams and the importance of SWM
		Disseminating information on the proper store and discharge of waste	Communicating and disseminating information designed to encourage people to use storage containers with lids and set out refuse for collection at the prescribed time on the prescribed day
		Improving methods for guiding the residents	Methods for selecting publicity methods; methods for developing publicity tools; the use of CBOs
	Ensuring that proper discharge methods are used	Selecting proper discharge methods	Selecting discharge methods, including discharge at the curbside or waste collection points; adequate consideration to culture and customs
		Developing discharge rules and ensuring compliance with them	Designating the time and type of container for the discharge of waste; promoting the growth of CBOs that work to ensure compliance with these rules
Expanding and improving collection service	Establishing a collection system	Clarifying the responsibility for collection	Clarifying where collection responsibility lies depending on the source and nature of wastes especially hazardous, non-hazardous, etc.
		Establishing organizations responsible for collection	Defining the relationships among entities that do actual collection, those that supervise the service, and those that finance it
	Formulating collection plans	Assessing the current situation	Surveying collection rates, the collection service available area, the levels of service user satisfaction, etc.
		Appropriate planning and implementation	Setting improvement goals above and developing and implementing measures to achieve these goals
	Expanding collection service	Build-up of collection equipment	Procuring new collection equipment
		Promoting the involvement of NGOs and civil society organizations in primary collection	An arrangement where NGOs are responsible for primary collection along feeder roads from residential areas to arterial roads, from where the municipal government takes charge of secondary collection
		Outsourcing SWM services to the private sector or introducing privatization	Development of a contract administration and supervision framework
	Improving collection efficiency	Improving collection methods	Decreasing the collection frequency from every day to every other day; changing from door-to-door collection to station collection
		Reviewing collection routes	Taking shortest routes; avoiding traffic jams
		Improving personnel management methods	Ensuring appropriate personnel distribution and payment; preventing the pick-up and separation of recyclables during collection; improving operational efficiency
		Replacement of equipment	Removing old or damaged equipment
		Improving equipment	Replacing trucks with compactors or container trucks
		Improving the maintenance system	Preventive maintenance of equipment; prompt repair; proper inventory control, including timely replenishment
		Ensuring compliance with discharge rules	Allowing refuse discharge on the collection days
		Introducing transfer stations	Reducing transportation costs
		Outsourcing SWM services to the private sector or introducing privatization	Development of a contract administration and supervision framework
		Collection cost analysis	Assessing the proportion of collection costs in the total waste service costs; calculating the total collection costs and their unit costs (the total collection costs divided by the total collected amount)

Components	Subcomponents	Elements of subcomponents		Descriptions and examples of items to be improved
	Improving the quality of collection service	Keeping regular collection hours	Personnel management	Managing the working hours for drivers and collection workers
			Reviewing collection routes	Taking shortest routes; avoiding traffic jams
			Securing well-maintained equipment steadily	Improving the maintenance system and replacing equipment
			Keeping regular collection hours and informing the public of such collection hours	Calling for the discharge of waste in accordance with collection hours
		Collection service that will leave no waste uncollected	Improving collection methods and informing the public of such improvements	Introducing bell collection
			Ensuring that discharge rules are strictly observed	Ensuring that people set out refuse in a container or bag only on collection days
	Improving public area sanitation	Reducing the mobilization of resources for public area sanitation	Improving collection service	Implementing measures shown above
			Installing public dustbins	Installing dustbins in public areas
			Improving the practice of throwing away garbage	Calling on the public to use dustbins and properly set out waste for collection
		Optimizing public area sanitation	Optimizing the combination of manual operations by sanitation workers and mechanized operations	Maintaining manual operations by sanitation workers with an appropriate level of mechanization
			Improving the efficiency of sanitation methods	Improving waste containers, transportation methods, sanitation routes, etc.
			Ensuring safety of sweepers	Providing uniforms, gloves, tools, etc.
Introducing and improving intermediate treatment(not limited to methods cited here)	Volume reduction	Introducing and improving size-reduction facilities		
		Introducing and improving the compaction process		
	Waste reduction	Introducing and improving incineration facilities		
		Collection of recyclables		See "Recycling and waste reduction"
		Introducing and improving composting facilities		
	Stabilization and detoxification	Introducing and improving incineration facilities		
		Introducing and improving sterilization facilities		
		Introducing and improving chemical treatment facilities		
	Energy recovery	Introducing and improving waste-to-energy plants		
		Introducing and improving plants using biomass energy		
Improving final disposal	Institutional building	Clarifying the responsibility for final disposal		Clarifying the division of responsibility for operation, management and financing of final disposal
	Final disposal planning	Assessing the current situation		Operation methods, remaining life years, environmental impacts, etc.
		Appropriate planning		Setting goals and defining ways to achieve them in light of the items above
		Appropriate planning procedures and consensus building	Participatory planning process	Dialogue with local residents
			Information disclosure	Ensuring transparency of the planning process
	Preventing or reducing the environmental impacts of final disposal sites	Appropriate site selection		Sites where ground water levels are low, ecological resources are scarce, or the topology is steep
		Appropriate design and construction of final disposal sites		Enclosing bunds, seepage control, leachate collection and treatment, gas collection and venting, monitoring facilities, etc.

Components	Subcomponents	Elements of subcomponents		Descriptions and examples of items to be improved
		Environmental impact assessment (EIA)		Proper EIA of such projects as the expansion of existing landfill sites and the development of new landfill sites
		Proper operation of final disposal sites	Control and management of incoming vehicles	Installation of truck scales, etc.
			Securing cover soil	Procurement on-sites or purchase from off-site sources
			Securing and maintaining heavy machinery	Heavy machinery procurement and maintenance systems
			Training and allocating engineers	Mastering landfill operating skills
			Implementing soil covering; operating and maintaining environmental pollution control facilities	Implementing environmental pollution control activities
			Cost analysis and reduction; securing of operating capital	Assessing the proportion of final disposal costs in total sanitation costs; securing financing
			Establishing the monitoring framework	Monitoring surface and ground water in the neighborhoods
			Outsourcing/privatization of SWM services to the private sector	Development of a contract administration and supervision framework
			Waste picker control	Setting rules on the collection of recyclables and soil covering; helping them find new jobs; organizing them
		Development of legislation that calls for the prevention or reduction of environmental impacts of final disposal sites		Requirements and guidelines for landfills; clarification of the oversight responsibility
		Introducing intermediate treatment facilities for waste stabilization		Incineration, composting, chemical treatment, etc.
Promoting recycling and waste reduction	Promoting recycling	Promoting separate collection of recyclables	Promoting source separation of recyclables	Promoting the sale of recyclables to scrap dealers
			Promoting community-based collection of recyclables	Encouraging local residents or schools to join forces to collect and sell recyclables
			Institutionalizing informal collection activities	Establishing a system to register buyers of recyclables and waste pickers at landfills; improving the working environment
			Introducing separate collection of waste	By the municipal government or its contractors
			Introducing facilities to select recyclables	By the municipal government or its contractors
		Promoting the use of recyclables	Promoting the purchase of recycled products	Raising public awareness; introducing a labeling system
			Introducing a green procurement system	Setting numerical targets on procurement of recycled products by government agencies
	Promoting waste reduction	Promoting waste reduction at home		Disseminating methods and technique to reduce waste at home
		Promoting waste reduction at establishments		Disseminating reduction technologies for the production process; training production; providing financial support for improving production processes
		Introducing extended producer responsibility (EPR)		Setting the scope of waste involving EPR, the extent of EPR, etc.

Source : Compiled by OTSUKI Noriko

2-2 Cities and waste problems

Placing waste problems in the recipient city in a proper context and understanding their multifaceted aspects are prerequisite for determining the focus of aid.

Technical cooperation in the solid waste sector for developing country cities must first consider that each city is placed under different conditions. The first focus is SWM conditions for the city, including the types and amounts of wastes, how they are disposed of, and the technical, financial and institutional capacities of the city. It is necessary to determine the status and priority of waste problems in relation to other problems facing the city. This section briefly look at the status and characteristics of urban waste problems and then perceives their general trends from different aspects.

2-2-1 Urban waste problems

(1) Status of waste problems in the municipal government

Conserving the living environment to protect the public health of city residents is one of the basic civil services of the municipal government. In that sense, proper disposal of waste that residents generate from their daily activities constitutes a key element of civil service. In developing country cities, however, solid waste management (SWM) by municipal governments are generally inadequate due to their insufficient institutional capacities, coupled with the lack of funds and technologies, low levels of public interest in SWM, and distinct social conditions.

In densely-populated cities, waste generated from daily activities may be left in streets, vacant lots and waterways. This not only spoils urban landscapes but also causes health risks for residents by way of air, soil and water pollution. Open burning emits smoke and dust, which causes air pollution for cities. Incineration with incinerators may emit dioxins and other hazardous substances and pose health hazards, if they are of primitive type and cannot control incineration properly. Dumping large quantities of waste on the ground where the groundwater table is high contaminates soil and groundwater, resulting in poor qualities of drinking water. Organic waste dumped in rivers decomposes and gives off odors, and rivers thus polluted emit methane and other hazardous gases. Accumulation of such waste block river flows, causing floods during the rainy season.

In the early stages, SWM service is aimed at maintaining public health and cleaning up streets. Such service generally takes the form of cleaning streets and collection and removal of waste by manual labor. Only part of the city is served. Such sanitation service plays an important role in reducing unemployment because it requires large manpower.

Collection and recycling of waste are also done by the informal sector. Scrap dealers recover metal, paper and other recyclables in waste, and sell them on local markets. Waste pickers pick up recyclables to gain cash income there. This kind of primitive recycling system has advantages in terms of resource recycling. However, it is quite problematic in that the system is maintained by people who works in adverse social environments and in poverty state. In addition, recycling that disregards public health-reuse of used bottles that are not disinfected, for example-poses health hazards.

In developing country cities, the residents are generally less concerned about air, soil and water pollution due to inappropriate solid waste management as well as health risks it poses. Likewise, control of pollution caused by waste is given low priority by municipal governments. In general, as the economy develops and living standards in cities go up, SWM service improves. Growing interest in health risks of improper waste management prompts the introduction of sanitary

landfill. The areas with access to collection service expand and the collection rates increase. However, cities in countries poorer than middle income countries have slums as well as wealthy districts, and waste collection and recycling constitute an important source of income for slum residents.

In contrast, cities in developed countries such as Japan, Germany and South Korea no longer see solid waste management only in the context of keeping cities tidy and maintaining sanitation and public health. They are beginning to see SWM as part of larger efforts to create a "recycling-oriented society" or "recycling economy." There are moves among developing country cities to learn and introduce such an idea soon. For example, the Chinese government is recently showing great interest in efforts toward a recycling economy.

As described above, municipal solid waste management has many aspects, including keeping streets tidy, maintaining sanitation and public health, making civic life comfortable, and promoting resource recycling. Technical cooperation programs and projects for developing country cities must clarify which aspect will be emphasized as the first step. To do so, it is important to assess the needs of the recipient city that accurately reflect the current state of affairs there.

(2) Type, quantity and composition of waste

In general, the quantity of waste increases as income levels improve. Lifestyles and regional characteristics have a great impact on waste composition.

Municipal solid waste is generated from a range of sources, and its type and properties vary depending on the source. In addition, different counties define, classify and handle waste differently.[2]

In many developing countries, waste is not so clearly classified as in Japan. Instead, residential waste and waste generated from shops, markets, restaurants, offices, etc. are lumped into "municipal solid waste (MSW)." Such MSW corresponds with "general waste" in Japan, but it is not divided into household waste and business waste in many developing countries. That means that waste from shops, markets, restaurants, offices, etc. are processed or disposed of together with residential waste as one. Vegetable garbage and food residues from food markets and restaurants, in particular, emit odors after decomposing. Such garbage turns watercourses into sewage canals if dumped into them. Some developing counties have regulations and systems to control hazardous wastes. However, such wastes from household industry or medium and small factories may be blended with municipal solid waste.

There is a clear correlation between income levels on one hand and waste quantities and composition on the other. The higher the income levels grow, the more the per capita waste generation becomes, and so does the proportions of paper, plastic, glass and metal. A World Bank report[3] describes the quantities and composition of urban municipal solid waste per capita in the world (Table 2-4). The proportion of "others" for low-income countries is large because it includes ashes from coal and charcoal used as fuel. The similar situation was seen in South Korea during the 1980s, but the proportion of ash in residential waste fell sharply due to the spread of city gas. More than 80% of urban MSW excluding "others" in low-income countries is organic matter such as kitchen waste and food residues.

As these examples show, waste quantity and composition are closely related to changing lifestyles. Nonetheless, it should be noted that differences in classification and definition of

[2] In Japan, waste falls roughly into two types: general waste and industrial waste. General waste is subdivided into residential waste and ordinary business waste. Generators of industrial or ordinary business waste must dispose of such waste themselves or pay for the disposal.

[3] World Bank (2000)

Table 2-4 Generation and composition of urban MSW

		Low-income countries	Middle-income countries	High-income countries
Quantity (unit: kg/person/day)		0.64	0.73	1.64
Composition (%)	Organic	41	58	28
	Paper	5	15	36
	Plastic	4	11	9
	Glass	2	2	7
	Metal	1	3	8
	Others	47	11	12

Source : World Bank (1999)

waste among countries preclude direct comparison of these figures.

(3) Increasing waste and the growth of difficult-to-treat waste

As a global trend, waste quantities generated in cities are on a steady rise due to rural-to-urban migration, quantitative expansion of consumption-oriented lifestyles, and qualitative change of consumer goods (e.g. a wider use of plastic and packaging such as PET bottles, glass bottles and cans). Also increasing are wastes that are dangerous and difficult to dispose of, including contents of spray cans and infectious medical wastes. Developed countries now embrace the idea of extended producer responsibility (EPR)-whereby producers assume a certain level of responsibility for their products even after they are disposed of as well as during their production and use stages-as one of the basic principles of solid waste management. These countries are developing laws and systems to put the principle into practice. In developing countries, however, this principle is not yet commonly accepted. To make matters worse, materials collected as wastes in developed countries are sometimes exported to developing countries as used goods.

In fact, the difference between wastes and recyclables is not so clear. Wastes in a country may be recyclable resources in another country. For this reason, wastes are exported as resources in some cases. There are also case that hazardous wastes are mixed and exported illegally to developing countries. The Basel Convention, which came in force in 1992, prohibits transboundary movements of hazardous wastes from developed countries to developing countries.

2-2-2 Economic levels of cities and waste problems

Economic levels of cities are directly linked with finances and service delivery capacities of municipal governments, which in turn has a great impact on SWM.

SWM service of a city depends very much on its overall economic condition, living standards and consumption styles of the residents, and other factors. Among these factors, the economic level is the biggest factor in urban SWM. It influences both the condition of the residents-waste generators-and the service delivery capacity of municipal authorities in charge of waste collection and disposal. Again, as income levels rise, the quantity and type of waste will change, and so will the residents' expectations for the quality of SWM service and their willingness to pay (WTP). Moreover, the financial capacity of a municipality will determine the amount of financing and technologies that can be mobilized for SWM service. As a result, there are general trends as shown below:

(i) Low-income cities

Recyclables in waste are recovered by scrap dealers and others. The primary objective of

Table 2-5 Examples of waste composition in developing country cities covered by JICA development studies

Country/city		Laos	Nicaragua		Tanzania	Philippines	Honduras	Poland		Paraguay	Turkey	
		Vientiane	Granada	Managua	Dar es Salaam	Metro Manila	Tegucigalpa	Lublin		Asuncion	Adana Greater Municipality	Mersin Greater Municipality
Component	Unit							(with ash)	(without ash)			
GDRP[1)]	(US$)	87	265	400G	397	697	1,235	1,395G		1,810N	2960	3,000
Kitchen waste	%	16.9	49.84	34.86	42	45.82	47.2	45.27	65.26	36.6	70.77	75.53
Paper	%	2.8	5.29	5.37	3.1	15.39	11.5	13.67	11.11	6.4	13.8	9.88
Textiles	%	1.6	1.98	1.87	1.2	4.33	2.8	2.1	3.77	1.3	3.43	1.77
Plastic	%	6.1	6.11	3.88	2.2	15.6	7.1	4.4	3.8	3.9	6.42	5.87
Glass and wood	%	38.2	24.9	27.11	25.3	7.45	11.6	1.61	2.3	22.2	1.04	1.62
Leather and rubber	%	1.1	0.29	2	0.9	0.8	2.2	2.67	1.83	0.7	0.17	0.29
Combustibles-Total	%	66.7	88.41	75.09	74.7	89.39	82.4	69.72	88.06	71.1	95.63	94.96
Metal	%	3.7	1.11	1.69	2	5.47	1.9	3.31	3.05	1.3	0.72	0.53
Bottles and glass	%	9.3	1.05	2.91	3.5	2.69	3.5	5.23	6.51	3.1	2.55	3.33
Ceramics and stones	%	(Included in glass)	5.21	8.07	0.4	1.26	12.1	21.74	2.38	2.5	0.96	1.14
Miscellaneous	%	20.3	4.22	12.24	19.4	1.19	0.1	—	—	22	0.14	0.04
Noncombustibles-Total	%	33.3	11.59	24.91	25.3	10.61	17.6	30.28	11.94	28.9	4.37	5.04
Total	%	100	100	100	100	100	100	100	100	100	100	100
Apparent specific gravity (ASG[2)])	kg/l	0.17	0.2	0.2	0.39	0.18	0.2	0.22	0.18	0.22	0.29	0.31

1) No alphabet : GRDP (Gross Regional Domestic Product) cited from the final reports.
G : GDP/capita for the country
N : GNI/capita for the country cited from the World Bank's World Development Indicators (1998 or 2002 which is nearer to when the study was conducted for the city). GNI (Gross National Income), a synonym of GNP (Gross National Product), represents the total value of goods and services produced by the citizens of a particular country over a given period of time.

Source : prepared by OTSUKI Noriko.

Table 2-6 Classification and Sources of Solid Wastes

Source		Classification of solid waste
Residential	Single and multifamily residences	Food wastes, paper/cardboard, plastics, textiles, leather, yard wastes, trees/wood, glass, metals, ashes/cinders, end-of-life products (e.g. consumer electronics, batteries, oil, tires), and hazardous wastes
Industrial/ Mining	Manufacturing, construction sites, power and chemical plants, mines, refineries	Industrial process wastes, scraps, sludge, off-specification products, packaging, food wastes, ashes, hazardous waste etc.
Commercial Activity	Stores, hotels, restaurants, markets, office buildings, etc.	Paper/cardboard, plastics, wood, food wastes, glass, metals, ashes/cinders, end-of-life office equipment (PCs, etc.), hazardous wastes
Public Institutions	Schools, hospitals, prisons, government centers	
Construction	New construction sites, road repair, renovation sites, demolition of buildings	Dirt, sludge, wood, metal, concrete, etc.
Municipal services	Street sweeping, parks, beaches, other recreational areas, drinking water and wastewater treatment plants	Street sweepings; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas; sludge
Agriculture	Fields, orchards, pastures, dairies, feedlots, etc.	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g. pesticides)

Source : ESCAP (2000) "State of the Environment in Asia-Pacific Region," p.170, with revisions made by IMURA Hidefumi.

urban SWM service is to collect other unsanitary wastes and dispose them outside the city. Waste collection is dependent on human power and the area served is limited. Where collection service is unavailable, garbage and sludge that have no economic value are dumped or left on roads and vacant lots and in canals, damaging public health and urban landscapes. More than 90% of SWM costs are personnel expenses for collection.

(ii) Middle-income cities

Waste collection service by municipal authorities covers a wider area than in low-income cities. Trucks are employed for collection. Some cities use batch type incineration facilities and even compost wastes in pilot scale. Although open dumping remains, sanitary landfill is beginning to be employed. The proportion of collection costs in total SWM costs is lower, but remains between 50-80%.

(iii) High-income cities

These cities put more emphasis on waste reduction, separate collection and recycling. Incineration and sanitary landfill are in wider use. For this reason, costs of equipment and machinery, including maintenance costs, account for a large share of the total SWM costs, while collection costs represent less than 50%.

Table 2-7 provides a comparison of SWM practices among groups of cities of different economic levels based on case studies on 12 Asian cities.[4] Economic development in general results in more waste generation and higher disposal costs. As if to offset growing wastes, however, the quality of SWM service delivery by the formal sector tends to be improved as well. In fact, SWM service is improving year by year in cities in middle-income countries that are riding a tide of economic development. At issue are cities that have failed to catch such a wave. These cities can provide only limited service due to inadequate financing, allowing for the informal sector to play a larger role there.

These situations are summarized in Table 2-8.

Photo 2-1 An example of equipment used to produce compost from food residues in a slum.

A compost barrel for food residues installed in a slum in Dhaka, Bangladesh. The compost thus produces is a source of income as it is collected and bought by a NGO.

Table 2-7 Solid Waste Management in Cities (comparison of case studies in 12 Asian cities)

	Group A (low-income)	Group B (middle-income)	Group C (high-income)
City	Dhaka, Katmandu, Ulaanbaatar, Yangon	Cebu, Nonthaburi, Chongqing, Surabaya	Fukuoka, Kitakyushu, Macao
GDP per capita (USD)	Less than 3,000	3000～10000	Over 10,000
Waste generation (kg/person/day)	0.3～0.6	0.7～1.1	1.4～1.5
Collection coverage	Less than 70%	80 to 90%	Approximately 100%
Disposal costs (USD/person/year)	Less than 1	1～3	38～220
% of SWM expenditure in total municipal budget (%)	15.4～38	6～23.2	1.6～5
Recycling	Informal (metal, glass, plastic, composting)	Formal + Informal (metal, glass, plastic, composting)	Formal (metal, glass, plastic, furniture, textiles)
Incineration treatment rate (implementing cities / total cities)	0/5	1/4	3/3

Source : IGES (2002)

[4] ESCAP (2000)

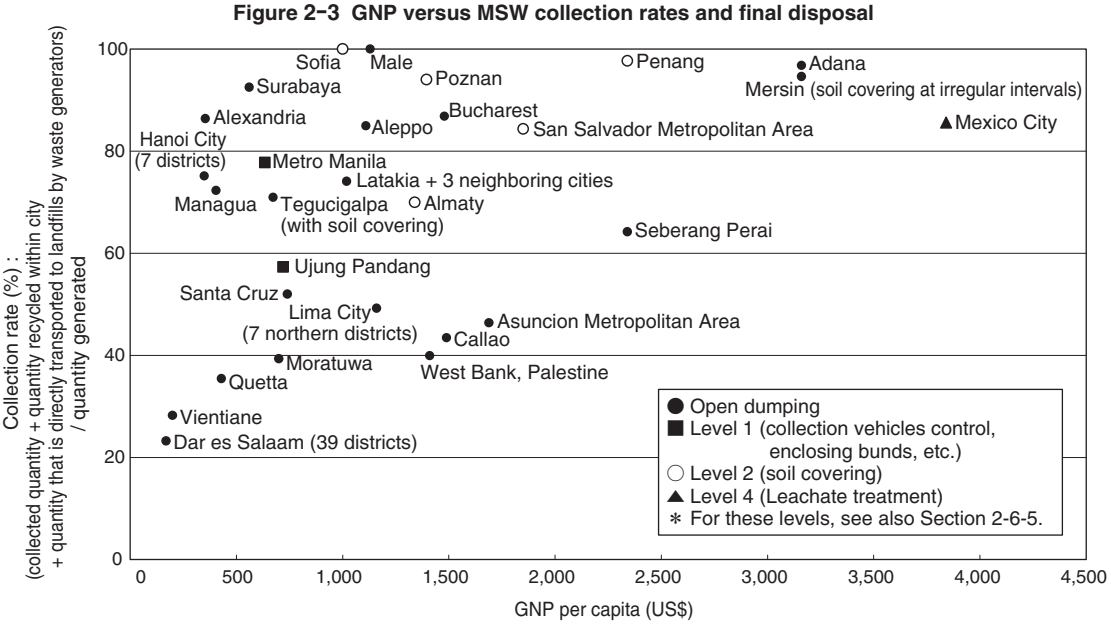
Table 2-8 Economic Development Levels and SWM Systems in Cities

Economic levels of cities / Activity	Low income	Middle income	High income
Source reduction	No organized programs, but reuse and low per capita waste generation rates are common.	Some discussion of source reduction, but rarely incorporated into any organized program.	Education "not to generate waste" gains momentum. Emphasis is placed on is waste reduction, reuse of materials, and recycling.
Collection	Service is limited to high visibility areas, the wealthy, and businesses willing to pay.	Expanded collection areas. Trucks are used for collection.	More thaw 90% of the city has access to regular collection service. Vehicles specially designed for collection are used.
Recycling	Most recycling is through the informal sector (scrap dealers and waste pickers). Localized markets for recycling are common.	While the informal sector is still involved, relatively large machinery is sometimes used for sorting and recycling. Materials are often hauled out of the city as recyclables.	Sorting and recycling with high technology. Recyclable materials are handled on a market economy basis.
Composting	No organized programs. Wastes including organic matter are not put to good use.	Efforts toward composting are made at many parts of the city. Large composting plants are generally unsuccessful. Small-scale composting projects tend to be more successful.	Large-scale composting is possible, but the market for compost is small (competition with chemical fertilizers, decreasing farmland around a big city).
Incineration	Not common or successful because of high capital and operation costs. High percentages of moisture and inorganic matters call for supplement fuel and have a smaller impact on volume reduction.	Incinerators are sometimes used but not common due to economic reasons.	Commonly adopted in cities where landfill sites are not readily available. Pollution control is a must. Cogeneration is also common.
Landfilling	Usually open dumping with virtually no environmental controls.	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common.	Sanitary landfills with strict environmental controls, including impermeable liners, seepage controls, leachate and gas treatment.
Costs	Collection costs represent 80-90% of the SWM budget. Collection fees are regulated by some municipalities, but the quality of collection service is low.	Collection costs represent 50-80% of the SWM budget. Collection and disposal fees are regulated by some municipalities. Innovative arrangements are in place for fee collection.	Collection costs represent less than 50 percent of the SWM budget. Large budget allocations to intermediate treatment, such as incineration, etc. Composting and recycling can reduce costs and increase options available to waste planners.

Source : Compiled by IMURA Hidefumi based on the data from ESCAP (2000) "State of the Environment in Asia-Pacific Region," p.176.

Box 2.1 Association of GNP with MSW collection rates and final disposal

Figure 2-3 GNP versus MSW collection rates and final disposal



Source : Compiled by OTSUKI Noriko based on a compilation of data obtained by member companies of the Japan Waste Management Consultant Association (JWMCA) through a development study by JICA and grant aid projects that they have implemented. The compilation has been made by a JWMCA member, and all the data are those at the time these studies and projects were implemented. GNP per capita is based on statistics of each country for convenience.

Figure 2-3 shows how per capita GNP relates to the collection rates of municipal solid waste (MSW) in the recipient cities. The collection rate here refers to the proportion of the collected quantity-including the quantity of MSW recycled or carried to disposal sites by waste generators themselves-in the generated quantity, not the quantity of MSW discharged. This is because many studies do not distinguish between the two types of quantities and do not provide the discharged quantity.

This figure indicates a correlation between high GNP per capita and high collection rates. However, in cities where GNP per capita is low, the collection rate varies greatly. High collection rates with low GNP per capita or low collection rates with middle-level GNP per capita can be explained by a number of factors. Among them are social structure, the level of participation of civil society in SWM, the forms of waste generation and discharge, and equipment provided by donors, as highlighted by the following cases.

(i) Sofia, Poznan and Bucharest once enjoyed substantial public services thanks to socialist policies. During the periods of the development studies, however, GNP showed no signs of steady growth at best, when the countries were in a transition toward a market economy.

(ii) In Indonesian cities such as Surabaya and Ujung Pandang, primary collection systems operated by CBOs are in place.

(iii) In the Asuncion Metropolitan Area, the waste generation rate is high due mainly to yard trimmings generated from detached houses, which are the norm in the area. Yet collected quantities are small compared with generated quantities because a large part is incinerated by waste generators themselved in their yards and elsewhere.

(iv) Managua had been provided with equipment in grant aid from Japan three years ago, when this data was collected (by the development study).

Figure 2-3 also indicates the conditions of final disposal sites when the development studies were launched using four symbols. There is a positive association between the sanitary level of final disposal sites and per capita GNP; as per capita GNP increases, the level will go up from open dumping to Level 1, Level 2 and further to Level 4.

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2-2-3 Population sizes of cities and waste problems

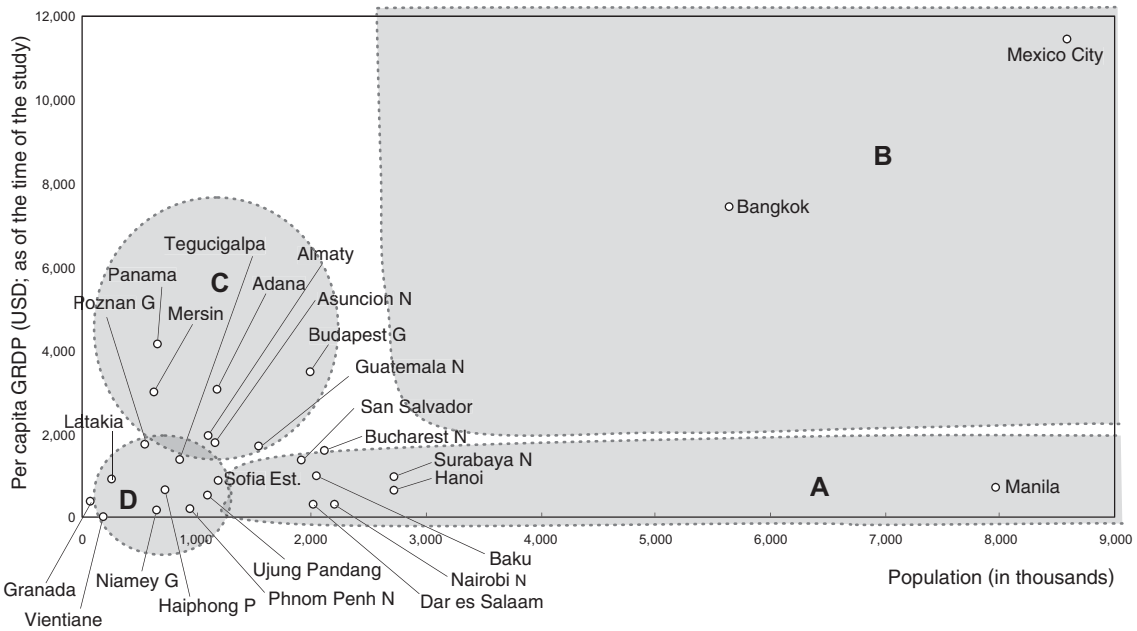
Solid waste problems for a city are significantly influenced by its population size.

In general, a populous, big city has a large-scale budget, and therefore it is more advanced in terms of institutional arrangements with a department specifically assigned to deal with SWM. On the other hand, a low-income city, with a low average income and a wider gap between rich and poor, tends to provide inadequate SWM service; collection service is often limited to rich residential districts, leaving slum areas without access to such service. Figure 2-4 classifies developing country cities into four groups in terms of population and GDP. SWM challenges for each group can be summarized as follows:

A : Large and poor (population one million or more; e.g., Manila, Dhaka)

- Given a large total quantity of waste generated with many generation sources, the expansion of collection service is an important task. In places where job opportunities are limited and cheap labor is readily available, waste pickers are actively involved in SWM and market forces play a certain role in promoting waste reduction and recycling.
- While collection service is expanding, landfill sites are becoming more and more scarce.
- The management capacity of the municipal government should be improved. Focus should be placed on capacity development that entails public participation, partnership and human resources development.
- Communities and NGOs are complementing inadequate SWM service by the public sector.

Figure 2-4 Types of cities by population and GRDP



Source : Compiled by OTSUKI Noriko and KONDO Sei based on a compilation of data obtained by member companies of the Japan Waste Management Consultant Association (JWMCA) through development study by JICA and grant aid projects they implemented. The compilation has been made by a JWMCA member. GRDP per capita is based on statistics of each country.

No alphabet : Population and GRDP (Gross Regional Domestic Product) quoted from the final reports.
G : GDP/capita for the country cited from the report
N : GNI/capita for the country cited from the World Bank's World Development Indicators (1998 or 2002, which is nearer to when the study was conducted for the city). GNI (Gross National Income) is a new terminology that replaces GNP.
Est. : Estimated GRDP based on GDP in the final report

Such community-based solid waste management (CBSWM) is facing a major challenging of expanding services geographically, as public interest and knowledge about waste problems, as well as income levels vary greatly from district to district, and there are areas where many immigrants from surrounding regions live.

B : Large and middle-income (e.g. Bangkok, Mexico City)

- As the economy reaches a certain level, a municipality will acquire technical and financial capacities. In such a municipality, collection service by the public (or private) sector will be improved to a satisfactory level.
- On a negative note, residents will be more environmentally conscious and inclined to NIMBY mind-set as the municipality's economic levels improve. The municipality will face a new challenge of how to build a consensus with residents and establish properly-managed landfills.
- Relatively high economic levels makes it more difficult to implement recycling with spontaneous waste pickers than in a city of Type A. As a result, the per capita quantity of waste landfilled tends to be larger, and so does the quantity of hazardous waste. This calls for the establishment of policies to promote waste reduction, recovery of recyclables, and separate processing of hazardous waste. Then waste education or larger environmental education will have a larger role to play in SWM.
- The proportion of wastes generated from commercial sources (including office buildings) is higher; residential wastes account for less than 50% in both Bangkok and Mexico City, while they represent 75% in Manila, which belongs to Group A. An effective option is to develop and implement a policy that focuses on these large waste generation sources.
- Aid for infrastructure development with loans and investments is effective for improving SWM. Such aid may have positive implications for neighboring countries in terms of the potential for south-south cooperation.
- Political factors stemming from heightened public awareness may significantly influence SWM service. Consensus building and social consideration are more sensitive issues.

C : Small and middle-income (e.g. Goa, Budapest)

- This type is often seen in regional cities in more advanced developing countries and cities in Central and Eastern European counties and island nations. Cities of this type most likely have an essential SWM system in place. There are different needs depending on the conditions in each country. Yet cities of this type generally need to improve their existing systems, such as a shift toward sanitary landfills.

D : Small and low-income (population below one million; e.g. Vientiane, Nuwara Eliya)

- Given low levels of economic development and therefore relative smaller quantities of waste generated, top priority should be placed on proper collection and proper disposal in landfills. As cities of this type tend to be short of funds, financial assistance is likely to improve the situation remarkably. Attention should be paid, however, to how to finance operating costs after such assistance.
- Municipal government should make efficient use of resources available and develop its capacity to achieve operational efficiency with the help of residents.
- There is potential for CBSWM where traditional communities are still functioning properly. As far as recycling is concerned, however, the market has often been established by waste pickers and junk dealers. Therefore, goals for CBSWM should be carefully established.

The above classification is highly conceptual. Proper understanding of issues facing each city or district requires consideration of a range of factors, including social conditions, cultural characteristics, functions of communities, waste composition and the waste flow. In many

cities that are expanding in both population and area, collection service is less likely to be extended to urban fringes, that is, low-income areas or squatter areas.

2-2-4 Other conditions that affect solid waste problems

National and climatic conditions and lifestyles peculiar to a given city have significant effects on waste composition and applicable disposal forms. These conditions should be considered when exploring means for appropriate solid waste management.

(1) Natural and climatic conditions

Natural and climatic conditions limit the options available for SWM. For example, landfills in areas with high precipitation need to pay special attention to rainwater drainage and on-site road access. Cities with steep topography may need to mobilize more resources for equipment maintenance because transportation vehicles and heavy machinery for soil covering at landfills are more prone to breakdown because of severe topographic conditions [5]. Low-altitude islands of Pacific island countries have no choice but to adopt coastal landfills and such landfills should be designed to prevent discharge into the sea caused by typhoons. In low and swampy areas, the traditional concept of sanitary landfill may not be an appropriate technology because earth and sand, which are used as cover soil at landfills, may be short supply. This is because they are also used as banking materials and considered to have high economic values [6].

(2) Lifestyles

Lifestyles also affect waste characteristics. In areas where coal is used for heating in winter (e.g. Ulan Bator, Mongolia), ash accounts for a large proportion of residential waste. In Seoul and other cities in South Korea, a large part of residential waste was charcoal ash up to the 1980s. Waste in South Korea has a high moisture content because Koreans eat a lot of kimchi (Korean pickle) and soup dishes and kitchen waste in the country includes these foods. Cities where high-density multi-family residents dominate produce relatively small quantities of yard trimmings. In contrast, cities where a detached house with a yard is the norm generate smaller quantities of kitchen wastes because they are often buried in yards or otherwise disposed of by waste generators themselves. Lifestyles that take mass production and mass consumption for granted are associated with increased quantities of packaging wastes (paper, plastic, PET, etc.).

2-2-5 Association with other sectors (drainage, excreta, sewage, public health)

Whether a municipal drainage system function properly significantly depends on the state of SWM. This is because uncollected wastes often find their ways into drainage canals and block drain. In fact, areas along drainage canales and rivers are often squatted by landless persons, they tend to dump wastes into these drains and watercourses. SWM is necessary from the viewpoint of the public health sector; collection points and landfills for wastes (especially garbage) may attract flies and mosquitoes, which in turn may carry infectious diseases.

In addition to SWM, urban public health may be affected by another major issue-treatment of human excreta and wastewater (domestic wastewater, sewage). Sludge generated from the treatment of excreta and wastewater may be handled as waste. This issue should be also taken into consideration as it is linked to the issues of composting and other forms of recycling of organic materials in SWM.

Particularly from the public health aspect, management of human excreta and sewerage development should be integrated with SWM, yet such integration have rarely been practiced.

[5] Kitawaki (2000a)
[6] Kitawaki (2000b)

Wastes are sometimes landfilled in upstream areas from where water is drawn for tap water. Much attention must be paid to the locations of landfills in relation to those of drinking water sources.

These subsectors are often under the jurisdiction of different departments. This fact should be paid attention to consider sector-wide approaches.

2-3 Organizational and institutional capacities of municipal authorities

2-3-1 Institutions

(1) The concept of rules and the roles of legislation

In general, the concept of institutions refers to not only laws and government institutions but also various arrangements and human relationships that drive society. For this reason, the World Bank and other donors have recently come to divide institutions into formal and informal rules. In other words, they see institutions as sets of these two types of rules and take notice of the role of the latter type [7].

Formal rules can be expressed as what are stipulated in documents, such as laws and government institutions. Informal rules, on the other hand, refer to social customs and norms, tradition, values and human relations that have been developed based on the culture, religions and history of a nation or region [8].

Informal rules play a major role in determining how formal rules function in a country or city. Seemingly similar laws and organizations take quite different forms of practices and have different implications depending on the country or city. In other words, how the laws and organization in the country or city function and achieve their purposes are largely determined by its informal rules.

One of the notions that summarize informal rules is social capital and such capital is the work of non-economic factors that determine the networking, communications and interaction among people, and these factors are meaningless without the context of social relationship.

It goes without saying that both formal and informal aspects should be addressed in providing assistance in solid waste management.

Different countries have different laws and government institutions regarding solid waste. In addition, institutions are subject to change according to the characteristics of waste problems. For example, SWM service in Japan was once based almost solely on the Waste Management and Public Cleansing Law. However, the basic principle of SWM service was then changed significantly, and a number of new laws were introduced, including the Containers and Packaging Recycling Law and the Basic Law for Establishing a Recycling-based Society. Despite this change, the basic nature of waste has not changed; waste is generated from daily activities. It is therefore natural that SWM is implemented by municipalities. Municipalities are responsible for collection, treatment and disposal of waste while the central government establishes an institutional framework. As a result, the scope of SWM service varies significantly from city to city within a country, depending on the financial capacity of cities. This is especially true of cities in developing countries.

The level of SWM service, not to mention any other public service, is highly dependent on how far institutionalization under the law is implemented. The term institutionalization under the law here refers to the development of formal rules written in laws and regulations. Institutionalization involves such aspects as: (i) development of relevant legislation; (ii) development of competent government institutions; (iii) financing; and (iv) capacity development and securing of human resources necessary for institutionalization.

Table 2-9 compares the progress in legislative development for SWM among selected Asian countries [9]. According to the table, most of

[7] World Bank (1999)
[8] *ibid*, World Bank (2001)

these countries have already SWM legislation. However, institutionalization by law or ordinance does not suffice, as SWM is primarily implemented by municipalities. The point is whether such legislation has been translated into effective rules and thus properly implemented.

Clear definition of wastes by law is a prerequisite for the development of a SWM system.

The type of waste determines risks involved, management methods and treatment technologies [10]. For this reason, it is essential for each country to clearly define wastes and then set out responsibilities and standards for waste

Table 2-9 SWM legislation in selected Asian countries

	Specific legislation	Remarks
Japan	Waste Management and Public Cleansing Law (1970)	Separate legislation for recycling
China	Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste (1995)	
Mongolia	Law on household and industrial waste	The "environmentally-friendly waste management program" was endorsed by the Cabinet
Malaysia	Environment Quality (Scheduled Wastes) Regulations (1989) based on the Environment Quality Act (1974)	No legislation for non-hazardous wastes (as of 2003), but some cities have Refuse Collection, Removal and Disposal By-Laws based on the Local Government Act of 1976.
Thailand	The Public Health Act (1992) and the National Environment Quality Control and Enhancement Act (1992) cover SWM but they have no specific provisions.	Wastes generated from industrial plants are virtually controlled by the Factory Act of 1992 (or the Industrial Estate Authority of Thailand Act of 1979 for those within industrial estates).
Indonesia	PP No. 85/1999 concerning the Amendment of the PP No. 18/1999 (only for hazardous wastes)	No legislation for municipal waste (as of 2003)
Philippines	Solid waste: Ecological Solid waste Management Act of 2000 (RA9003) Hazardous wastes: Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990 (RA6969)	
Viet Nam	Law on Environmental Protection (1993) Government Directive No.199/TTg (1997) [Prime Minister's Decision on Urgent Measures to Manage Solid Wastes in Urban and Industrial Districts] Government Directive No.155/1999/QD-TTg (1999) [Regulation on Hazardous Waste Management]	
Cambodia	Sub-Decree on Solid Waste Management based on the Law on Environmental Protection and Natural Resources Management (1997)	
Myanmar	No legislation (as of 2001)	
Sri Lanka	National Environmental Act No.47 (1980) Extraordinary of the Municipal Council Ordinance (1987) as a standard municipal ordinance.	
Nepal	Solid Waste (Management and Resource Mobilization) Act (1986) Local Self-Governance Act (1999)	Solid Waste Management National Policy (1997). Acts and policies concerned have become largely irrelevant after much of the authority over SWM was delegated to local governments under the Local Self-Governance Act (1999).
Bangladesh	No legislation (as of 2003)	Provisions on waste management in the Dhaka City Corporation Ordinance.

Source : Compiled by WATANABE Taisuke from JICA reports.

[9] ESCAP (2000)
[10] See Section 2-5 for details.

management according to the types of waste in order to control environmental pollution and take rational measures.

Developing countries where SWM is at nascent stages generally lack statutory or institutional definition of wastes. For this reason, they often combine different types of waste in the waste stream, which consists of collection, transportation, treatment and disposal. In some of the countries where the central government has not enacted SWM-related laws, municipalities have established relevant ordinances.

It is impossible to develop an appropriate SWM system without clear statutory definition or classification of waste. A lack of such definition may invite improper disposal or treatment and then result in environmental pollution. Consequently, assistance in SWM presumes laws and institutions for SWM, including clear definitions and classification of wastes. Or it should be aimed at establishing such laws and institutions (with capacity development support in this sector).

Formal rules cannot be implemented effectively without statutory definitions of the scope of SWM service and the competent departments. The next step is to see if each department is provided with adequate budget allocations and human resources in relation to its services. Bureaucratic sectionalism and lack of coordination among government offices are common problems for all the countries in the world to different degrees. Yet this problem is often a major challenge for developing countries in terms of aid effectiveness. For example, equipment that has been provided for use by the entire implementing agency is sometimes used by a single department only.

(2) Informal rules: roles of social capital

Unwritten rules play an important role in some recipients. Lack of this understanding will be a major obstacle in achieving aid effectiveness.

Even in cities where waste collection service by municipalities has not been fully institutionalized, some kind of collection system is in place. If municipal authorities cannot mobilize enough financial resources to deliver collection, transportation and treatment services, the practical option may be to allow for a certain level of involvement of the informal sector, including waste pickers. Such involvement will be made possible by social capital of a given city, such as human networks, relationships of trust, and social norms.

Such informal rules, however, are difficult for external donors to assess. Imprudent intervention by such donors may even trigger a friction or conflict with local communities. Involvement or assistance in solving problems in a specific city by external donors has both benefits and limitations. The key is accurate assessment of the situation of the city. Suggestions beyond the practical capacity for aid implementation are irrelevant.

SWM has many factors other than technology. Waste reduction at source and separate collection are important elements of SWM, and they require community involvement. Developing a network for communicating information and knowledge with the help of CBOs is a key to wider implications of aid. At issue here is whether a community as a whole can take collaborated action. Collaborated action may be impeded by heterogeneity in the community, including a gap between rich and poor, religious differences, and a caste system [11].

In fact, such negative social capital is a major obstacle to the economic development of developing countries. Removing that obstacle is

[11] These factors that have negative effects on development may be also regarded as part of social capital. See JICA (2002).

no easy task. What is also needed is to establish dialogue relations and partnership between local authorities and the residents. In this context, NGOs are expected to play a positive role as they are familiar with local problems and issues. In fact, NGOs can serve as mediators among different stakeholders. Support for the activities of such NGOs is also a task of development aid.

(3) Need for national policies and plans

National policies and plans for SWM are prerequisites for appropriate planning of municipal SWM for each city. Without master planning at the national level, there may be a lack of consistency in SWM among different cities. It is also necessary to consider involving stakeholders in the policymaking and planning processes. Affairs regarding treaties and other international frameworks, as well as comprehensive statutory and institutional responses (laws, ordinances, etc.) to SWM, fall under the responsibility of the central government. Support at this level includes, in the context of JICA assistance, recommendations through development studies and the dispatch of experts who also serve as policy advisors. As assistance at this level concern national policy, there are many constraints also. Yet if such assistance is implemented successfully, its impact will be great.

2-3-2 Organizations and management

The central and local governments have a major issue of how to maintain their organizational capacities.

(1) Central government organizations

The central government is tasked with the development of legislation and overall policy at the national level, while municipalities provide SWM service. Only a few developing countries have a department specializing in SWM in a central government office [12]. In many developing countries, SWM is administered by a limited

Box 2.2 M/P reflected in national planning

–Training Course: Landfill Technology for Solid Waste Management in Malaysia–

In its Master Plan Study for Hazardous Waste Management in Romania (development study; between February 2002 through August 2003), JICA supported the formulation of M/P and A/P in the hazardous waste management sector, where a policy response was urgently needed. Romania needed to develop a SWM system that is in harmony with EU standards toward joining the EU. To that end, the country had to formulate a national plan for SWM. With this background, this master plan study was designed to develop a M/P that is consistent with national planning so that the M/P would eventually be reflected in a national plan for hazardous waste management.

In a typical development study by JICA, a proposed M/P is submitted toward the completion of the study. In this particular study, however, JICA spent a period of almost six months during the latter half of the study to help Romania to incorporate the proposed M/P into national planning, in line with pilot projects. The objective was to allow the country to make the M/P and A/P its own. This process most likely played an important role in developing the ownership of the implementing agencies in relation to the application of the M/P and A/P. Nevertheless, the M/P and A/P were integrated into the national plan and strategy for SWM and formally approved by the Romanian government in September 2004.

KONDO Sei

* The content of this box has been prepared with reference also made to the findings of the interview survey that was conducted by SAKAGUCHI Kiichiro (EX CORPORATION) when he visited Romania again in April 2004. Mr. Sakaguchi was the leader of the development study mission team to the country.

[12] Such government offices include the ministry of the environment and the ministry of public health. Industrial and hazardous wastes are sometimes under the jurisdiction of an industrial ministry or agency. In such a case, clear distinction of roles should be made among different government offices.

number of staff members, who often works for other sectors.

The central government sets rules based on laws and regulations under laws. By laws and regulations, procedures or performance standards are set, such as approval of the construction of landfill sites and other facilities and the operation of private businesses, as well as setting technical standards for such facilities. Central government also guides municipalities though financing (e.g. subsidies). Funds from the central government have a great impact particularly on municipalities that lack capital investment for the construction of new landfills.

Developing countries have a greater risk that frequent transfers and job hunting of staff members may prevent organizations from accumulating intellectual expertise.

(2) Municipal organizations

Different cities (and countries) have different government institutions for SWM. At any rate, they generally have some department in charge of SWM, as waste collection is one of the fundamental public services provided by municipalities. In some municipalities, collection, landfill and equipment maintenance are taken care of by different departments. In this case, integrated management or even coordination among different types of operation is difficult. In addition, it is necessary to define in writing the often blurred definition of responsibility of each department. Clear distinction on role is also needed for stakeholders outside municipal organizations, including communities, private organizations and contractors. Supervision is also needed for contractors and privatized organizations if any.

As waste collection and street sweeping are labor-intensive, municipalities employ many workers for these operations. Better SWM service with quality improvements through operational streamlining and on-time collection requires training and strict supervision of workers, which is often difficult.

There are a number of reasons for such difficulty. First, the sheer number of workers makes it difficult to supervise all of them properly. Second, because their opportunities for promotion or job change are limited, they lack incentives for operational improvement. This is discussed in detail in Section 2-4-1. Third, collection of recyclables, a factor for reduced operational efficiency, is a valuable income source.

These difficulties associated with labor management provides an incentive for municipalities to contract out some of SWM services to private businesses. Yet it is extremely difficult to fire many workers because unilateral dismissal invite strong opposition from them.

Organizations or institutions in form do not necessarily mean that they function in substance. Institutionalization must involve not only the establishment of institutions but also a built-in mechanism to operate and maintain them effectively. Specific requirements include: regular examination and assessment of potentials for better service; development of expertise in SWM systems; preparation of statistical data and manuals; mobilization of necessary resources, including funds, capital and equipment; and capacity development for each of the staff at organizations through long-term training. It is important to establish a framework that facilitates endogenous promotion of management capacities to make appropriate use of human, physical, and intellectual assets of organizations.

There is also a need for a mechanism for evaluating the performance of public service delivery, identifying items that need improvement, and putting the continuous improvement process in place. The development and operation of such a mechanism is easier said than done. It starts with the preparation of necessary documentation. The next step is to strengthen organizational management with the introduction of performance standards as well as

internal and external auditing systems. This will facilitate the gradual process for improvement.

(3) Regional waste management

It is often the case that a municipality cannot find appropriate location for a waste treatment or disposal facility and instead find one in other municipality. Taking advantage of such opportunities, municipalities sometimes join forces to construct, operate and maintain waste treatment or disposal facilities. This approach can achieve economies of scale in relation to the treatment and disposal of collected wastes. Operational efficiency is often increased under an arrangement whereby waste collection is implemented by each community and treatment and disposal jointly by neighboring municipalities. A major prerequisite for such an arrangement is coordination among the municipalities, which may not be possible without articulating its advantages and disadvantages based on appropriate planning.

An intermunicipal arrangement can take the form of an agreement, a SWM association or even an integrated authority. In some countries, the procedures for establishing intermunicipal associations are provided for in local government laws. Many capital cities have some kind of confederation of municipalities that forms a metropolitan area.

(4) Human resources

Human resources of the SWM department of a municipal authority fall into two categories: administrative officials who develop and implement the operational framework; and sanitation workers who actually provide SWM services on the ground.

Administrative officials in developing countries tend to lack special expertise in SWM due in part to frequent personnel shuffling and staff's tendency to quit jobs, making the administrative management capacity for SWM often vulnerable[13]. A major challenge is how to render personal capacities into organizational capacities in a sustainable manner and further develop a mechanism for endogenous and sustained processes for organizational improvement as discussed above. Another major challenge is how to motivate staff, who tend to lose their drive because their jobs are often despised.

A problem with sanitation workers is that their operations, such as collection and transport of wastes, tend to be regarded as unskilled labor. Many low-income countries do not now have automobiles for collection; they use push carts (or pulling carts) instead[14]. They may be unskilled workers, but they should be trained so that they collect all the eligible waste in the collection area and that they work safely on the busy streets.

Thus, such training should be supported by documentation to explain the reason and the process of the operation, training and monitoring of the operation. Training will not be successful unless waste management authorities understand the need for it.

Financial vulnerability by low priority of SWM in municipalities and a large proportion of labor costs in the SWM budget are two of the major characteristics common to developing countries.

2-3-3 Finance

Municipal SWM service is usually financed in the general-account budget of a municipality, unless the municipality has a waste management public corporation with an independent budget. In municipalities that collect service fees, such fees go to either the general budget or the budget of the SWM department. The bottom line for designing any public service is the assessment of the levels

[13] A Laotian counterpart in a JICA project stayed in the same office for more than ten years, and this seems to have had a favorable impact on the implementation of the recommendations in the M/P study (see section 3-2 for details). Such an arrangement may have a downside; it may promote a top-down approach and hinder information sharing within the organization.

[14] See Section 2-6-2.

of service and costs. The details of SWM service in a municipality and its cost-effectiveness should be accurately analyzed in the context of development aid and technical cooperation as well. Municipalities without data on itemized costs should focus on the preparation of such data.

Costs of waste collection, treatment and disposal are much dependent on the levels of waste collection service and treatment and disposal technologies. In low-income cities, which do not afford advanced technologies for treatment and disposal, labor costs for collection and transport services account for a large share of the SWM budget[15]. Only rich cities can afford facilities for appropriate intermediate treatment and final disposal because a vast amount of money is required for their operation and maintenance as well as their construction. Since it is unfeasible to cover these costs with fee collection from residents, they should be financed by allocations of the general-account budget of a municipality. Hence the level of SWM service depends on the financial capacity of a municipality to a large extent.

Although SWM requires a certain level of funds regardless of the financial condition of a municipality, it tends to be given low priority in budget allocation. Budget allocations to SWM may greatly change due to political factors. These circumstances point to the need for reinforcing the vulnerable financial base and securing revenue sources.

Financial management is also an important issue because SWM costs account for a large share-usually 20-50%[16]-of municipal fiscal spending in developing countries. More appropriate financial management requires four essential elements: (i) improving cost recovery; (ii) strengthening accounting control (costs, budget) and strict information management concerning service delivery; (iii) increasing access to investment financing; and (iv) reducing costs. The following paragraphs outline these elements.

(1) Cost recovery

Some people argue that residents should be charged user fees for waste collection and disposal services. It is not easy, however, to charge such fees in developing countries due to such factors as a large poor population, rampant fee evasions, and a large cost of fee collection for a municipality[17].

Collecting fees according to the amount of waste generated is no easy task. A more practical and effective approach is to require waste generators to set out waste in fee-charging garbage bags for collection-an approach has been introduced by many municipalities in Japan. This approach is adopted in South Korea on a national

Table 2-10 Options to improve cost recovery

Mechanisms	Can adequate revenues be generated?	Can the revenues be easily collected?	Does the polluter pay more?	It the mechanism politically feasible?	Is the mechanism easily enforceable?
User charges:					
Solid waste tax	+	−	+/−	−	−
Volumetric charges	+	−	+	−	−
Tipping fees	+	+	+	−	+/−
Other sources:					
Property taxes	−	+	−	−	−
Business license fees	+	+	−	−	+
Utility surcharges	+	+	+/−	−	+
Grants	+	+	−	−	−

Source : Bartone (2000a)

[15] In municipalities where vehicles are used for collection and transportation, fuel costs also represent a large part and are therefore a burden on municipal finances. This is also true about heavy machinery at landfills. Such machinery is sometimes out of operation due to a lack of budget allocations for its fuel (see the case of Laos in Section 3-2).

[16] Cointreau-Levine (1994) .p7.

[17] To overcome such difficulties, some municipalities collect sanitation or waste collection fees together with utility charges as pay-for-use rates. The idea is to cut costs associated with door-to-door collection and to charge users in part according to their living standards.

scale and in Nonthaburi, Thailand (a city near Bangkok) on a trial basis. Income from the sale of such garbage bags can be used for various purposes, including covering part of labor cost for waste collection. Because it is difficult to recover total SWM costs with this approach, this income should be used to create a recycling market or other good purposes.

Options to improve cost recovery are summarized in Table 2-10.

(2) Strengthening the financial management system

To stabilize SWM finance, it is necessary to solidify the basis for its management. To that end, the following items should be reinforced:

(i) Accounting for costs and expenditures: itemized costs (operation and maintenance [collection, transportation, landfill, road sweeping], fee collection, debt payment and depreciation)
(ii) Clarification of budget and income
(iii) Computer-assisted management

The most important requirement for analyzing the current state and problems with SWM service is cost analysis. Cost analysis is based on the calculation of basic data for each type of operations, including waste collection, disposal and road sweeping, namely the quantity handled and manpower and costs for each type of equipment (labor cost, capital cost, operation and maintenance cost, depreciation and amortization cost). Cost analysis allows for efficient review of the allocation of the SWM budget. It also provides a means of quantitative assessment when reviewing the allocation of the municipal budget as a whole.

Table 2-11 Typical SWM costs in Latin America and Asia

Service	Cost
Collection	15—45 US$/ton
Road sweeping	10—20 US$/ton
Transportation	5—15 US$/ton
Disposal	3—10 US$/ton

Source : Bartone (2000a)

[18] Bartone (2000a)
[19] Cointreau-Levine, et al. (2000), Part I.

(3) Increasing access to investment financing

It is important to increase access to investment financing because in addition to current expenses, a lot of money is needed for new landfill sites and other purposes. The following are specific options to do so [18]:

- Reinforcing the creditworthiness of municipalities
- Establishing special loans for municipalities
- Promoting private-sector investment
- Considering matching grants to cope with externalities

(4) Reducing costs

The following are some of the cost-cutting options:

- Reducing surplus workforce

Municipalities tend to secure workforce more than necessary as part of job security arrangements. Reviewing routes for waste collection and road sweeping may also make it possible to streamlining workforce.

- Use of private contactors

It is a common practice to contract out some services to the private sector for efficiency and cost reduction (see the next section).

2-3-4 Partnership with the private sector

Public-private partnership (PPP) is being promoted in the SWM sector as well either as an option to complement public services or for efficient service delivery. Advantages of PPP include [19]:

- The private sector can provide a more efficient or cost-effective service because it is under the pressure of market forces to achieve profitability and pay greater attention to customer satisfaction.
- The private sector often has better access to capital financing.
- The private sector may have easier access to specialist skills and expertise. For example,

companies can form joint ventures with international specialist firms.

- The private sector is leading the development of waste management technologies in the waste industry. The involvement of private sector may provide access to state-of-the-art technical services[20].

Some people believe that the private sector is always cheaper, more efficient, and more reliable. Others believe that the private sector does not care for the environment and will cause serious pollution. These beliefs are all common misconception concerning private sector participation[21].

(1) Considerations for private sector participation

Proper contracts and management by the public sector, and a competitive environment are keys to the success of PPP after its introduction.

Considerations for public sector participation are summarized below[22,23]:

(i) Maintain a balance between the private sector and government

It is important to create an competitive environment. This can be achieved if government retains part (at least 30% at the beginning) of the overall collection service area and continues to provide the solid waste collection service in this part until private sector participation is well established. It is not advisable to commission the entire collection area to the private sector from the beginning. In addition, private sector participation should be phased in at the same pace as the increase in demand for SWM service and the decrease in the number of sanitation workers through attrition. Hasty introduction of private service may invite opposition from such workers.

(ii) Labor redundancy

One of the most pressing concerns when privatizing is how to minimize the termination of employees. Freezing the hiring of new staff to allow for natural attrition is one of the options to minimize the negative social impact.

Box 2.3 Where does the waste go?: waste business in Manila

Solid waste management in Metro Manila continues to be in a critical situation; new landfill sites are scarce and existing landfills are almost full (see Section 3-1). In a desperate effort to alleviate the situation, local authorities recently presented a proposal to haul solid waste by train and dispose of it at landfills more than 100 kilometers away on a regular basis. Under these circumstances, how is the waste generated every day disposed of?

Private waste collection business is thriving in Metro Manila. Private service providers collect waste for a fee under contract to condominiums and residential areas in the metropolitan area. It is said that the private sector collect almost 60% of waste generated in Metro Manila.

Such private businesses should be given approval for final disposal and supervised properly by a competent local authority (Solid Waste Management Office of the Metro Manila Development Authority in this particular case). Yet the authority does not seem to keep track of these businesses, and it is unclear where the collected waste has gone. They likely dispose of the waste in their private land in the suburbs without proper management or monitoring. Some people even talk about "waste mafia."

In Japan too, illegal dumping of industrial waste by private businesses have come to the surface for some time. Examples in the Philippines and Japan suggest that private sector participation could undermine the ban on illegal dumping without proper licensing, supervise and monitoring by government.

YOSHIDA Mitsuo

[20] The keynote address at the ISWA Annual Congress 2000 in Paris.
[21] Cointreau-Levine, et al. (2000), Part I, pp.5-6.
[22] *ibid*, Part II, pp.23-36.
[23] Institute for International Cooperation, JICA (1993)

(iii) Appropriate duration of agreement

Efforts should be made to minimize investment risks in order to promote capital investment by the private sector. Agreement durations should cover the standard depreciation period. For example, contracts or franchises that involve investment in vehicles should have a minimum length of five years. Shorter periods bring about unfavorable results for both contactors and public authorities (e.g. higher prices or lower quality of service because contractors or franchisees are forced to depreciate their investments over shorter period).

(iv) Willingness to pay

Collection of user charges enables the service to be financially sustainable. House-to-house surveys can indicate which methods of waste collection are preferred and the sensitivity of generators to the level of the charge that they will be asked to pay. Surveys also provide contextual information on their ability to pay for service. On the other hand, until people actually receive a service, they are not able to predict accurately how much they would be willing to pay for it. For this reason, willingness-to-pay surveys need to be conducted both prior to, and after, the start of the waste collection service.

(v) Economies of scale

Pilot testing and time-and-motion study can determine collection efficiency, which depends on: the number of workers assigned to the equipment; the types of containers; the locations of collection points; and the road and traffic conditions. In the case of transfer systems, the capacity of the transfer vehicles, the distance to the disposal facility, and the sizes of the collection areas are major determinants of collection efficiency. Economies of scale for landfill mainly come from landfill capacity. For this reason, bundling the needs of several small to medium-sized cities into one regional facility needs to be considered as appropriate.

(vi) Contract documents[24]

Specifications and requirements should be carefully specified in private sector participation agreements so as to monitor and supervise the performance of private service providers (and penalize them if necessary). To that end, contractual documents should specify the service quantitativeness such as collection frequency and the amount of waste to be collected. This makes it necessary to public authorities to continue providing service in part of the collection service area to keep track of operating costs.

(vii) Performance monitoring

The aspects of performance to be monitored include the frequency, quantity, efficiency, productivity, reliability, quality and cost of service. Comparative performance monitoring of all private sector and government players increases competition among service providers.

(viii) Guarantee against political risk

Risk of political intervention-including intervention in the selection of contractors and interference in actual operations-is a major obstacle to effective private sector participation. The best way to minimize the risk of political intervention is to improve the transparency and accountability of the procurement process, and making procurements truly competitive.

(ix) Licensing

For collection of special wastes (such as from hospitals and laboratories) or general wastes from large generators, private firms may be allowed to compete freely in getting subscribers to their service. However, a program to license only reliable firms is essential to block the entry of unscrupulous companies that cut costs by illegal dumping and other unacceptable practices. As part of a licensing program, legislation is necessary to grant licenses only to reliable firms. A special category of license for hazardous wastes should be required.

(2) Capacity required of municipalities to supervise private sector

The introduction of private sector participation usually requires municipal

[24] See Cointreau-Levine, et al. (2000), Part V. for specific contractual clauses and sample contracts.

strengthening, because of the new tasks which municipal managers are required to perform, including appropriate contracting-out and performance supervise and monitoring. The following paragraphs list issues that generally need to be addressed in capacity development for municipalities and in preparation for the participation of the private sector:

(i) At the municipal level

- Strengthening of municipal capacity to analyze existing costs and the estimated costs of privatization activities which could increase investment and improve efficiency
- Establishment of new municipal ordinances to achieve such objectives as cooperation with resident, implementation of the user pays principle, appropriate discharge of waste, and waste reduction
- Strengthening of capacity to specify technical requirements and performance standards and operations monitoring indices
- Strengthening of capacity to prepare the documents for contractual and licensing agreements, evaluate bidders and negotiate the terms of agreement
- Improving the flexibility and efficiency of the municipal workforce
- Development of cost recovery mechanisms
- Development of competence in supervision and performance monitoring
- Development of mechanisms to enforce sanctions for poor performance and illegal conduct

(ii) At the central government level

- Development of policy guidance on private sector participation and cost recovery, to enable municipal leaders to take necessary political steps
- Development of legal deterrents against illegal dumping of wastes and the use of open dumps, coupled with adequate capacity for enforcement
- Development of guidance and standards for segregation, storage, treatment, and disposal of each categories of wastes

(3) Involvement of micro and small enterprises (MSE)

A micro and small enterprise (MSE) can take the form of a small private enterprise, co-operative, community-based enterprise, or labor contract by a group or social organization. MSEs cannot provide large-scales services or take advantage of economies of scale. Despite these disadvantages, MSEs have the following advantages in terms of the waste management business aspects[25]:

- MSEs can provide services at a low cost due to such factors as low capital cost with the use of handcarts, etc. and lower wages of MSE workers compared with workers hired by municipal counterparts.
- Because of their small size, MSEs can better cope with different types of housing and access roads.
- Since MSEs are usually based in the neighborhood they serve, they favor community participation and control. They also can play a role in recycling promotion and other public environmental education.
- MSEs are labor-intensive and thus can create more employment than large enterprises.
- The involvement of a number of MSEs creates environment of competition among them.

(4) Considerations for the participation of international waste industry

In the context of private sector participation, businesses in the waste industry abroad (from developed countries such as the U.S. and Germany) can often participate in SWM in developing countries. Such participation takes the form of investment, BOT or direct participation. In recent years, some developing countries take advantage of CDM of the Kyoto Mechanism to lure the waste industry in developed countries to projects designed to collect landfill methane gas or even generate power using such gas. In fact, UNDP is proactively encouraging developing countries (e.g. Bangladesh, India, Indonesia and

[25] Haan, et al. (1998), pp.11-16.

Latvia) to use CDM in order to attract finances from developed countries for improving their landfills. Regarding projects for methane gas collection and power generation, there is concern about the safety and environmental impact of colleted gas or suspension of collection for some reason.

There are some concerns about direct participation of the private sector overseas associated with their special emphasis on profitability of SWM service (setting charges for collection, treatment and disposal). For example, the private sector may provide services only to the wealthy who can afford such charges. In addition, agreements for such private sector participation tend to be monopolistic in nature to secure profitability and their period is often more than ten years. Such agreements may provide a quick fix to the immediate problems and generate income for developing countries from licensing fees. However, they may limit future options for SWM policy (as highlighted by the case of Phnom Penh[26]). To prevent such a situation, municipalities in developing countries should improve their capacity regarding contract negotiations.

Municipalities must have the capacity to supervise and control the activities of the private businesses under contract. However, many developing countries do not have enough experience or expertise in proper SWM to carry out such supervision and control regarding the performance of obligations stipulated in such agreements. Private sector participation under these circumstances has the risk that public service delivery will be at the mercy of private sector entities. In fact, SWM service in Biratnagar, Nepal was thrown into disarray after a U.S.-based company, which had been providing service under contract to the city, withdrew from the business for cost-effective reasons[27]. If the municipal government had had the capacity for supervision and control, it could have known the withdrawal beforehand and the confusion could have been averted at least.

2-4 Social factors[28]

2-4-1 Historical and sociocultural background of sanitation service and sweepers

It is necessary to consider what assistance can be provided to reduce social prejudice and discrimination.

(1) decomposition of garbage under subtropical or tropical climate

Many developing countries are in the tropical or subtropical regions. Southeast Asia and South Asia, in particular, are characterized by a high temperature and humid climate. In addition, kitchen waste and other organic matter account for much of municipal solid waste (MSW) in developing countries, as discussed in Section 2-1-1. Due to these factors, organic matters (especially kitchen waste) decompose extremely fast. These wastes, if left for a few

[26] Phnom Penh Municipality concluded a 47-year concession agreement with a Canadian-affiliated company Cintri in March 2002. The agreement granted to Cintri all the rights concerning SWM services in the entire city, ranging from waste collection to final disposal and fee collection (although provisions concerning the development, operation and management of landfills were removed from the agreement in December 2002). The agreement includes a provision that Cintri is under no obligation to provide waste collection service in economically unfeasible areas. As a result, many parts of the city were left without access to collection service.

[27] Plummer and Slater (2001)

[28] JICA (2002) characterizes the notion of social capital, which is recently regarded by the World Bank and other donors as an important concept for development, especially in social development sector. In this study, networks, organizations and membership, norms and values, trust, and group behavior are viewed as useful social resources although they are not visible. These resources are traditionally handled as social considerations. What is significant is that they are regarded as capital that can be measured and accumulated and that can be altered by external intervention. The 2002 study does not provide case studies for SWM sector due to time constraints, this study committee on SWM also fails to have in-depth discussion on the application of this concept or its relevancy, validity, necessity and significance. However, the relevancy and validity of the social capital concept in SWM must be pursued both theoretically and empirically in the future. Pargal, et al. (1999) may serve as a basis for such discussion.

days, begin to give off an offensive odor and invite flies. Garbage (organic matter) has nothing to do with odor or insanitariness right after it is thrown out. However, it begins to decompose if it is not treated promptly and properly. This decomposing process gives the impression that garbage itself is a filthy thing that makes people uncomfortable. This has implications for the lowest social status of people engaged in SWM. The following paragraphs discuss considerations for SWM from the viewpoint of waste workers. Some cases in South Asia and other regions are used to illustrate these considerations.

(2) Social status of the waste disposal (sanitation) work and sweepers

In developing countries, production and consumption are at the center of economic activity. Government offices and the general public alike do not have much interest in the waste disposal process after consumption. There are two major reasons for this. First, budget allocations for SWM service, which is low on the policy agenda, tend to be small when the municipal budget itself is limited. Second, residents regard waste as filthy and unsanitary as discussed above. They do not relish touching refuse and try to stay away from it. Especially in South Asia, people try to keep a distance even from those who handle waste, resulting in social disdain for them.

People involved in sanitation service in South Asia are often those in a certain classes, ethnic groups or religious sects-socially vulnerable minority groups. In Hindu societies of South Asia, sanitary service is the traditional occupation of sweeper caste groups and was originally linked with night soil disposal. According to the social notion of purity/impurity in Hinduism, sanitation service and night soil disposal are considered an impure act. For this reason, certain caste groups at the bottom of the social stratification are often engaged in these services. They are generally known as Bhangi[29] (the generic term) in northern India, Chuhra in Punjab Province, Mehtar in Bihar Province and the Bengal region, and Chyame or Pode in Nepal. Minority religious sects or ethnic groups that provide sanitation service include Christians in Punjab Province, Pakistan (Chuhra's mass conversion between late 19th century and early 20th century) and Indian Tamils in Sri Lanka (who migrated from the Tamil region of southern India).

As the urban population grew, waste generation increased and so did demand for sweepers. In addition, sanitation service was considered less severe than night soil disposal in terms of physical "dirtiness." For these reasons, people not belonging to certain caste or ethnic groups who have traditionally been engaged in sanitation service began to enter this sector. Now the urban poor sees municipal sweepers as those who enjoy stable income compared with informal sector workers.

In Dhaka city, sweeper caste groups (Hindus) once dominated the quota of municipal sweepers. Now poor Muslims from rural areas outnumber these traditional sweepers. Compared with Muslim sweepers, sweeper caste groups have three social disadvantages as minorities: (i) they are not Bengali in terms of an ethnic group; (ii) they are Hindus in a Muslim-dominated country in terms of religion; and (iii) they are ranked the lowest in the caste hierarchy in a Hindu society. With sanitation service now regarded as one of the viable occupations among the Muslims, Hindu sweeper caste groups are having a hard time for their very survival; they have been deprived of the opportunities for education or vocational training.

(3) Toward eliminating social prejudice and discrimination

One of the important issues for proper SWM is how urban residents recognize and understand sanitation service and sweepers. If there is social prejudice and even discrimination against sanitation service and sweepers, it is difficult to rally enough support from the residents even if

[29] For details about Bhangi, see Syamlal (1992) and Shinoda (1995).

municipalities call for their support and cooperation for proper implementation of SWM. Sweepers themselves are often too much swayed by such prejudice and discrimination, which reduces their morale.

This is why social prejudice and discrimination must be eliminated as soon as possible. There are two major challenges in doing so. The first challenge is related to sanitation or physical dirtiness. There are two types of physical dirtiness. One is dirtiness derived from waste itself, especially kitchen garbage that can decompose rapidly. The other is dirtiness in physical appearance of sweepers who have to be engaged in SWM without the provision of uniforms, masks, gloves or boots (and their physical health problems).

The second challenge is how heightened environmental awareness can be put into action for SWM. Middle and upper classes in developing countries are increasingly aware of environmental issues due in part to a growing volume of information on environmental degradation. Today, the significance of environmental NGOs is recognized in any developing country. Such NGOs are expanding their activities into SWM in cooperation with local communities, including the collection of recyclables. This demonstrates that middle and upper classes are beginning to show their interest in SWM in areas where they live, while working for environmental NGOs as staff or members as part of their duties. Still, few NGOs or CBOs have gone far enough to involve sweepers in their programs for hygiene education and environmental education and interact with them so as to understand their socioeconomic conditions and the actual state of sanitation service as a whole. At issue is how to plan and implement such environmental education programs [30].

2-4-2 The informal sector — waste pickers and recyclable collectors

(1) Conditions and waste pickers and recyclable collectors

Efforts should be made to integrate waste pickers and recyclable collectors in the SWM framework, rather than just exclude them.

A typical scene at waste transfer stations and landfills in developing countries is that recyclables (wastes that can be recycled as resources) in wastes are dug up or taken out and sold to junk shops. This operation is done by waste pickers (scavengers) and recyclable collectors. Their economic activities constitute part of the urban informal sector, which accounts for a large part of the economy of developing countries.

From a socioeconomic perspective, waste collection activity in the urban informal sector have the following advantages and disadvantages. The advantages include its significant contribution to effective recycling of metal, glass, paper, plastic and other finite resources in a practical manner. Such recycling is nonetheless pursed in developed countries with much investment, although its systems and forms are different. Another advantage is that it provides an important job opportunity and income source for the poor in developing countries, where employment opportunity in the formal sector is limited. It is worth noting that many of the waste pickers and recyclable collectors are migrant workers, that is, people from the provinces (this business is one of the few trades that they can easily enter into) [31]. Moreover, the percentage of women and children is higher than in other trades [32].

[30] A joint project between JICA and the sanitary department of Delhi City incorporates training of low caste sweepers working on the ground into a technical assistance program, in addition to an environmental education campaign for residents. From JICA, KAMIKAWA Yoshio, a long-term expert, and OKUZAWA Shinjiro, Project Formulation Advisor, have participated in this project, formally known as the Pilot Project on Segregation of Household Waste.

[31] Nakanishi (1991), p.111 and pp.171-172. Nakanishi concludes from surveys on slums in and around the Philippine capital of Manila that recyclable collection is one of the typical trades for newly-arrived migrant workers. He explains the fact that many of them are relatives to each other or from the same provinces in terms of their relations with their employers, in other words, patron-client relations.

[32] Furedy (1990)

On the other hand, waste collection in the urban informal sector has two major disadvantages. First, disorderly picking of recyclables at curbside containers and waste transfer stations scatter other wastes, making the immediate environment unsanitary and extremely reducing the efficiency of public waste collection service. Second, waste pickers and recyclable collectors work in a dangerous and unsanitary environment. They have a much higher risk of health hazards than in other types of workers[33]. For example, they are highly susceptible to respiratory and dermatological ailments and injuries as they are exposed to smoke and toxic gases from open burning at landfills, pathogens from the decomposition of organic matters including carcasses and kitchen garbage, and dangerous objects such as broken pieces of glass and metals.

(2) A shift in the evaluation of waste pickers and recyclable collectors

JICA and other international aid agencies traditionally focused on the disadvantages outlined above in their studies and aid projects, although they paid some attention to the advantages. Aid agencies emphasized the need to exclude these informal waste workers from the public SWM process, especially from transfer stations and landfills. They explored ways to meet that need.

In recent years, however, international aid agencies are shifting its aid approaches and methodologies. Based on many years of their experience, aid agencies are increasingly aware that the option of simply excluding waste pickers and recyclable collectors from the SWM process has its limitations. In fact, it is extremely difficult to expel them from transfer stations and landfills unless the root cause-poverty they live in or poverty in society as a whole-is dissolved. Aid agencies are beginning to understand that the issue is how to live with them, not exclude them.

Based on this understanding, JICA has already implemented a project in Tegucigalpa, the capital city of Honduras. A major product of this project, the M/P report on SWM[34], includes a recommendation that waste pickers and recyclable collectors should be encouraged to participate in the process of developing the rules for operating a landfill so that C/P will fully understand the environmentally problematic practices of landfill operators[35].

As this example shows, aid projects should be designed to maximize the advantages and minimize the disadvantages of these informal waste workers to the benefit of SWM. To that end, the following steps should be taken.

The first step is to integrate recyclable collection activity by waste pickers and recyclable collectors into the formal SWM system (though such means as organizing them into micro enterprises and hiring them at new recycling centers). Donors can encourage them to establish their associations, for instance. The second step is to improve their welfare and working environment by, for example, providing sanitary education/training and protective gears such as masks, gloves and boots.

Specific components of these two steps include: fact-finding survey and registration of waste pickers and recyclable collectors to organize them; provision of hygiene education (including vaccination, medical treatment and protective gears); provision of opportunities for children to receive school education; support for the establishment of distribution channels for recyclables; and partnership with relevant NGOs. Unfortunately, however, only a few central and local governments in developing countries recognize the urgent need to plan and implement these actions at the moment.

(3) Considerations for the development of a formal recyclable collection system

Ideally speaking, the development of a

[33] Hunt (1996), pp.111-118.
[34] JICA (1999)
[35] Nagaishi and Doi (2002)

formal system for recyclable collection should be supported by the efforts of waste pickers to organize themselves. In reality, however, government agencies, private businesses and NGOs will play a central role in operating such a system [36]. In the development process, the following issues should be considered:

(i) Promoting awareness of human rights

At issue is to what extent staff at government agencies, private business and NGOs can work with waste pickers and recyclable collectors on an equal footing with a strong sense of human rights - the former generally come from the middle and upper classes, while the latter are ranked the lowest in the socioeconomic hierarchy in a given developing country. Unless this issue is thoroughly addressed, specific measures to improve their working and sanitary conditions will not be implemented in earnest. If the two groups fail to forge a relationship of trust as a result, there will

Box 2.4 A case of waste pickers and recyclable collectors
–A thought at the Matuail Landfill site in Dhaka, Bangladesh–

There is a final disposal site currently in use in the Matuail area, located in the southeast suburbs of Dhaka city. More than 200 waste pickers and recyclable collectors work at this landfill. Most of them come from the rural areas of Bangladesh, not from Dhaka. The proportion of women and children is noticeably high although no statistical data is available.

When I visited the landfill, I saw a women in her twenties engaging in "resource recovery" work on a huge pile of waste. Her work was obviously health-threatening. It included collecting plastic packaging from a pile of waste, burning it in an empty oil drum cut in half with foul-smelling smoke billowing from it, and then cutting a lump of the black ash into cubes of side 15 centimeters. These cubes were traded as "solid fuel."

The woman used to live in the southern part of Bangladesh, where most of the land is inundated during the rainy season. She lost her small field due to soil erosion by the river nearby. Five years ago, she left her home town with her husband and children for Dhaka and arrived at this landfill. Her husband has been too ill to work for years. (I did not ask how he has fallen ill. Maybe I was afraid that her answer would be that he ruined his health by making this "solid fuel" for a long time.)

When a plastic material is burned at a low temperature, it emits highly toxic dioxins. Everyone in Japan knows this fact partly because of the extensive media coverage of dioxins a few years ago. The Japanese government has tightened its control over dioxin-producing practices. But this woman has probably been deprived of the opportunity to know the danger of burning plastics totally. Even if she knew it, she would have a hard time finding an alternative job or livelihood.

The solid fuel she makes surely finds its way into the hands of poor people because of its cheap price. It is perfectly obvious that both the producer and consumer of this fuel suffer health hazards. Behind this tragedy is the socioeconomic conditions peculiar to developing countries-poverty and lack of knowledge and information.

MIYAKE Hiroyuki

* The content of this box is based on the experience of Professor MIYAKE Hiroyuki, a member of our study committee, when he visit the Matuail Landfill site in Dhaka in December 2003.

Photo 2-2 A woman engaged in "resource recovery" at the Matuail Landfill site

[36] In Payatas, the Philippines, a missionary NGO has succeeded in organizing waste pickers and even supporting them to set up micro enterprises through community-based activities. Vincentian Missionaries (1998)

be no prospect for rectifying the situation.

(ii) Necessary education and training for employers

Appropriate and adequate education and training should be provided to "employers" under a recyclable collection system-high and middle-ranking officials of government agencies, managers or contact persons at private businesses, and staffs of NGOs-to ensure fairness and transparency in employing waste pickers and recyclable collectors. If such job openings are limited in a sociopolitical environment where graft is rampant, both employers and employees may become conscious of a patron-client relationship between the two. There is a high risk that competition or even conflict among these informal workers will intensify for the limited job openings. As a result, employers may demand a bribe from them as a employment guarantee fee. (In fact, this practice is common in the employment of sweepers in some developing countries.)

(iii) Consideration for women and children

It is essential to consider how to guarantee employment opportunity for the socioeconomically vulnerable in the case of a limited quota for employment as mentioned above. Recyclable collection service allows for entry of women and children as a easy means to earn cash income despite its hard working and sanitary environments, as discussed earlier. In short, it provides a livelihood for people who are generally regarded as the socioeconomically vulnerable. The formal recyclable collection system to be introduced should be designed to guarantee free and easy entry for the socioeconomically vulnerable. If the system is designed to give priority to men in employment, women, children and other socioeconomically vulnerable people will be excluded. That would put them into dire poverty. For this reason, these people must be given the opportunity to receive appropriate education and vocational training so that they will have more job opportunities.

(iv) Relationship with recyclable collection mafia

In some developing countries, mafias sometimes organize waste pickers and recyclable collectors. Some municipal officials even maintain good relations with such mafias by receiving bribes. It is important to sever these relations when developing a formal recyclable collection system. System planners should ask themselves: "do we have no choice but integrate these mafias into the formal system in an acceptable manner? or can we exclude them?" They have to weigh up all these options from every angle and based on all the information available.

2-4-3 Community-based SWM; community participation

How external donors can support CBSWM?

Community-based solid waste management (CBSWM) is the approach whereby members of a community themselves manage such activities as waste collection, resource recovery (e.g. composting) and sale of recycled products. This approach is recently attracting attention of donors.

CBSWM arises because government institutions often fail to satisfy communities' needs for SWM service although they are expected to play the leading role in solid waste management. In that sense, members of CBSWM organizations tend to take pride in keeping a distance from government institutions although they do not intend to go against them. This is one of the factors that make it sometimes difficult for traditional aid approaches-providing ODA through government institutions-to involve existing CBSWM organizations or arrangements. CBSWM can be classified into the following three types according to the characteristics of the implementation structure.

(i) In Type I, community activists set up a

CBSWM organization, which finds suitable waste collectors and contracts out all the primary collection services to them. Although residents support such contractors through source separation and other means, waste collectors collect waste collection fees door-to-door. (e.g. a CBO in Dhaka)

(ii) In Type II, the community concludes a service contract directly with a private business, which is often a micro enterprise. The business collects fees directly from service users. The service may include everything from waste collection to final disposal. (e.g. a community in Manila)

(iii) In Type III, community activists set up a CBSWM organization, which plans and manage SWM service, including fee collection and other financial activities. The service often includes a wide range of operations, including recycling of recyclables and composting as well as waste collection. Workers are hired and paid by the CBSWN organization. (e.g. an NGO in Dhaka)

There may be hybrid types between or among the three. In Type I and Type II, the level of independence of the CBSWM organization or arrangement is not necessarily high, although the community exercises its initiative. In actual service delivery, community members are passive service receivers. In Type III, on the other hand, the CBSWM organization maintains a high level of independence and proactive organizational management. The analysis of these three types suggests that proactive participation and motivation on the CBSWM organization members are keys to CBSWM. Type III deserves attention in terms of not only solid waste management but also community participation and community empowerment.

(1) Role of community members in CBSWM

Community members participate in CBSWM or contribute to it by paying fees, providing equipment or labour. The role of community leaders is especially important. The sustainability of CBSWM is largely dependent on their initiative [37].

In addition, it is essential to ensure the contribution of women. In many societies, women are responsible for their households and for keeping them clean. They are the primary users of urban services and play a major role in setting the trend in waste storage and discharge.

(2) Organizations

Organized CBSWM activities are carried out by micro-enterprises or community-based organizations (CBOs) or through the partnership between these two types of organizations.

(3) Issues

A study by the Water and Environmental Health at London and Loughborough (WELL) identifies the key lessons which have been learned from community-based initiatives and the issues to be tackled [38].

(4) Factors that increase sustainability

Due to the factors above, external donors often have difficulty making CBSWM take root in communities after their aid projects are completed. In this context, a study concludes that project design that considers the following factors can increase the sustainability of CBSWM [39].

(i) Communication

Communication strategies, like awareness-raising campaigns, stimulate community members to participate and support projects. This can increase local ownership of projects and enhance a sense of responsibility for services.

(ii) Community leaders and CBOs

Community leaders and CBOs can stimulate community participation and ensure that community needs are taken into account. Community leaders can act as intermediaries

[37] Barangays in the case study of the Philippines in Section 3-1 provide a good example to support the notion that the outcomes greatly vary depending on the initiative and qualifications of community leaders.

[38] Ali and Snel (1999)

[39] Moningka (2000), pp.15-19.

Table 2-12 Key lessons and issues for community-based initiatives

Category	Issue
Willingness to participate	Motivation on the part of the community cannot be assumed, and willingness to manage schemes is initially low. Many communities feel that it is solely a municipal responsibility to undertake the collection, transportation and disposal of waste.
Linkages with the municipality	Community-based collection schemes could ultimately become part of the municipal system if the linkages between the communities and the municipalities are addressed at the inception stage of the schemes.
Finance	In community-based waste collection schemes, both cost recovery and access to finance are important. This has to be addressed both at the community level and at the city level.
Ability of the poorest to pay	The ability and willingness of the poorest to pay for waste collection schemes is very limited.
Reliability of workers	Waste collectors (workers) are often perceived by the community to be unreliable.
Location and space for communal bins	It is difficult to secure adequate space for storing waste for collection and for recycling.
Gender sensitivity	Women are to a large extent responsible for household waste management. A proportion of municipal sweepers (waste collectors) is female. There is an important gender dimension at both levels.
Equipment	For an efficient waste collection system, it is important to use equipment which is appropriate to the physical nature of the area and to the characteristics of the waste.
Transfer and transportation of waste	A reliable primary waste collection scheme depends upon the design and location of transfer and transportation.

Source : Compiled by WATANABE Taisuke from Ali and Snel (1999)

between CBOs, the municipal authorities and other stakeholders to solve conflicts or overcome constraints. In whatever way community leaders are involved, their representativeness and legitimacy should be assessed. CBOs must also be representative of the community. If community leaders or CBOs do not represent the community or represent only a small part of it, difficulties will arise.

(iii) Women

Women play a determining role in waste management and form important channels of communication. Through such channels, women can be active members of CBOs and stimulate participation of other women in the community.

(iv) Municipal authorities

Support and recognition from municipal authorities can bolster community initiatives and CBOs. In fact, such support and recognition are imperative, because municipal authorities transport and dispose of waste that has been collected.

(v) Intermediaries

An organization, like a NGO, which can act as an intermediary or interface between the community and other stakeholders, plays a vital role in sustaining activities of CBOs. NGOs sometimes adopt different collection methods. In that case, standardization of these methods is necessary for the benefit for SWM for the whole municipality.

(vi) Cooperation between the CBO and the local authority

Cooperation implies creating a partnership between the CBO or micro-enterprise and the municipality based on a clear division of responsibilities and a mutual commitment to carry out the service. In this way, conflicts between the CBO or micro-enterprise and the local authority can be prevented and the continuity of the waste service ensured.

(vii) Finance and operation

Financial and operational stability are necessary for the continuation of services. Setting up an effective fee collection system is necessary to make the waste system financially viable and to ensure its continuity.

2-4-4 Promotion of environmental education and public awareness

(1) Importance and activities of waste-related education in developing countries

Solving SWM problems requires not only the advancement of science technology and the

introduction of necessary systems but also a light level of public awareness and behavior commensurate with that level. In other words, waste-related education and awareness programs are needed as well. This is because storage and discharge of waste is done by citizens as waste generators. It can be said that proper implementation of SWM will not be possible unless citizens acquire proper knowledge, raise their awareness, and put acquired knowledge and heightened awareness into action. This should be emphasized particularly in developing countries, which cannot mobilize necessary financial resources to the development and introduction of technologies for SWM. Nonetheless, developing countries are lagging behind in environmental education that covers SWM. It was not until recently that central governments and NGOs in the developing world recognized the need to raising public awareness about sanitation and environmental conservation and began to put that recognition into action with the help of multilateral institutions and governments and NGOs in developed countries [40].

Environmental education initiatives have recently launched in many developing countries. Botswana is tackling the problem of illegal dumping with not only legislative measures but also a policy that focuses on environmental education on waste. Under the policy, the country is mounting a number of awareness raising campaigns (including a campaign to reduce the use of plastic bags) and school education programs. Illegal dumping was rampant in Botswana. For example, of the 250,000 tons of residential waste generated annually, 62% was dumped illegally outside government control, and only 38% was collected and transported to landfills for proper disposal [41].

For information, of the JICA projects for municipal solid waste management (MSWM) since 1991, there are 11 pilot projects (P/P) that are designed to provide hygiene education or raise public awareness. Most of them are implemented in or after 1995 [42]. In other words, almost all of the recent pilot projects in master plan studies on SWM include components on hygiene education or awareness-raising among the residents. This indicates that JICA takes into consideration environmental education as a major issue. [43]

(2) Objectives and target areas of environmental education

Waste education and awareness campaigns alone do not provide fundamental solutions to solid waste problems. Wide-ranging environmental education should be promoted.

As discussed above, a small but increasing number of cities in developing country are working to raise the MSWM awareness of local adults and children through hygiene education and environmental education. Yet waste education alone does not provide a fundamental solution to municipal solid waste (MSW) problems. This is because MSW problems do not arise independently as they are closely related to a range of other development and environmental problems.

For this reason, broader environmental education is necessary at communities and schools. Such education should be designed to provide knowledge (and incentives to raise awareness) about the environmental as a whole and even encourage local adults and children put

[40] JICA also sends experts, JOCVs and Senior Overseas Volunteers to developing countries to provide environmental education that includes SWM.

[41] Kgathi and Bolaane (2001), pp. 342-353.

[42] Even before 1995, some of JICA's study missions to Laos, Poland and other countries mounted awareness campaigns of their own initiative in projects that were not characterized as P/P.

[43] See Table 1-5. All the development studies (M/P) under review stress the need for community participation and awareness campaigns to promote such participation. This provides further evidence that such requirements are deemed essential for SWM. Section 3-4-2 outlines recent P/P on environmental education in Sri Lanka.

that knowledge into action[44]. This is quite obvious in light of the current arrangement whereby knowledge is unilaterally communicated from municipal officials to residents and from teachers to pupils and students (teaching by rote).

What are the goals and methods of ideal environmental education then? The internationally recognized objective of environmental education is defined in the Belgrade Charter. The 1975 charter states that "the goal of environmental education is to make a world population get much aware of and concerned about the environment and its associated problems... towards the solution of current problems and the prevention of new ones."[45] According to the charter, the objectives of environmental education are[46]:

(i) Awareness: to help individuals and social groups acquire an awareness of and sensitivity to the total environment and its allied problems.

(ii) Knowledge: to help individuals and social groups acquire basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.

(iii) Attitude: to help individuals and social groups acquire social values, strong feelings of concern for the environment and the motivation for actively participating in its protection and improvement.

(iv) Skills: to help individuals and social groups acquire the skills for solving environmental problems.

(v) Evaluation ability: to help individuals and social groups evaluate environmental measures and education programs in terms of ecological, political, economic, social, esthetic and educational factors.

(vi) Participation: to help individuals and social groups develop a sense of responsibility and urgency regarding environmental problems to ensure appropriate action to solve those problems.

Target areas for environmental education can be divided into school education and home/community education. In other words, schools, parents and communities play an important role in environmental education. School education is deemed most important than home/community education for the promotion of environmental awareness. School education is designed to accommodate two development stages of children. At the first stage (between babyhood and the lower grades of elementary school), there is no distinction between sensibility and reason (cognition). Children recognize things intuitively while creating a mental image of them. For this reason, sensuous cognition and physical cognition are emphasized at this stage. At the second stage (the upper grades of elementary school and above), practical cognition based on practice and knowledge is also emphasized apart from sensuous cognition[47].

(3) Issues for SWM-oriented environmental education in developing countries

In light of the above discussion, the following paragraphs summarize the issues and explore future directions for waste-oriented environmental education in developing country cities.

(i) Current state and issues

Developing countries generally place emphasis on hygiene education and basic subjects such as arithmetic and national language in school education. The concept of environmental

[44] Japan also needs such education. Schools in Japan now provide "integrated learning" classes in an effort to make a shift from the traditional style of teaching by rote. These classes are designed to encourage pupils and students to develop their problem-solving ability and have a "zest for living." Many schools teach environmental education in these classes. They are exploring participatory, hands-on teaching methods that are appropriate for "integrated learning" classes with the help of local residents. Although teachers are expected to serve as coordinators or facilitators in these classes, many of them are at a loss what to do because of a lack of experience or training in this new teaching style.

[45] UNESCO (1975), p.86.

[46] Environmental education is a component of Education for Sustainable Development (ESD), which is advocated by the United Nations as comprehensive and integrated education designed to solve problems facing the world in the 21st century. ESD-J, a Japan-based organization that has been established to promote ESD, is chaired by ABE Osamu, Professor at College of Social Relations, Rikkyo University. Prof. Abe stresses the importance of "sustainable community development" for creating a sustainable society. For details, see Abe (2004).

[47] Sajima (1999), pp.19-22.

education has not yet taken root there. Although information and knowledge about the environment are communicated at times in science and social studies classes, this cannot be characterized as systematic environmental education that is designed to appeal to the senses of pupils and students and prompt their action.

(ii) Target

The target of environmental education is pupils and students at school and local residents in communities. At school, environmental education should be designed to appeal to the senses of pupils in lower graders and encourage older children to put what they have learned into practice in their daily activities. Because environmental education is a rather new concept, it is necessary to ensure that municipal officials, NGO staffs, and teachers receive substantial training in advance. Environmental education for pupils is especially important because the future of SWM depends on them. Besides, it is more difficult to change the already-established mind-set and behavior of adults.

(iii) Content

SWM-oriented environmental education should include such aspects as maintaining public health (through hygiene education, etc.), keeping the streets clean and tidy, closing the loop to conserve resources and energy, and protecting the human rights in relation to social prejudice and discrimination derived from waste. It should further be linked with other problems associated with development and environment. Such linkage can be established by, for example, teaching the fact that certain types of plastic wastes produce dioxins when burnt at low temperatures, as an introduction to the problem of air pollution or health hazards. Another option, among others, is to present a case in which plastic wastes drifting in the sea killed turtles and fish because they ate these materials, as an introduction to the subject of biodiversity.

(iv) Approaches

An effective approach would be to provide many opportunities for hands-on experience, in addition to lecture-type teaching, particularly at the level of basic education. It is important that learners can enrich their senses, enjoy learning, and maintain their interest. There should be a linkage between school education and community education. If environmental education is taught only at school, not at the community level, in other words, if adults, who assume social responsibilities, have no interest in or knowledge about the environment, children who want to conserve the environment may be discouraged. In addition, if people receive environmental education at school but have no such opportunities after graduation, their knowledge and awareness about environmental conservation will surely wane, as so will the level of participation in environmental conservation activities. For these reasons, it is necessary to take every opportunity to explore how best to promote environmental education at the community level. To that end, it is necessary to encourage residents to participate in environmental education programs with the help of environmental NGOs and others, as discussed earlier. Moreover, long-term, sustainable approaches are required because it takes environmental education a long time to produce positive outcomes[48].

2-4-5 Securing landfill sites: consensus-building concerning the citing of disposal facilities

The construction of waste disposal facilities must be based on a consensus with local communities, and developing countries are no exception.

Many of the final disposal sites in developing countries lack a proper management of carried-in waste or other environmental controls. They are often just open dumping sites with no measures to minimize environmental pollution. The border between a landfill and the surrounding area is unclear in many cases. Such landfills have a range of adverse effects on the

[48] Institute for International Cooperation, JICA (2005)

environment and landscape of the surrounding areas with odors, flies and rodent vectors, untreated landfill gas and leachate, and windblown litter.

Consequently not only neighboring residents but also the general public as a whole develop an aversion to such "locally unwanted facilities," that is, NIMBY (not-in-my-back-yard) syndrome. This public sentiment is what makes it difficult to construct new disposal sites or enlarge the existing ones in developing countries. The sentiment is so strong that a mere plan to construct a sanitary landfill or other disposal site that pays adequate attention to the environment and the landscape almost always invites opposition from local residents and even becomes a major focus of public concern.

This trend is especially noticeable in recent years among growing public concern about the environment and progress in the democratization process, as illustrated by the case study of Manila, the Philippines in 3-1. Now, securing sites for landfills is the key to the success of a MSWM system as a whole in developing countries as well.

It may be inappropriate, however, to attribute the cause of local opposition-often described as the NIMBY syndrome-only to the egoism of local residents. It is more appropriate to regard it as the consequence of adverse sentiments developed over the years toward insufficient treatment technologies at disposal sites, odors, pollution by leachate, salt damage, damage to crops by methane gas, fires, and other hazards.

It is therefore impossible to construct or enlarge landfills or other disposal sites without building a consensus with local residents and other stakeholders. Such consensus calls for the following requirements:

(i) Eliminating community aversion to disposal sites

As mentioned above, disposal sites in developing countries are mostly open dumping sites or more of the same sites with inadequate measures to protect the environment or landscape. Residents cannot image exactly what a sanitary landfill is like, and they tend to have a strong prejudice toward landfills in general. Moreover, municipal officials cannot persuade residents because they have little knowledge and experience with sanitary landfill. The prejudice of residents toward disposal sites should be removed with demonstration projects that improve existing sites using the sanitary landfill method.

(ii) Involving residents in landfill projects as early as the planning phase

Clearly, it is important to involve residents in the decision-making process of a project as early as the planning phase toward consensus

Table 2-13 Technical measures to avoid the NIMBY syndrome in relation to final disposal sites

Category	Technical measure
Establishment of construction technologies for final disposal sites	・Establishment of liner facilities and the leachate collection system that are mutually supportive ・Technologies to install seepage control works and the groundwater pollution monitoring system ・Working face minimization and section landfill technologies to minimize leachate ・Appropriate technologies for leachate treatment
Establishment of landfill and management technologies at final disposal sites	・Monitoring technologies of the appropriateness of carried-in wastes ・Landfill technologies to enlarge the aerobic landfill area for the purposer of early stabilization (in the case of semiaerobic or aerobic structure) ・Proper control of the amount of leachate ・Technologies for landfill separation and early stabilization ・Clarification of the working face ・Leachate treatment technologies ・Cover material selection and soil covering methods ・Landfill gas control technologies ・Landfill subsidence control technologies and monitoring ・Technologies to control landfill water balance ・Emergency response technologies for contamination, fires, etc.

Source : Hanashima (1994), with revisions made by YOSHIDA Mitsuo

Box 2.5 Building a Consensus with Residents for New Landfills —Case Studies of Cambodia, Laos and Sri Lanka—

(i) Study on Solid Waste Management in Phnom Penh Municipality in the Kingdom of Cambodia (development study)

JICA provided support for the Stung Mean Chey Disposal Site (SMCDS), the only landfill in Phnom Penh as a pilot project of this study. The objectives of the project were to improve the facilities and operation of the landfill and to consider the validity of candidate sites for a new landfill. As far as SMCDS, the study mission from JICA focused on facility and operational improvement because the city government had already secured land in the adjacent area.

As for a new disposal site in Dang Kor, the study mission played a more positive role. Specifically, the mission reviewed candidate sites based on the results of the existing surveys and the field survey. The mission also helped the city government with two public hearings before the government procured the actual site.

In the first public hearing (October 20, 2003), members of the mission explained why a new disposal site was necessary to 96 residents from 12 villages that would be affected. After introducing the findings of this development study regarding the state of SWM service in Phnom Penh, mission members explained why this particular area had been chosen for a new disposal site based on review findings. The members also presented a detailed landfill plan and called for understanding and cooperation for further surveys by explaining what would be surveyed and why.

The second public hearing (December 25, 2003) was attended by 379 people, including 248 landowners within a one-kilometer radius from the center of the proposed disposal site, as well as residents along the proposed access road and the downstream area of the nearby river. City officials briefed the attendants on the background of the construction plan. Members of the study mission presented the findings of the EIA survey and the outline of the plan.

After these public hearings, the city government obtained approval from the government on January 15, 2004 and set up a site acquisition commission. Later, a surge in land prices and other factors promoted the commission to amend the plan in consultation with the study mission. The commission eventually succeeded in concluding land purchase agreements with the landowners.

NAGAISHI Masafumi

(ii) A case of landfill construction in Laos

A development study (M/P) for Laos recommended a project to construct a new disposal site in an area where waste had been dumped illegally after the completion of the study. When this project was implemented, there was no major opposition from local residents partly because waterworks were also built for them. As discussed later in Section 3-2, the fact that things went smoothly during the site acquisition phase played a major role in ensuring that the recommended project was not only accepted but also put into action successfully. This experience provides a lesson that adequate attention should be paid to site selection and residents.

Kondo Sei

building among diversifying awareness of residents. Of course, the need for this arrangement is not limited to "locally unwanted facilities" like disposal sites.

(iii) Establishing the monitoring framework

It is important to ensure that competent entities, usually municipalities, operate and maintain disposal sites in a properly and sustained manner. This is an effective approach for alleviating or even eliminating the aversion of residents and involving them into projects.

Table 2-13 summarizes technical measures to remove the aversion of residents to landfills in light of the three requirements outlined above. This table also serves as a list of objectives or components of technical assistance projects,

(iii) Study on Improvement of Solid Waste Management in Secondary Cities of Sri Lanka (development study)

As one of the pilot projects of this study, JICA provided support for the Gohagoda landfill site (existing) in Kandy city and Moon Plains landfill site (new) in Nuwara Eliya city. Specifically, the project improved landfill facilities, transferred sanitary landfill technologies, and established a monitoring committee. (The case study of Sri Lanka is discussed in detail in Section 3-4.)

The monitoring committee was set up to ensure that the competent municipality properly operates and maintains the landfill in a sustained manner. It comprised the representatives of the neighboring communities, officials at relevant agencies, staff members of environmental NGOs, officials at the Central Environmental Authority (CEA), municipal officials in charge of SWM, and members of the environmental committee. The monitoring committee established a system for holding regular meetings, making evaluation based on a monitoring checklist, and making its findings known to the residents.

The establishment of the monitoring committee also served to raise the interest of the residents in the landfill, In this context, Nuwara Eliya city deserves special attention. The city's monitoring committee was set up at an early stage and chaired by a monk living near the landfill. Thanks in part to the monk, the committee was able to hold a number of briefings for residents at his temple and visit the site to keep track of progress in the construction work. After the landfill went into operation, primary school children toured the site as part of environmental education. Officials at neighboring municipalities visited the landfill to gain expertise in sanitary landfill. This disposal site is clearly serving its purpose as a model sanitary landfill of Sri Lanka.

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Photo 2-3 Building a consensus with residents around Moon Plains landfill site in Nuwara Eliya city

Photo on left : A briefing for residents around the landfill
Photo on right : On-site inspection by monitoring committee members

which should accommodate technical levels of recipients. Such technical assistance and capacity development constitute a basis for winning the understanding of residents regarding landfill siting and building a consensus with them.

Japan is recently employing the risk communication technique in building a consensus with local residents in relation to the establishment of waste treatment and disposal facilities[49]. Developing countries are also advised to consider adopting this technique. Risk communication is a pragmatic approach that has emerged in the 1970s to deal with problems such as hazardous chemical materials. It tries to solve problems through the interaction process in which the sender and receiver exchange information and view about the risks involved. In risk communication, it is important to communicate

[49] Urano, ed. (2001); Ishizuka and Tanaka (2003); and Bredariol and Magrini (2003)

(share) both positive and negative aspects of the issue in question in a fair manner. By promoting such communication, the stakeholders can develop a relationship through which they can consider and cope with the risks involved and eventually take action to avoid them.

2-5 Health and environmental factors

This section provides an overview of environmental pollution caused by waste, with a special focus on public health problems as well as environmental pollution in developing countries.

2-5-1 Pollution related to the generation, transportation and dumping of waste

Municipal solid waste (MSW) includes: residential waste, such as garbage and bulky wastes from households; and business waste such as paper waste from office buildings and other wastes from shops and restaurants. Human excreta are sometimes included in MSW in countries such as Japan[50]. Residential waste tends to increase as the economy expands. In developing countries, garbage and other organic wastes represent the main proportion of MSW. Plastic waste from containers, packaging and bags is on the rise in urban areas.

(1) Public health problems

Wastes, when they are left as they are, generate foul odors. Odors from decomposed food residues and other wastes attract insects and rodents such as flies and rats, causing public health problems. These odors, whose sources are ammonia, hydrogen sulfide, or other chemicals, are not just a nuisance; they may be the cause of poisoning, irritation of the respiratory mucous membranes or otherwise damage human health. Furthermore, human excreta or sewage sludge, if handled with other wastes and treated inadequately, provides routes of infection for viruses, bacteria, protozoa, vermin and other disease vectors, or rodents[51]. It is believed that improper waste management was the cause of a series of cholera outbreaks in Japan during the late 19th century.

The situation in developing countries is worse as a result of inadequate waste collection systems and improper landfill operations partly due to insufficient capacity of the facilities and equipment. In Bangalore, India, for instance, untreated waste is dumped into a large open dumping landfill. An epidemiological survey on child waste pickers at this landfill showed that the incidences of parasitosis, scabies, bronchial disease, digestive disease and lymphoadenoma were significantly higher than that for other children in the city[52]. This indicates the harsh working conditions for waste pickers and suggests that improper waste landfill is quite detrimental to public health. Waste that is left uncollected and other litter on urban streets due to inappropriate collection also cause similar public health problems.

(2) Pollution caused by illegal dumping and littering

In areas without access to collection services, wastes are simply discarded, causing the public health problems mentioned above. Wastes that have been collected may be dumped illegally before they reach the landfills in order to cut transportation costs, or for other reasons. This practice also causes the above-mentioned public health problems or problems similar to those arising when wastes are disposed of in open dumping landfills (which is discussed in section (6) below). To make matters worse, pollution may remain unnoticed, since illegal dumping often occurs in inconspicuous locations.

[50] In Japan, all types of wastes not defined as industrial wastes are aggregated as "general waste," which includes residential waste, human excreta, and business wastes, such as paper waste from office buildings. General wastes that pose a high risk of affecting human health or the living environment, such as materials that are explosive, toxic, infectious, etc. are stipulated as "specially controlled municipal wastes."

[51] Kitawaki (2000b); Carpenter et al. (2001)

[52] Hunt (1996)

(3) Pollution associated with incineration

Incineration is often an option for relatively high-income countries or areas where landfill sites are extremely difficult to secure. The volume of waste is reduced by incineration (volume reduction). Incineration ash (also known as bottom ash or main ash) and fly ash (air-borne solid particles extracted from the incineration gases) often contain heavy metals and other hazardous materials, requiring special controls when they are landfilled [53].

Apart from the concentration of such toxic metals, it is widely known that the incineration process also produces soot and dust, hydrogen chloride, nitrogen oxides, mercury, dioxins (PCDDs/PCDFs), coplanar PCBs (Co-PCBs) and other new types of hazardous chemical substances [54]. Incineration plants should be designed to minimize the emissions of chemical substances that are harmful to human health. This can be achieved with facilities that prevent the production of these substances or through the installation of exhaust gas treatment equipment.

(4) Pollution associated with composting

Composting is one of the options often adopted for the intermediate treatment of MSW in developing countries. There are two major reasons for this. One is that organic wastes, including garbage, account for more than 50%-sometimes over 70%-of MSW in the developing countries. The other is that this option not only reduces the volume of waste, but also produces compost, which can be used as a soil conditioner or alternative fertilizer [55].

However, proper precautions should be exercised to avoid soil pollution from the compost. Hazardous materials have little chance of finding their way into compost if the raw materials for the compost are wastes that have been properly separated at source (e.g. vegetable garbage from vegetable markets, or fish waste from fish markets). If wastes generated in cities are mixed and used to produce compost, that compost will without doubt include heavy metals and other hazardous materials, even if every effort has been made to remove these materials as part to the pretreatment process. Inevitably, compost made directly from MSW has a high concentration of heavy metals and other hazardous materials. If such compost is admixed with the soil, these hazardous materials accumulate and become concentrated, causing soil pollution [56]. This is one of the factors that reduce the marketability of MSW-derived compost. It is advisable to limit the application of compost made from mixed waste on crop fields, which absorb heavy metals well. The regular application of such compost to the same field is very risky. Ultimately, its use is virtually limited to gardening and forestry.

(5) Positive and negative aspects of recycling

In developed countries, the wider use of disposable containers and packaging, such as polyethylene terephthalate (PET) and other plastic bottles, paper cartons and aluminum cans, is generating an increasing amount of waste whose total volume is rising at an alarming rate. The reduction, reuse and recycling of such wastes is a major challenge for solid waste management (SWM).

In developing countries, on the other hand, a social system for recycling these materials has often already been established. In such systems, the materials are separated at source and recovered by waste pickers and others for reuse or

[53] Main ash and fly ash are handled as separate types of wastes. In Japan, main ash is regarded as general waste due to its low elution concentration of heavy metals and is disposed of at controlled landfill sites. Fly ash, on the other hand, contains a high concentration of heavy metals and dioxins. It is classified as "general waste subject to special controls" and is required by law to receive intermediate treatment (detoxification processes to prevent elution). See Kankyo Horei Kenkyukai, ed. (2004), p.19, and Ishikawa (1995).

[54] Hiraoka (1990); Tanaka (1996)

[55] Hoornweg et al. (1999)

[56] Yoshida et al. (2003); Hamdi et al. (2003); Hoornweg et al. (1999)

reprocessing according to market demand. Ultimately, public health problems and environmental pollution associated with MSW can be reduced significantly by separating, reusing and recycling these recyclable materials. A major issue for development assistance is how to enable solid waste management (SWM) in developing countries to become more efficient while ensuring that the existing recycling systems are maintained on a sustainable basis. In this context, the activities of an NGO in the City of Manila in the Philippines, provides a good example. This NGO helped waste pickers living at the landfill sites to set up recycling businesses. While reinforcing the existing recycling system, these activities contributed significantly to the establishment of environmentally friendly SWM [57].

Yet the "venous industry" that reuses and recycles waste in developing countries does not deserve unconditional praise. Generally speaking, recycling is technically costly. Under pressure from market forces, recycled products generally have to compete with those made from virgin materials. There is a strong incentive to cut costs at the expense of consideration for working conditions, the quality of recycling facilities, and the environmental impact, even though the costs of manually separating wastes are already low. This is illustrated by the case of Dhaka, Bangladesh (see Photo 2-4). There is always the risk of health hazards and environmental pollution.

The separation process for recycling means that materials not recovered in the process are disposed of as wastes. These wastes, if left uncollected at the collection points, pollute the soil there and cause public health problems.

(6) Environmental impacts associated with final disposal sites

Among the environmental impacts associated with final disposal sites, pollution from landfill leachate and gas emissions is well known.

Leachate is produced in landfill layers and seeps into the surrounding soil and groundwater, causing environmental pollution. The amount of leachate is determined by the water balance involving rainfall at the landfill site. The rainfall that seeps into the landfill layer as "input" elutes the hazardous materials and produces leachate as the "output." For this reason, the leachate can be reduced primarily by preventing rainfall from seeping into the landfill layer. New landfill sites should be designed to control leachate with a seepage control structure.

In the landfill layer, organic matter is largely decomposed by microorganisms. Due to this decomposition process, the components of the leachate change over time. In the early stages of a landfill, relatively acid leachate is produced, eluting heavy metals and other hazardous substances. The

Photo 2-4 Informal separation and recycling scenes in Dhaka city, Bangladesh

Waste collection work is dependent on low cost labor, especially women and children (photo on left). The recycling workshops are generally small and their working conditions are harsh. The photo on the right shows a factory where plastics recovered from waste are remelted and cast into slippers.

[57] Vincentian Missionaries (1998)

elution process is a continuous long-term one. Studies[58] show that organic matter is largely decomposed within the landfill. According to these studies, the concentration of such organic matter in leachate, which is 1,000 times the environmental standard (in terms of BOD), will be significantly reduced by the time the leachate is leaked into the environment, as long as organic matter is carried by infiltrating rainwater. In short, a landfill can be regarded as a huge decomposition reactor driven by microorganisms.

Although the structure of the landfill is important, the most effective solution to the problem of environmental pollution caused by leachates is landfill control. This solution prohibits the carrying-in of wastes (often industrial wastes) that contain high concentrations of heavy metals and other materials that cannot be decomposed by microorganisms, undiluted solutions of organic hazardous materials, and materials soaked in such solutions. Wastes that include hazardous wastes are subjected separately to strict controls on their disposal.

In fact, due to inadequate landfill controls, leachate from final deposal sites is causing environmental pollution in newly-industrialized cities in developing countries. Such leachate is often found to contain high concentrations of heavy metals or hazardous elements such as bromine, which are used in flame retardant additives. Tunisia, for example, is struggling to cope with leachate that contains hazardous substances from a landfill that was closed in 1999. Before its closure, this open-dumping landfill received municipal and industrial wastes generated from the greater Tunis region over 30 years. This leachate contained high concentrations of non-metallic elements such as boron, sulfur, arsenic, selenium and bromine, and heavy metals such as titanium, chromium, cobalt, nickel and mercury. These hazardous substances are now polluting the soil and sediments and affecting the water quality of the groundwater and lakes around the closed landfill[59]. This illustrates the negative legacy that results from inadequate landfill controls or the disposal of untreated hazardous wastes in landfills.

Landfill gases are another byproduct of the process of the decomposition of organic waste by microorganisms within landfills. Its components include carbon dioxide, methane, nitrous oxide and hydrogen sulfide. Hydrogen sulfide, even in small quantities, is highly toxic and landfill gas with a low concentration of this substance is hazardous to human health. Carbon dioxide and methane are greenhouse gases, thus their impact on the global environment is a matter of concern.

Methane gas deserves special attention because its contribution to global warming is more than 20 times that of carbon dioxide. There are two options for reducing methane gas: (i) collecting the gas from landfills and using it as a source of energy; and (ii) designing landfills to curb methane emissions. For the first option, anaerobic landfills, which are commonly adopted in Europe, are recommended. With this method, donors are recently considering assistance that takes advantage of the Clean Development Mechanism (CDM) under the Kyoto Protocol and the Global Environment Facility (GEF) to construct facilities to collect methane gas and generate power[60]. For the second option, the preceding study by JICA[61] estimates the relative greenhouse effects of different types of landfill methods (in terms of CO2 equivalent). According to the study, if the effect of an anaerobic landfill is assumed to be 1.0, that for a semiaerobic landfill is 0.43, compared to 0.23 for a recirculatory semiaerobic landfill and 0.16 for an aerobic landfill. Therefore, a reasonable solution is the adoption of a semiaerobic landfill or aerobic landfill. Donors should provide support for landfill design that employs these methods.

[58] Tanaka et al. (1991); Ikeguchi (1994)
[59] Yoshida and Ghrabi (2002); Ibrahim et al. (2003)
[60] UNDP (2003) focuses on the applicability of CDM. The applicability of these options in India is noted in ETSU (1997) and Shekdar (1997), in Viet Nam in Augenstein, et al. (1996), and in Asian developing countries in Shikura and Harada (1997).
[61] Institute for International Cooperation, JICA (1993) Chapter 6, Section 1.

Box 2.6 The Road to Sanitary Landfill: Fukuoka Method

At landfill sites in Japan, leachate is usually controlled through a seepage control structure, such as impermeable liners or non-corrosive, stable partitions, so that it will not pollute the groundwater. (Inert type landfill sites and controlled landfill sites are required by law in order to prevent the leachate from seeping into the groundwater or public water bodies.) This approach is difficult for developing countries to adopt for both financial and technical reasons. Landfills in developing countries should be improved by less costly and the application of more appropriate technologies.

The Fukuoka landfill method is a semiaerobic landfill structure developed through joint research between the Faculty of Engineering, Fukuoka University, and the City of Fukuoka, which was launched in the late 1960s. This structure has large leachate collection and drainage pipes (large-diameter pipes) and gas collection pipes laid at appropriate intervals along the bottom of the landfill. This arrangement allows the leachate to be drained out of the landfill. In addition, the convection of air due to heat generated from the waste decomposition process allows fresh air to flow into and through the landfill. This makes the waste layers aerobic, thus promoting microbial activity. Microbial activity drives the decomposition process of the waste and reduces the BOD of the leachate as well as methane gas emissions. Since the landfill gases are largely made up of carbon dioxide, the contribution of the semiaerobic landfill to global warming is about half of that of an anaerobic landfill, which allows less air in the waste layers. Moreover, by draining leachate promptly out of the landfill, the semiaerobic structure controls its seepage into the groundwater table, reducing its impact on the groundwater [1].

Since the structure is simple and the cost is low, the Fukuoka method can be applied in developing countries using locally available resources. A technical cooperation project designed to improve a landfill in Malaysia (to which MATSUFUJI Yasushi, Professor at Fukuoka University and an expert in this method, was assigned) adopted this method extensively and achieved considerable success. Successful cases using this method were subsequently reported from Iran, China, Mexico and the Pacific region, thus attracting international attention [2]. As it has been highly evaluated as an appropriate technology, JICA is promoting this method in its Technical Training Program of Overseas Participants. Using the teaching materials that it has developed [3], JICA is promoting technology transfer and technical guidance (see Section 1-3 for details).

YOSHIDA Mitsuo, KONDO Sei

[1] Matsufuji (1997) [2] Johannessen and Boyer (1999) [3] Including teaching materials for JICA-Net; JICA (2004).

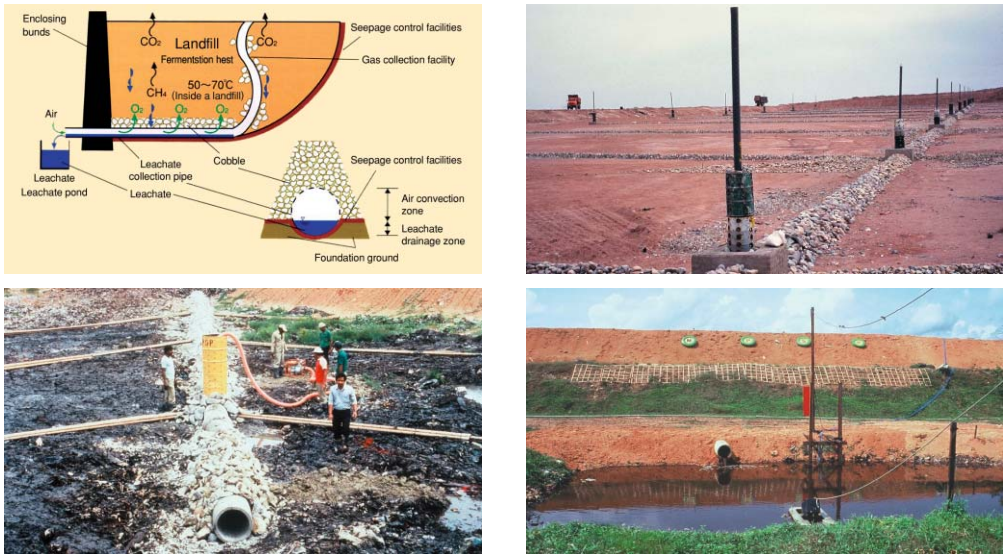


Photo 2-5 Structure of the Fukuoka method and its application in developing countries

Upper left : Structural chart of the Fukuoka method (Courtesy of the City of Fukuoka)
Upper right : Application in Teheran. Gas collection pipes laid at appropriate intervals. (Courtesy of the City of Fukuoka)
Lower left : Application in Malaysia under the guidance of a JICA expert (Prof. MATSUFUJI Yasushi). Bamboo, oil drums, construction debris and other materials that are locally available are used for the Fukuoka method. (Courtesy of Prof. Matsufuji)
Lower right : A retention pond and the termination of a leachate collection and drainage pipe in the landfill shown in the photo at lower left. The end of the drainage pipe is open to the air.

* These photos are provided through Mr. SAKAI Michihiro (now assigned by the City of Fukuoka to the UN Habitat Fukuoka Office).

2-5-2 Hazardous and medical wastes

Hazardous or medical wastes require proper management, since even small quantities can have a serious impact on the environment and human health.

Although this report generally deals with non-hazardous solid wastes, this section focuses on hazardous and medical wastes. This is because these types of wastes are often mixed with non-hazardous wastes for collection, treatment or disposal in developing countries. It is also often the case that developing countries do not have regulations regarding hazardous wastes [62]. Even if they do, such regulations are often disregarded.

(1) Industrial wastes and hazardous wastes

In developing countries, problems with industrial waste disposal tend to arise when industries are concentrated in certain areas or when hazardous wastes are generated in large quantities [63].

For donors, it is important to first check whether the recipient country concerned defines and controls hazardous wastes. In fact, many developing countries do not define industrial waste; they just classify wastes into just hazardous and non-hazardous wastes. Some developing countries have no classification system for wastes in the first place. The next step is to examine the definitions, if any, of radioactive, infectious and explosive wastes. These types of wastes, together with wastes collectively characterized as toxic or hazardous, need to be handled separately and differently from general municipal waste.

The proper management of hazardous substances in industrial waste is an extremely important issue for developing countries today. Businesses in developed countries are increasingly adopting a strategy of processing industrial products in developing countries where labor costs are low. If environmental standards in such developing countries do not cover new pollutants, these businesses may run the risk of discharging unregulated hazardous chemicals into the environment. For example, there is a possibility that chlorinated organic solvents, such as trichloroethylene (TCE) and tetrachloroethylene (PCE) used in dry cleaning or cleaning integrated circuits and printed circuit boards will be discharged indiscriminately into the soil and groundwater, contaminating drinking water. If discharged in large quantities or in high concentrations, these chemicals cannot be decomposed by microorganisms alone and they will find their way into the atmospheric circulation system and the hydrological cycle, including the rivers and oceans. They might even cause environmental pollution on a global scale.

Problems with hazardous wastes can be analyzed in three types of cases, as listed below:

- No regulations over industrial or hazardous wastes.
- Regulations over industrial or hazardous wastes in place but no treatment facilities based on such regulations.
- Both regulations over industrial or hazardous wastes and treatment facilities in place, but the regulations are not fully implemented.

It should be noted that even if regulations are in place, there is always an incentive to dump hazardous wastes illegally or mix them with other wastes, since the treatment of hazardous wastes is more costly than for non-hazardous wastes.

(2) Medical waste

Different countries define medical waste differently. Yet it is reasonable to use the term "medical waste" or "health care waste" as the

[62] In Japanese law, hazardous wastes (specially controlled municipal waste and specially controlled industrial waste) refer to wastes specified by a Cabinet Order as those that are explosive, toxic, infectious or otherwise harmful to human health or the living environment. However, the criteria for hazardous wastes vary greatly depending on the country. In some countries, wastes that are flammable, corrosive, or reactive as well as toxic are classified as hazardous wastes and regulated accordingly. In many other countries, wastes are divided into hazardous and non-hazardous wastes for the purpose of statutory control, without classifying them as industrial or non-industrial.

[63] The adjective "hazardous" here implies both "toxic" and "dangerous."

generic term for waste generated in medical services in general, and refer to waste that involves risks associated with vehicles of infection as infectious waste or pathological waste. Infectious waste, which must be placed under tight controls, accounts for 25-40% of medical waste as a whole[64].

Without the proper management and disposal of infectious waste, biohazards will result, including the spread of communicable disease. In developing countries, infectious waste is sometimes treated in the MSW flow (Photo 2-6), but this is quite dangerous. The public should be made aware of the risks involved. Hospitals must ensure the segregated management of infectious waste. WHO has published a detailed manual concerning the safety management of medical wastes.[65] This manual should preferably be followed.

Incineration is the most common and recommendable treatment for infectious waste. This does not mean, however, that any incineration method is appropriate. Microorganisms that are sources of infection must be processed in a suitable high-temperature chamber for a specified period so that they are completely disinfected. Unless this requirement is met, harmful bacteria and other pathogens may remain in the incineration residue or exhaust gases. A study in Japan shows that after infectious waste was burned in a small-scale rubbish furnace, the quantity of which was larger than the furnace's capacity, harmful bacteria remained in the exhaust gases and incineration ash[66]. Without appropriate incineration technology, it is impossible to prevent environment pollution that results in biohazards.

Some developing countries (the Philippines, Tunisia, etc.) ban the incineration treatment of waste as well as medical waste altogether for fear that it might produce dioxins. Donors should support these countries in ensuring the proper management of medical waste by such means as exploring alternative treatment technologies and conducting risk assessment.

(3) Transboundary movement of hazardous wastes to developing countries

Transboundary movements and the ocean dumping of wastes that contain toxic chemical wastes can have a serious impact on the global environment. Between the 1970s and 1980s, developed countries in the West exported hazardous wastes to countries in Africa and South America. Without proper treatment, these wastes often polluted the soil, groundwater and the environment in general in these countries[67]. In 1988, for example, more than 3,000 tons of wastes

Photo 2-6 Environmental pollution caused by hazardous wastes in Dhaka city, Bangladesh

The photo on the left shows medical (infectious) wastes that are collected as municipal solid waste. The photo on the right shows sludge open-dumped next to a leather processing factory. The sludge may cause hexavalent chromium pollution.

[64] Institute for International Cooperation, JICA (1993)
[65] WHO (1999)
[66] Takatsuki (1991)
[67] Third World Network (1989), Nomoto and Sakumoto (1996) Chapter 6.

that contained a large quantity of PCBs were shipped from Italy to Koko Port in Nigeria and left in the open air near the port. The shipper took back the wastes after strong protests from the Nigerian government. The freighter carrying the wastes sailed around the world but was denied entry at every port. This is known as the Koko incident.

To avoid the recurrence of such an incident, the international community adopted the Basel Convention on the Control of the Transboundary Movement of Hazardous Wastes and their Disposal in March 1989, at the initiative of UNEP. This convention, which controls the export of hazardous wastes by countries that have appropriate waste treatment technologies, came into effect in May 1992. Requirements under the convention include written consent, prior notification, and re-importation in the case of inappropriate export or disposal. Today, the transboundary movement of hazardous wastes is controlled under the Basel Convention, the London Convention and other international agreements. Yet the movement of such wastes from developed countries to developing countries is not always fully controlled due to such factors as inadequate domestic laws in the former countries and the economic benefits to be gained from the transfer of such wastes [68].

Issues concerning the management of hazardous wastes in developing countries include the development of legislation and standards, the improvement of monitoring technologies, the adoption of proper treatment methods, and the establishment of methods for environmental impact assessment. However, it may be worth adding that such monitoring and treatment methods cover the physical and technical aspects alone and provide after-the-fact solutions only. In other words, they are passive solutions; the focus should be on how to assess hazardous waste generation and proper treatment of the wastes [69]. The development of treatment and management methods is indeed necessary, but a more important issue is how to reduce hazardous wastes generation, in other words, how to control such wastes in the "upper reaches" of the waste stream.

2-6 Technical issues and structural factors along the waste management flow

This section summarizes technical issues and factors in each stage of the waste management flow (also known as the "waste stream" and "waste flow") as shown in Figure 2-5. Since it is difficult to limit the focus of discussion to the technical aspects, other aspects-including background information and factors related to solution planning-are also referred to, as necessary.

2-6-1 Generation, separation, storage and the discharge of wastes

Whether wastes are properly handled from the generation to the discharge stages has a considerable impact on the entire waste stream and urban sanitation.

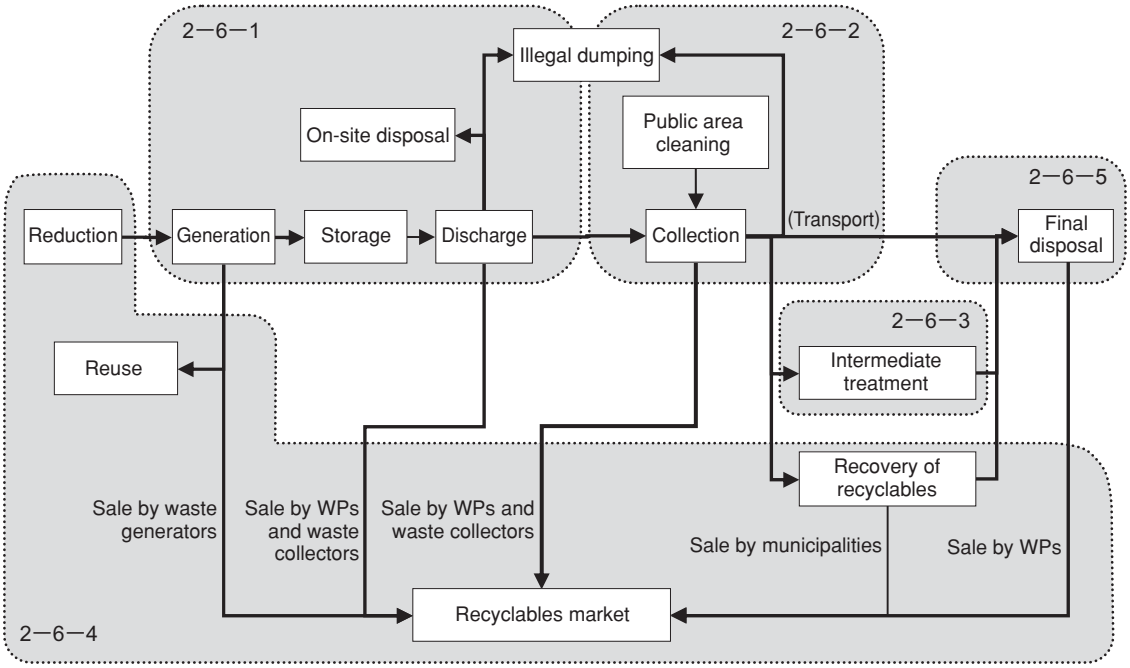
(1) Overview

Waste is generated when a product becomes useless from the point of view of its owner in the light of its designed purpose. Recent discussions concerning waste management have tended to focus on the stages before waste generation-or on waste reduction to be exact. Waste reduction can be achieved by selective purchasing or the production of highly durable goods. This theme is discussed in Section 2-6-4. This section instead focuses on waste generation as the first stage of the waste stream. It is worth noting that recyclables separated at source are sometimes not recognized as "wastes" by waste generators. This should be remembered when conducting field surveys on waste generators to collect waste generation data.

The behavior of each generator of waste determines how these wastes are treated from

[68] Clapp (2001)
[69] Takatsuki (1991)

Figure 2-5 Flow Chart of a Typical Waste Stream



WPs : Waste pickers.
The number corresponds to the section concerned.

Source : Compiled by OTSUKI Noriko

generation to discharge. Whether the wastes are properly handled at these early stages in the waste flow is an important factor in the improvement of the entire waste flow and urban sanitation. These stages are the only phases where the waste generators are directly involved in solid waste management (SWM). These stages therefore reflect the knowledge and awareness of the generators concerning waste management.

Once the waste is generated, the first thing the waste generator does is to store it. The types of containers used to store waste are very diverse depending on financial capacity and custom. Plastic buckets or bamboo baskets may be used as containers. When the condition of such storage containers-what they are made of, in what form, whether they have a lid, and where they are placed-is inappropriate with regard to the quantities and properties of the wastes, a range of problems may arise, including foul odors, windblown litter, and the attraction of flies, rats and other pathogen-carrying animals.

Waste stored by the waste generator is discharged within a short time. How the waste is discharged is closely related to the type of collection service available to the waste generator (the forms of collection services are discussed in the next section). Table 2-14 shows problems associated with the discharge of wastes and possible solutions that can be adopted by the waste generators.

Sharp-edged or pointed items in waste, explosive wastes and liquid wastes may cause safety and health problems at the subsequent stages of intermediate treatment and final disposal no matter how they are collected. Wastes with such properties are regularly generated from households as well as industrial plants and medical institutions. Municipalities should establish storage and discharge rules according to the properties of the wastes, publicize these and ensure that the residents observe them.

(2) Discharge out of wastes where the collection service is inadequate

Residents may dispose of waste themselves by burying or burning it in their backyards or may even dump it illegally in areas where no collection service is available or the service is inadequate or inconvenient in terms of the low collection frequency or distance to the collection point. These uncollected wastes may litter the neighborhood and give rise to secondary problems. For example, they may find their way into ditches, causing flooding due to blockage. In addition, rainwater may gather in the emptied waste containers, providing a breeding ground for mosquitoes and flies.

Avoiding these adverse situations requires expanding the collection areas and improving the collection service. The next section discusses how this can be achieved.

2-6-2 Collection and transportation of waste

Waste collection and transportation are the basis for SWM and represent the major proportion of the SWM budget in developing country cities.

Waste collection and transportation constitute the operations to transfer wastes from their source to the ultimate destination-the final disposal sites (or intermediate treatment facilities). The most important objective of SWM services is to "remove waste from the neighborhood." In this sense, the operation of collection and transportation forms the basis of SWM services. However, developing country cities, especially cities that are experiencing rapid population growth or fast-growing urban sprawl, often fail to achieve this objective since they lag behind in providing collection services for the entire city. Nevertheless, collection and transportation represent the largest proportion of the SWM budget in developing country cities. For this reason, the introduction of optimal systems in these stages of the waste stream can produce significant outcomes.

With regard to terminology, the division between collection and transportation is sometimes blurred. In this section, the whole operation of transferring wastes from their source to the final disposal sites (or intermediate treatment facilities) is referred to as "collection and transportation." When these two words are used separately, "collection" means "gathering

Table 2-14 Problems and solutions at the discharge stage according to the form of collection

Collection form	Problems	Solutions for the waste generators
Door-to-door collection	Waste scatters when loading it onto the collection vehicle.	• Use a waste container that minimizes litter when loading.
Curbside collection	The wind or animals scatter waste placed at the curbside. Waste scatters when loading it onto the collection vehicle.	• Use a bag or container that can hold the waste securely. • Use a container or net that prevents dogs, cats, crows, etc. from scattering the waste. • Do not place the waste at the curbside too early. (The municipality needs to set the collection times and to notify the residents.)
Station collection	Waste litters the collection points. Waste remains uncollected, disfigures the landscape or attracts rats and flies. Waste is scattered when the collection workers load it onto the vehicle manually, e.g. by using a shovel.	• Place the waste in a plastic bag that should be securely closed. • Place the waste properly within the designated space. • Use a container or net to prevent dogs, cats, crows, etc. from scattering the waste. • Do not place the waste at the collection point too early. (Municipality needs to establish the collection times and to notify the residents.) • Residents who use the same collection point take turns in cleaning it regularly, as appropriate (depending on the division of responsibilities between the municipality and the residents regarding the management of collection points.)
Bell collection	Waste is scattered when loading it onto the collection vehicle.	• Load the waste onto the collection vehicle carefully. Take every opportunity to avoid litter. • Use a waste container that minimizes the generation of litter when loading.

Source : Compiled by OTSUKI Noriko

wastes from the various sources" while "transportation" means "transferring the gathered wastes to the final disposal sites (or intermediate treatment facilities)."

(1) Collection methods

One of the technical issues in the collection stage is the selection of an optimal collection method. Table 2-15 shows the major forms of collection and their characteristics.

The selection of an optimal method is merely a process through which solid waste planners consider: which type of collection method in the table they will adopt; what equipment they will use; how often they will collect the wastes; and how they will allocate human resources. Waste planners should examine a range of issues from their social, economic, natural and cultural aspects. Among such issues are: the quantities and characteristics of the wastes, the financial capacity of the municipality, road conditions, the availability of support from the waste generators, lifestyles, the home environment, land use in the neighborhood, and climatic conditions.

Table 2-16 shows how each of these issues or considerations affects the selection of the collection methods. There may be other issues and considerations depending on local conditions. In addition, it is often the case that more than one method is adopted for the area concerned, rather than only one.

Based on their own vested interests, many people are formally or informally involved in collection services. These services also interact with residents in various ways on a daily basis. As a result, the services are often susceptible to political intervention. In addition, since these services are closely associated with the discharge

Table 2-15 Collection forms and their characteristics

Collection form	Method	Advantages	Disadvantages
Door-to-door collection	Waste collectors visit each household and receive the waste. Equipment other than vehicles is often used, such as handcarts and animal carts. It is not feasible to haul wastes collected door-to-door directly to final disposal sites in terms of both distance and operational efficiency. This method is usually combined with station collection, and door-to-door collection covers transfer from the generator sources to the collection points.	Quite convenient for the waste generators. It creates many jobs since it is labor intensive.	High labor cost. Minimal participation of the waste generators in SWM.
Curbside collection	The waste generators place the waste in front of the front door or entrance of their homes. Handcarts and vehicles are used for the collection. Some municipalities use containers that can be lifted mechanically and emptied into the collection vehicles.	Convenient for the waste generators.	Could scatter waste or otherwise disfigure the landscape due to the use of inappropriate containers or a discrepancy between the discharge time and the collection time.
Station collection	The waste is carried to the communal collection points by the residents or door-to-door waste collectors for temporary storage. This method is also referred to as container collection if containers are placed at the collection points. Dump trucks, compactors and other vehicles are usually employed for transportation from the collection points.	High collection efficiency. Once the collection points are established, can provide collection services in hitherto non-service areas due to poor accessibility to individual houses.	Inadequate management of collection points results in the scattering of waste, creating unsanitary conditions. Sites for the collection points may be difficult to secure. Waste, containers, concrete enclosures and other structures at the collection points may be affected by strong sunlight, torrential rain, wind gusts, and animals living nearby. Manual transshipment of waste to the collection vehicles may cause problems, including short shipment, scattering of waste, and loss of time.
bell collection	Waste collectors call the attention of residents by ringing a bell or playing music from a loudspeaker on the collection vehicle. Dump trucks, compactors and other vehicles are usually employed in this method.	High collection efficiency in rather densely-populated areas. Little litter since there is no time lag between set-out and collection.	Inappropriate for residents who are busy or living in high-rise multifamily dwellings. Meaningless if residents are not at home. To avoid this, waste planners need to establish a collection schedule (collection day and time) and make it known to the residents. Municipalities need to operate the collection work according to the set schedule.

Source : Compiled by OTSUKI Noriko

behavior of the waste generators, an approach that goes beyond technical solutions, apart from optimal design of the methods of collection, is required when such services are introduced.

(2) Problems associated with diversifying the collection service providers

It has been considered in most cities that SWM, particularly waste collection services, should be the responsibility of municipalities. Yet, in many developing country cities, the collection capacity does not fully meet public demand for the collection services. In fact, an increasing number of municipalities are promoting private sector participation (PSP) to expand such collection services. The fact remains, however, that the success of PSP depends on the institutional capacity of the municipality, including its ability to supervise and pay private service providers. In addition, it may be difficult for municipalities to provide public waste disposal services for squatter settlements. As if to fill this void, a range of small-scale non-public organizations, such as NGOs, CBOs and micro-enterprises, are increasingly providing such services to these areas (see Sections 2-3-4 and 2-4-3).

Given the limitations of the capacity of municipalities, participation of a range of entities in collection services is essential in order to achieve the key objective of removing waste from every neighborhood. Yet attention should be given to the need for integrated waste management that covers the entire waste flow, as illustrated in Figure 2-5. Unless wastes collected from their source are transported to landfills and properly disposed of, problems arise elsewhere in the form of illegal dumping, for instance. Long-distance haulage and landfill management, which are beyond the capacity of small-scale non-public organizations, should essentially be the responsibility of municipalities.

For this reason, if a municipality wants to promote collection services by NGOs, CBOs and micro-enterprises as a component of its SWM, the municipality should have sufficient SWM

Table 2-16 Issues and considerations in selecting the collection methods

Issues	Considerations in collection method selection	Factors that affect collection method selection
Quantities and characteristics of the waste	Average waste generation on a mass basis; average density; average waste generation on a volumetric basis.	Required volumetric capacities of waste storage containers and collection points; required collection frequency (depending on the relationship between the available space and the waste generation on a volumetric basis); capacity and specifications of the equipment.
Financial capacity of the municipality	Financial capacity for replacing/purchasing and maintaining equipment, hiring workers, etc.	Applicable equipment options; collection frequency; collection form options.
Road conditions	Width; traffic congestion level; gradient; roadbed conditions.	Types and specifications of the equipment.
Configuration and arrangement of the collection points	Configuration that facilitates waste removal from the collection points; distribution density of the collection points.	Waste in bags or waste only? Collection vehicles are compactors, container vehicles or trucks?
Availability of support from the waste generators	Willingness of the waste generators to bring waste to the collection points and support their management; a sense of solidarity among the waste generators.	Collection form options; methods for managing collection points.
Lifestyles	Whether family members are at home or not; their daily schedules.	Collection form options; collection work plan.
Home environment	Availability of storage space depending on, for example, whether the homes are multifamily dwellings or detached houses.	Collection frequency.
Land use in the neighborhood	Availability of space for the collection points depending on, for example, the density of the homes and land ownership.	Collection form options; distribution of the collection points.
Weather conditions	Decomposition rate for organic wastes under hot and humid conditions; possibility of the collection points being inundated due to high rainfall.	Collection frequency; structures for storage containers and collection points.

Source : Compiled by OTSUKI Noriko

capacity so that it can transport wastes that have been collected by these small-scale non-public organizations to the landfills and dispose of them properly.

(3) Problems with the recovery of recyclables at the collection stage

In many cases, recyclables are recovered at the collection stage by collection workers. Problems associated with this practice include low collection efficiency and injuries resulting from picking the waste. The recovery and sale of recyclables often provides an important supplementary source of income for collection workers whose regular pay is usually low. This is why the social aspects of SWM need to be addressed in addition to the institutional and managerial aspects.

(4) Waste transportation

Waste transportation rarely becomes an issue if the final disposal sites (or intermediate treatment facilities) are located near built-up areas, since such transportation is regarded as an extension of the collection services. In areas experiencing rapid urbanization, however, it is physically difficult to construct a final disposal site near the built-up areas. Moreover, the NIMBY (not in my backyard) phenomenon is growing amid democratization and the heightened awareness of city residents. In fact, the tendency is for final disposal sites to be constructed further and further away from built-up areas.

When final disposal sites are far from urban areas, the time taken for driving becomes longer than for collecting if the collection vehicles always transport wastes to the final disposal sites. This is economically unfeasible in terms of the energy efficiency of transportation and operational efficiency of the collection workers. This is because more time is spent on transport than collection. There is even the possibility that wastes will be dumped illegally on the way due to a lack of conscientiousness or inadequate supervision of the drivers and workers. To solve these problems associated with long haulage distances, it is necessary to consider the introduction of transfer stations, where wastes are transferred from collection vehicles to larger vehicles such as tractor trailers.

Higher transport efficiency is achieved when the transfer stations are constructed nearer to the waste collection areas. The nearer the transfer stations are to residential areas, the greater the attention that needs to be paid to the environmental, sanitary and social aspects of this arrangement. Transfer stations, for their part, should be designed to ensure that the working area is closed to the outside with the use of covering and other structures, so that odor emissions, waste scattering and food scavenging by animals can be prevented. When waste pickers are to be given opportunities to recover recyclables, it is necessary to control their entry and exit, and set rules on operational procedures.

(5) Public area cleansing

In developing country cities, the cleaning of streets, parks and other public areas often represents a significant part of SWM.

Cleaning of the streets, parks and other public areas, together with the collection and transportation of waste, plays an important role in SWM in that it removes waste from cities to maintain sanitary conditions. Public area cleaning often represents a major part of SWM as a whole in developing countries[70]. This is due to the following factors:

(i) Traffic scatters the stones and sand on the road surface due to bad road conditions.

(ii) Waste is left uncollected on the streets or in

[70] JICA (1992) estimates that street sweeping accounts for 23% of the total expenditures of the SWM department of the Vientiane Municipality. It represents about 50% of the collection expenditures. According to JICA (1999), street sweeping makes up 39% of the total SWM expenditures in the Tegucigalpa area, Honduras. This is comparable to collection expenditures.

other public areas due to inadequate or inappropriate collection services.

(iii) People litter because there are no litter bins installed in public areas or because people do not observe the discharge rules.

(iv) Waste from landscape care and tree trimmings are generated in large quantities in tropical regions where the vegetation is abundant.

(v) Street sweepers are also often hired without demand assessment under pressure to create jobs.

Steps to be taken to reduce factors (ii) and (iii) include improving the collection services as discussed earlier, installing litter bins for pedestrians, controlling littering, and promoting civic education to ensure that every citizen observes the discharge rules. These steps can reduce the burden of public area cleaning on municipal finances.

Yet the need for public area cleaning remains. To improve this service, the following issues should be considered:

(i) Weighing up the pros and cons of introducing street sweeping cars

Public area cleaning provides a means of creating jobs in developing countries, where labor costs are low. Many women also work as street sweepers[71]. As a result, some of the street sweeping cars are not actually needed in many cases. When they are judged to be necessary, even so, it is important to select street sweepers that can accommodate an operational environment that is significantly different from that in developed countries, since roads in developing countries are often covered with scattered stones and sand.

(ii) Optimizing storage containers, transshipment and transportation for street sweepings

In a typical street sweeping operation, street sweepings collected in containers by the sweepers are transshipped to vehicles at transfer points and hauled to the final disposal sites. The time taken for transportation to the transfer stations and transshipment there should be reduced for operational efficiency. Steps to this end include: the use of large containers as far as possible; the adoption of a system that allows for direct transshipment to vehicles at the transfer points without unloading the street sweepings onto the ground before loading; and the selection of sweeping routes that minimize the need for sweepers to cross the street.

To ensure the safety and health of sweepers, it is important for them to wear gloves, masks, uniforms and other protective gear.

(6) Maintenance of vehicles

Solid waste management employs vehicles and heavy machinery for the processes of collection, transportation and final disposal. The number of service years of such vehicles is about seven years in developed countries, but often more than ten years in developing countries. Decrepit vehicles themselves cause air pollution and may block the traffic if they break down on the road. Moreover, frequent breakdowns hinder the reliable delivery of collection services and the proper management of final disposal sites. Therefore, the maintenance of vehicles is an important issue, but it faces the following problems in developing countries:

(i) Municipal solid waste in developing country cities tends to be high in organic and moisture content and the density is therefore also high. This means that the weight load on vehicles tends to be higher than in developed countries, where the load capacity is specified in volume rather than weight.

(ii) The operational environments are harsh, with roads in a bad state of repair and landfill sites in a muddy condition due to the high rainfall.

(iii) Vehicles are often provided by external donors. The problem with this is that spare parts and technical support are unavailable where there are no agencies of the vehicle manufacturers concerned. Another problem is the difficulties associated with the systematic procurement of spare parts, unified inventory control, and the acquisition of repair skills, if the fleet has various types of vehicles.

[71] The website of UNEP/International Environmental Technology Centre (http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/SP/SP3/SP3_4.asp (Accessed in October 2004).

(iv) Operational control procedures such as keeping vehicle operation records and inventory ledgers of vehicles and spare parts are not institutionalized.
(v) Financial mobilization to replace vehicles and procure parts is inadequate. Even if funding is adequate at the municipality level, the SWM department often cannot spend even a small amount of money at its discretion to take prompt action since municipalities tend to be excessively fastidious in ensuring accountability for their expenses.
(vi) Other departments often control the entire vehicle fleet of the municipality, hindering prompt or flexible action by the SWM department.

To solve these problems, a number of steps should be taken when introducing vehicles and heavy machinery. Among such steps are: designing specifications to accommodate local conditions (such as natural conditions, road conditions, the quantities and characteristics of the waste, and the types of the existing vehicles), instructing how to use and manage, establishing meticulous aftercare systems, improving management frameworks, and formulating financial plans to purchase spare parts and equipment in the future.

2-6-3 Intermediate treatment

Intermediate treatment has many advantages, such as volume and weight reduction and stabilization of the waste, but the introduction of this treatment requires careful examination of its cost-effectiveness.

Intermediate treatment refers to any type of processing applied to the waste between its collection and final disposal. This has many advantages: volume and weight reduction of the waste, stabilization of the waste (elimination of decomposability and toxicity), effective use of resources, and reduction of its impact on global warming.

The following paragraphs summarize major options for intermediate treatment and issues associated with each option. Waste reduction and resource recovery are also discussed in Section 2-6-5.

(1) Size reduction

Size reduction processing may be applied to bulky wastes such as furniture and electrical appliances so that they can be easily sent for final disposal. After size reduction processing, recyclables may be recovered, including the recovery of iron using powerful magnets. In developing countries, however, such bulky wastes are mostly recovered as recyclables before their collection and transportation. Therefore, size reduction processing is largely applied as part of a pretreatment process for composting, which is discussed later.

(2) Incineration

Incineration is a major technique for intermediate treatment in developed countries. Japan's municipal waste incineration rate is exceptionally high. This is because landfilling is costly due to the high price of land, and the volume and weight reduction of the waste afforded by incineration greatly reduces the final disposal costs. In addition, energy recovery from incineration helps prevent global warming. Such energy recovery is called "waste-to-energy" as an alternative to fossil fuel electric power generation.

However, incineration may not be appropriate for many cities in developing countries for the following reasons:
(i) Final disposal costs are generally low in developing countries since land prices are relatively low and the final disposal methods are simple. Waste reduction by incineration therefore does not significantly reduce the final disposal costs. Hence, incineration is irrelevant as a financial measure in general. The impact of incineration on waste volume reduction is less when the density of the waste is higher than in developed countries, which is often the case.

(ii) A comparison with the composition of waste in cities in developed countries shows that waste in the developing countries contains more kitchen waste, earth/sand and yard trimmings, and less paper and plastics. Thus the calorific value of the waste is lower, which requires supplementary fuel for incineration, in other words, extra operational costs.
(iii) There is a lack of financial capacity to cover the cost of the construction, operation and maintenance of incinerators.
(iv) There is a lack of highly skilled personnel that can control pollution and maintain stable incinerator operations, which are made more difficult by the variable composition of the waste.

For these reasons, before introducing the incineration process, it is necessary to weigh up a number of factors, including the level of difficulty of securing final disposal sites in the future, the costs of final disposal, trends in the quantities and characteristics of the waste, and the technical level of the municipality [72].

(3) Composting

Composting refers to a microbial process in which the organic portion of the waste is allowed to decompose under aerobic conditions. The resultant product, known as compost, does not give off odors or decompose. Compost is applied to farmland and pasture as a soil conditioner or organic fertilizer. It is also used as a cover material for landfill sites. Composting has a number of advantages. It reduces the waste to be disposed of in landfills. When the compost is put to use in landfills, it reduces methane emissions caused by the anaerobic decomposition of the organic portion of the waste. The contribution of methane emissions to global warming is much greater than that of carbon dioxide emissions. If impurities such as plastics and metals are removed from the compost for the purpose of quality control, as discussed later, they can be recovered as recyclables.

Due to these advantages and the high organic content of MSW in developing countries, composting is generally regarded as a promising option for waste treatment. However, the following issues should be considered before deciding to apply this option:

(i) Demand prospects for the compost

Demand in the agricultural sector is subject to seasonal fluctuations. The construction of storage facilities and other steps are required to cope with these fluctuations.

(ii) Economic viability

The sales price of compost should be set based on such factors as the price of alternatives (synthetic fertilizers and manure) and the willingness to pay on the part of farmers (consumers). The cost of transportation between the market (farms) and composting facilities should also be taken into account. Municipalities should be ready to bear a financial burden caused from economic viability lower than their expectations.

(iii) Quality control

To improve the quality of compost, it is necessary to introduce separate collection or remove impurities at the pretreatment and final phases of composting. Demand forecasting in (i) and price setting in (ii) should be carried out according the quality of the compost. A viable option may be to compost only market waste, which is generally organic and stable in composition.

Photo 2-7 An example of small-scale composting equipment (in Manila, Philippines)

The rotating drum allows for mixing and aeration.

[72] The World Bank has prepared a useful and comprehensive tool for decision-makers for the introduction of municipal solid waste incineration in developing countries. Rand et al. (2002).

(iv) Disposal of residues

Residues are inevitable. It is necessary to forecast their quantities and develop a disposal plan.

(v) Consensus building

It is inevitable that the composting process will produce foul odors to varying degrees. This is why consensus building with local residents is necessary, not to mention careful site selection. Some composting facilities installed without prior consensus building were forced to close [73].

There are two types of composting: centralized large-scale composting that serves the whole or part of the area of a city and decentralized small-scale composting that covers a certain number of waste generators or a community. Composting processes can be largely divided into two types: the windrow process and the aerated static pile process. The former is a simple method of building the material (waste) into a large pile like a ridge and physically turning (mixing) it on a regular basis to maintain aerobic conditions. The latter method involves building the material into a pile over a vent pipe and forcing air through the material. For facility operation, a wide range of options are available in relation to shredding, fermentation, recyclables recovery, and a choice between manual or mechanical operation for each process. The facility design and operational management should accommodate local conditions, including: the quantity and quality of the incoming wastes, the general conditions in the recyclables market, wage levels, the area of available land, and the distribution and fluctuations in compost demand [74].

(4) Biomass energy

Biomass energy is energy based on the carbon in plants produced by photosynthesis, which uses the energy from sunlight. When biomass energy is consumed, carbon is released. This carbon was originally in the air when the biomass was formed. Therefore, biomass energy does not increase carbon dioxide in the air, unlike oil, coal and other fossil energy sources. This is why biomass energy is regarded as a renewable form of energy that does not contribute to global warming.

Since food residues, yard trimmings and paper in MSW are broadly regarded as biomass, energy produced by the incineration process discussed in the preceding paragraphs is a type of biomass energy. When the term "biomass energy" is used in a narrow sense, it refers only to energy produced using industrial organic wastes, that is, chaff, bagasse (residues left after the extraction of the juice from sugar cane), manure and other similar wastes that are generated in large quantities. Biomass energy can be used by burning biomass directly or the gas or oil produced from the biomass through methane fermentation or pyrolysis to generate heat or electric power. Ethanol, which is produced by the alcoholic fermentation of biomass, can be used as an alternative fuel to gasoline [75].

2-6-4 Waste recycling and reduction

Waste recycling and reduction is an important element of SWM in developing countries as well as developed countries in terms of reducing SWM costs, effective use of resources, and lessening the burden on the environment. Developed countries emphasize waste reduction, reuse, recycling, heat recovery and proper disposal in this order of priority. This idea is increasingly accepted by developing countries. This section focuses on the promotion of the 3Rs (reduce, reuse, recycle) in the context

[73] In Katmandu, Nepal, for example, a composting plant that had been constructed with aid from a bilateral donor was forced to suspend operations in the face of many complaints from local residents. In a suburb of the Tunisian capital, an automatic composting plant was built with aid from another bilateral donor. Yet the Tunisian Government decided to close the plant under pressure from local opposition. Instead, a new plant is being constructed in a rural area.

[74] Hoornweg et al. (1999) provides a useful guidance note for the introduction of composting in developing countries. This document is downloadable from the website of the World Bank.

[75] Ikegami (2002), in the introduction, provides a useful reference material on the use of biomass energy in the solid waste sector.

of SWM in developing countries.

The characteristics of waste reduction and recycling in developing countries are as follows:

(i) The informal sector plays a large role.

(ii) The value of recyclable materials is higher than in developed countries, allowing recycling to be economically viable. With the growing importation and exportation of recyclables, the price of recyclables is susceptible to market fluctuations.

(iii) Recycling such as waste pickers provides an easy access to income for workers under harsh employment conditions.

(1) Recycling

1) Flow of recyclables recovery

As the waste flow chart in Figure 2-5 illustrates, materials in waste that retain a utility value may be traded in the recyclables market. The recovery of recyclables involves reclaiming what can be traded in the market from wastes. In developing countries, a large part of recyclables recovery is undertaken by the private sector, including the informal sector. By the access to the recyclables market, a wide variety of wastes are recovered, including bottles, cans, paper, metal and plastic. It is estimated that the recycling rate-the proportion of recyclables to be recovered in waste as a whole-is generally higher in developing countries than in developed countries. Behind the high recycling rate are urban population growth and limited employment opportunities. Low labor costs mean that it is possible to gain profits from the recovery of even recyclables with a low market value. Thus recyclables recovery in developing countries is more related to economic gains than to the goal of SWM in many cases.

The fact remains, however, that the recovery of recyclables has a number of advantages in the context of SWM, including the effective use of finite resources, the reduction of waste quantities to be transported and landfilled, and the extension of the service life of the final disposal sites. Recyclables recovery as a policy of the municipality is aimed at obtaining the benefits of these advantages.

The locations at which recyclables can be recovered are roughly divided into four, although they are subject to local conditions.

(i) Generation sources and their surroundings

Collectors make the rounds of households, collection points and establishments.

(ii) Collection process

Collection workers recover recyclables through their work (including the transshipment process at the transfer stations).

(iii) MRFs

Recyclables are separated from wastes and recovered at materials recovery facilities (MRFs, also known as recycling centers). At some MRFs, workers on both sides of a belt conveyor pick out specified recyclables from wastes on the moving belt. Other MRFs are smaller-scale community-based facilities that are equipped with separate containers for different types of recyclables. Waste generators bring recyclables to these facilities and place them in type-specific containers.

(iv) Final disposal sites

Waste pickers recover recyclables from wastes at the final disposal sites.

The recyclables stream after this primary recovery is complex. Yet recyclables recovered here generally go to secondary collectors/separators known as junk shops or intermediate processors for use in manufacturing products. For reference, Figure 2-6 shows the stream of paper (including recycled paper) and paper products in Malaysia.

2) Actors in the recycling process

It is assumed that the following actors input waste into the recycling process. Note that two considerations should be taken into account. Firstly, in developing countries, the informal sector plays an important role in the recycling process, unlike in the developed countries, as

discussed earlier. Secondly, municipalities are not so enthusiastic about recycling as a result.

(i) Households

The collection rate of such materials as glass, cans and plastic by collectors will improve if source separation is promoted at the household level. Source separation of organic wastes is an effective option in municipalities where there are favorable conditions for recycling these wastes, which represent the largest share of MSW in developing countries. It is common practice for collectors, scrap dealers and communities to recover recyclables from waste collection points.

(ii) Communities

Recycling activity at the community level is a major component of community-based solid waste management, which is now attracting attention. Such activity revolves around the composting of organic wastes and the collection of recyclables. See 2-4-3 for activities at the community level.

(iii) Establishments and markets

Recovery by scrap dealers is common.

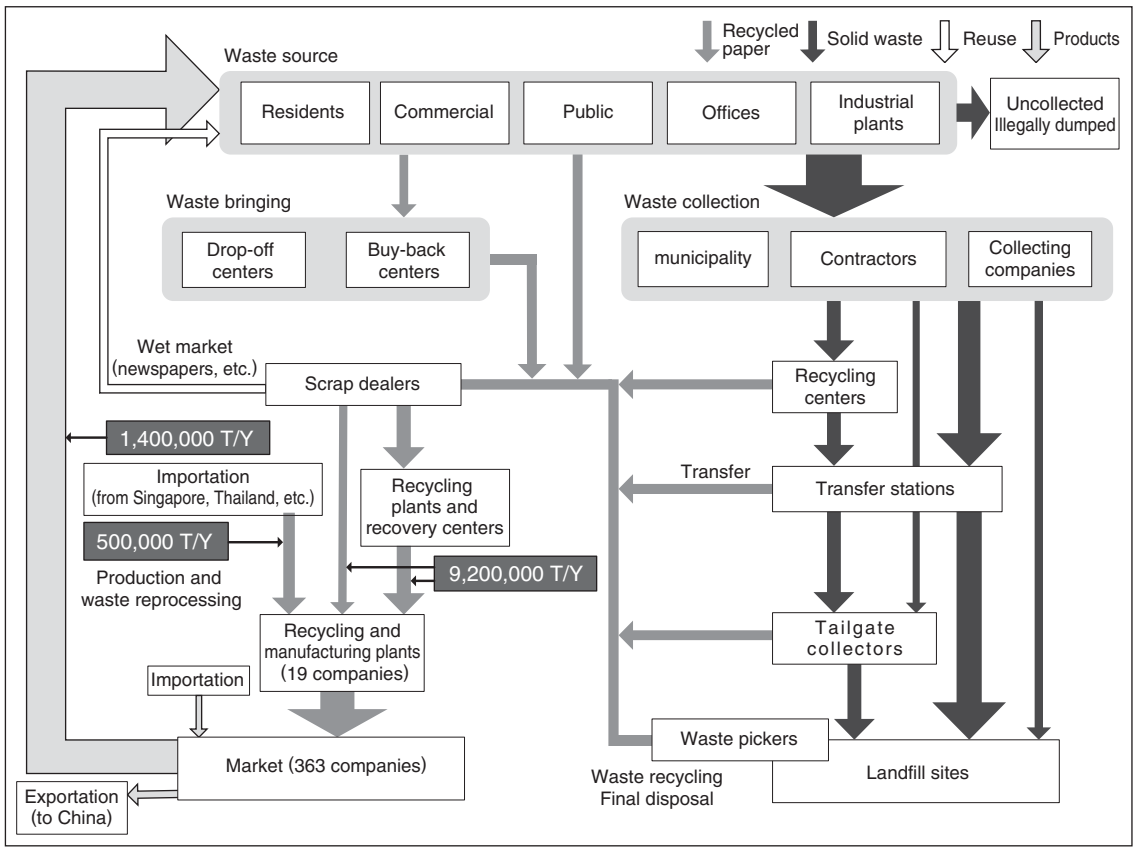
(iv) Scrap dealers and recyclers

Recyclables are further sorted by scrap dealers. Collection and sorting at this level may be multi-layered. Junk shops are sometimes concentrated in a particular area, as exemplified by auto parts dealers in large cities. The transportation costs involved vary according to the distance to the users of the recycled materials.

(v) Collection workers and waste pickers

Collection workers do recover recyclables during their work. They typically mount a basket on the collection vehicle for this purpose. Waste pickers recover recyclables from wastes at the landfill site.

Figure 2-6 Flow chart of the paper and paper product stream in Malaysia



Source : JICA (2004e)

(vi) Municipalities

Materials that can be recycled are already in the recycling stream without the intervention of the municipalities. Under circumstances where recyclables are traded on a market basis, it is difficult for municipalities to implement effective recycling programs. Separate collection by municipalities deserves caution since it pushes up the total collection costs.

3) Recycling markets

The scale of recycling is largely dependent on the market for products made from recycled materials. To promote recycled products, it is important for governments to raise public awareness and purchase such products as a matter of policy.

Recycling activity is limited in island nations and other countries where the recycling market is small.

4) Characteristics of the urban informal sector

Informal recycling is practiced along with waste collection services in many countries. How to maintain the existing recycling system is an important issue for SWM planning. Such an informal recycling system has the following benefits [76]:

(i) Creation of employment and income
(ii) Savings incurred through waste reduction
(iii) Extension of the service life of landfills through reduction of waste
(iv) Conservation of natural resources
(v) Savings on foreign currency through reduced reliance on materials and energy imports
(vi) Higher cost-effectiveness than formal recycling systems

Mr. NAKANISHI Toru has conducted a study on the urban informal sector in Metro Manila [77]. He concludes that scrap collection is virtually the only sector that provides a rather easy income means of access to people who have just moved from the provinces-a labor market that guarantees freedom of entry to some extent.

In the study, NAKANISHI first puts forward the hypothesis that: "The competition mechanism is not working effectively in markets in the urban informal sector. The mechanism is made irrelevant by the division into groups with the same blood relationship or groups of people from the same province. This division is deepened by mutually-beneficial personal relationships that have been formed to avert risks arising from imperfections in information. Because of this division, the labor market has the nature of a monopolistic buyers' market."

Then NAKANISHI proves this hypothesis by presenting four major facts. Firstly, each scrap collector concludes a verbal (or tacit) agreement with his or her scrap trader. Secondly, there are disparities in the buying prices for scrap. Thirdly, scrap dealers make loans to their scrap collectors. Fourthly, traditional values and norms are built into the patron-client relations between them [78].

5) Considerations for municipality involvement

A major difference between recyclables recovery as municipal activity and the same process as a private sector activity is that the former is based on rules set by the municipalities while the latter is based on economic incentives, that is, profitability. Separate collection rules for the private sector cannot be set by municipalities, who by their very nature cannot possibly be flexible enough to cope with the ever-changing market conditions for recycled products. Moreover, since municipality rules have to be simple, they usually separate wastes by the types of materials, such as bottles and paper. The problem is that materials of the same type are lumped together regardless of their market value. Furthermore, when there is a system in place whereby waste generators sell recyclables to scrap dealers, only materials with a low market value are put out for separate collection by the municipalities.

For these reasons, the following considerations should be taken into account if the

[76] World Bank (2001)
[77] Nakanishi (1991), pp. 130-149.
[78] *ibid*.

recovery of recyclables is to be introduced as the activity of the municipality.

(i) Prospects for recycling becoming a burden on municipal finances

For the reasons mentioned above, separate collection by the government involves many risks. Municipalities should be ready to mobilize financial resources to cope with these risks. Municipalities should also recognize that their institutions are poor at selling things. A major precondition for bearing such a financial burden is to focus on improving SWM, including cost reductions in waste transportation and final disposal and extension of the service life of landfills, rather than on gaining profits directly from recyclables recovery. In fact, final disposal costs tend to be low in developing countries due to the simple final disposal methods. In many cases, the recovery of recyclables has little impact on the reduction of final disposal costs. In such cases, municipalities should give priority to improving the final disposal sites over mobilizing funds for recyclables recovery.

(ii) Promotion of a dialogue with waste generators

When municipalities call on waste generators to practice source separation, they need to provide information not only on how to separate wastes, but also on why the separation is necessary and where the separated wastes will go after their collection, in order to ensure their compliance.

A dialogue should be conducted to gain the cooperation of the waste generators to clarify the division of responsibility for recyclables recovery. The collection of mixed wastes is convenient for the waste generators, but puts a strain on the separation process at resource recovery facilities. On the other hand, source separation poses difficulties for the waste generators, but makes it possible to simplify the separation process.

Dialogue is also needed to build a consensus with local residents who may be affected by the construction of resource recovery facilities. Such a consensus is also needed on how to control possible noise and foul odors from these facilities.

(iii) Intervention in existing separated collection systems by the private sector

Supply and demand in the recyclables market are subtly balanced. If municipality intervention in separate collection destroys this balance, the livelihoods of the private sector actors involved are threatened. Municipalities should refrain from intervention in separate collection by the private sector as far as such collection of specific materials is deemed sustainable based on the prospects for recyclables generation. Rather, municipality should focus on measures designed to support recyclables collection by the private sector.

6) Environmental labeling

Environmental labeling is a measure to promote recycling and recycled products. An increasing number of developing countries have already introduced environmental labeling. Reducing packaging and containers and the use of plastic bags at the retail sale level requires changing the mind-set of consumers.

(2) Source reduction

As the income levels in developing country cities rise, there is an increasing need for source reduction.

1) Reduction by households

At the household level, kitchen waste can be composted or used for livestock feed. Wastes generated from high income households tend to contain a high proportion of recyclable wastes.

2) Reduction by establishments

Many establishments adopt cleaner production, waste minimization, and other techniques to reduce both production costs and wastes. These managements are attracting attention as win-win approaches that are designed to both improve productivity and reduce the pollution load[79], with many businesses still

reluctant to respond to calls for environmental regulations as part of industrial environmental management. However, the widespread adoption of these approaches is hampered by difficulties in distributing information and securing the human and financial resources.

3) Extended Producer Responsibility (EPR)

An increasingly number of countries have adopted the concept of Extended Producer Responsibility (EPR), or are considering adopting it. At issue is: (i) the scope of wastes for which producers are to be held responsible; and (ii) how producers fulfill their responsibilities.

2-6-5 Final disposal

It is insufficient to merely meet the objective of "removing waste from the neighborhood." Without proper final disposal, all the proceeding processes do not solve the problem-they just transfer the problem to another location. This goes against the idea of sustainable development and imposes environmental pollution on the future generations. Any intermediate treatment produces residues no matter how advanced it is. Such residues as well as untreated wastes have to be transported to the final disposal sites and disposed of there under proper management.

(1) Problems and solutions

Open dumps can and must be improved in stages as appropriate.

Final disposal sites are more likely to be open dumps in developing country cities when their economic levels are low. Open dumping is a method of just disposing of waste without any management and environmental controls. Problems with open dumping and their solution are summarized below:

(i) Control of incoming wastes

A lack of control of incoming waste makes landfill management difficult. It is necessary to record the type and number of incoming vehicles and the amount of waste they carry in. It is desirable for a truck scale to be installed at the entrance of large landfill sites that have a long service life.

(ii) Landfill boundaries

An undefined landfill boundary allows the uncontrolled expansion of a landfill over time. This not only aggravates the problems in (iii) and (v) below, but also constitutes a factor contributing to conflicts over land ownership and other affairs. It is therefore necessary to define the landfill boundary by, for example, surrounding the landfill area with enclosing bunds and planting trees in the outer zone.

(iii) Method of landfill operation

Wastes are not just unloaded into the landfill. Such wastes should be leveled and their surface should be compacted (surface compaction[80]). Volume reduction by this method makes room for more waste, leading to more efficient use of the landfill space. Note that no further action promotes anaerobic fermentation of the organic portion of the waste. This in turn produces landfill gases, such as methane or other flammable gases. These gases, if ignited, cause smoke damage to the landfill and the surrounding areas. To prevent smoke damage, the waste, after surface compaction, should be covered with earth or an alternative (e.g. construction soil, and stabilized waste after the decomposition process is completed). This operation is called soil covering. Soil covering is also aimed at preventing the landfill layer from generating foul odors and providing a breeding ground for flies and rodents.

[79] For specific efforts and issues, see JICA (2003c) and committee for the promotion of Cooperation on Cleaner Production, JICA (2001). To download the former, go to http://gwweb.jica.go.jp/km/km_frame.nsf and click Bunyabetsu Kadai [Sectoral issues] and select Kogai Taisaku [Pollution control], and Kadaibetsu Shishin [JICA's thematic guideline] can be downloaded. The English version of the latter can be downloaded by library search from http://lvzopac.jica.go.jp/library/indexeng.html as a PDF file (as of May 2005).

[80] The process of compacting the surface of the dumped waste in a landfill with heavy machinery or by other means. Surface compaction increases the density of the waste and thus the landfill capacity, extending the service life of the landfill and lessening the risk of landslides and other disasters.

As a general guideline, when the haulage amount exceeds 50 tons a day[81], sufficient leveling and surface compaction necessitates the introduction of heavy machinery, such as bulldozers and wheel loaders, for soil covering.

In the case of soil covering, gas collection pipes must be installed given the risk of accumulated landfill gases exploding. Landfill gases can be vented into the air directly. They can also be collected and burned to convert methane to carbon dioxide, which has far less greenhouse effect, or to generate electricity and heat.

(iv) Approach roads and onsite roads

If approach roads and onsite roads are in a bad state of repair, they become muddy in the rainy season, making it difficult for vehicles to use them. Without access to the inside of a landfill, vehicle drivers and workers have no choice but to unload waste at the entrance or the surroundings of the landfill, leading to disorderly dumping. This is why these roads should be made less vulnerable to rain with pervious fill or by other means.

(v) Leachate management

Leachate refers to the moisture content of the waste itself or rainwater infiltrating into waste that has seeped out. Leachate is often recognized in developing countries as blackish water seeping out of a mountain of waste at landfills. It contains dissolved substances such as organic matter and its decomposition products, including chlorine and heavy metals that were originally contained in the waste. Leachate causes water pollution when it comes into contact with surface water or groundwater.

Leachate management starts with minimizing leachate generation. This can be done by soil covering to prevent the infiltration of rainwater, minimizing the working face and collecting and draining rainwater around the landfill. The leachate generated should be collected by leachate collection pipes laid on the bottom of the landfill layers for treatment. Treatment options include: a circulation method whereby the leachate is sent to a lagoon for primary treatment and then sent back to the landfill; aeration; and the multistage lagoon system for discharge into rivers. Selection of the most appropriate option is made taking into consideration such factors as precipitation, evapotranspiration, the area of the landfill, local water use and cost.

To adequately collect leachate so that it will not seep out into the natural water system, a number of steps should be taken before and during the construction of the landfill. These steps include: selecting a site with impervious layers, compacting cohesive soil, and laying an impermeable liner[82]. The installation of collection pipes expands the aerobic area in the landfill layer, thus promoting the decomposition of the waste.

(vi) Litter

Windblown litter disfigures the surroundings of a landfill. In addition to soil covering, a number of steps should be taken to prevent littering with waste. Among them are minimizing the working face, using a mobile fence around the working face, and building a separate fence around the site.

(vii) Waste pickers

Many waste pickers recover recyclables at landfill sites. They scramble to compete with each other for transportation vehicles to get recyclables with a higher market value. As soon as the wastes are unloaded, the pickers start working. This not only places the waste pickers at risk, but also inhibits unloading and soil covering work, bringing them into conflict with the sanitation authorities.

Just removing the waste pickers from the landfill sites is a difficult option. Recyclables recovery involves risks, but it provides an important source of livelihood given the limited

[81] World Bank, et al. (1998), p.14; Flintoff (1976), p.137.

[82] Johannessen (1999) provides a useful guidance note for the introduction of leachate management. Johannessen and Boyer (1999) report on the state of landfills in developing countries. Both documents are downloadable from the website of the World Bank.

job opportunities and the low educational levels of the poor. The short-term solution would be to control recyclables recovery work with rules that specify the hours during which waste pickers are allowed to work and exclude unregistered waste pickers. The long-term solution would be to encourage waste pickers to change jobs by providing opportunities for education and vocation training.

(2) Considerations for improving landfills

As discussed in Section 2-3-2, most of the SWM budget in developing countries is spent on the collection and transportation of wastes. Little is left for final disposal. As a result, open dumping and similar practices are given tacit approval. Yet the impacts that improper landfills have on the environment and landscape, and the public aversion to landfills as a whole, promotes the NIMBY phenomenon and makes the construction of new landfills extremely difficult. Therefore, converting existing landfills to sanitary landfills is essential in that it not only reduces the adverse effects on the environment and society, but also properly maintains the waste stream that ends in final disposal in a sustainable manner.

To improve landfills, the following considerations should be taken into account:

1) Understanding and support of decision-makers

Lack of understanding on the part of decision makers regarding the seriousness of the problem is one of the factors behind improper management at the final disposal sites in developing countries.

Once wastes are transported to the final disposal sites, many people think that the wastes have been disposed of properly. They rarely have any concern about what is happening at the landfills. Local residents around landfills remain small in number unless urbanization progresses. The public pay little attention to the fact that waste pickers, squatters and other vulnerable people are experiencing health hazards because of the landfills. Consequently, policymakers do not have much interest in problems with landfills. In urbanized societies where the adverse effects of landfills are attracting media attention, some politicians may begin to fan the NIMBY sentiment.

Photo 2-8 Leachate recirculation treatment system at a landfill in Mexico City

Leachate recirculation treatment at a landfill in Mexico City, Mexico. This system is low in cost and simple in structure, but high in treatment capacity. A gravel layer in the intake section (inset) and the pumping section (main photo).
Source : Yamamoto et al. (2003)

Again, appropriate final disposal is indispensable for full and proper solid waste management. This requires the mobilization of the necessary financial resources. Waste disposal costs at sanitary landfills amount to 3 to 10 dollars per ton depending on local conditions [83], such as the methods of procuring cover materials and the topographical features. Financial sources may be the general account budget of the municipality, the introduction of a system to charge waste collection services, raising collection charges, or financial support from donors overseas. Whatever the financial source may be, the understanding and support of decision-makers are indispensable.

2) Securing engineers

Many of the solutions to improving landfills identified above require some kind of equipment or facilities. For such equipment and facilities to

[83] Einsiedel (2000), p.152. For example, 200 liters of fuel is needed to operate a 180-horsepower bulldozer for eight hours for waste leveling, surface compaction, and soil covering. Many developing country cities cannot afford such additional fuel costs.

serve their original purpose, the people involved in landfill management needs to have sufficient skills. In other words, it is necessary to develop and hire appropriate human resources or train engineers. However, developing countries where open dumping is a common practice have virtually no practical skills for sanitary landfilling. This is why on-the-job training should be provided to achieve step-by-step improvements as shown below.

3) Setting appropriate levels and selecting solutions for improvement

In general, four levels can be set towards the goal of sanitary landfill.

The items to improve in relation to sanitary landfill sites and how far the environmental and social impacts can be minimized should be decided appropriately in relation to the characteristics and quantities of waste to be disposed of, the vulnerability of the receptors affected, the distances to them, and other factors that determine the relationship between the landfill and the receptors. The first step toward this end is to accurately assess the assumed impact based on local conditions, including: whether hazardous wastes are accepted; whether there is a water source used for drinking water; the distance to the aquifer and the geological conditions in between; and the population of the neighboring residential area and the distance to it. A wide range of options for improvement are available and their outcomes will vary greatly. It is necessary to select the option that is most appropriate to the level that has been set as a goal.

4) Step-by-step improvement

For many developing countries, it is often difficult to take all the necessary options at once due to technical and financial restraints. For this reason, a practical approach-implementing the feasible options in stages-is necessary.

5) Sustaining improvements

Some options for improvement-the introduction of equipment or facilities, for example-produce immediate results. Sustaining the improvements thus made requires strict operational management on a daily basis. To this end, it is necessary to regularly monitor littering, vehicle operations, the components of landfill gases, the properties of the leachate and other items for regular evaluation of the operation and maintenance arrangements of the landfill.

Table 2-17 Levels toward sanitary landfill

Key operations and facilities	Corresponding item number in Section 2-6-5 (1)	Level 1	Level 2	Level 3	Level 4
Control facilities	(i)	○	○	○	○
Measurement of the incoming waste	(i)	○	○	○	○
Enclosing bunds	(ii)		○	○	○
Buffer zone	(ii)		○	○	○
Landfill equipment	(iii)	○	○	○	○
Daily soil covering and gas venting	(iii)		○	○	○
Approach and on-site roads	(iv)	○	○	○	○
Leachate circulation treatment	(v)			○	○
Leachate purification	(v)				○
Seepage control works	(v)				○
Mobile fence for litter prevention	(vi)			○	○

Source : Compiled by OTSUKI Noriko from Matsufuji (1997), pp.1-15.

(3) Development of new landfills

Landfill site selection is the key to the successful development of new landfills; it can significantly reduce the cost of lessening the adverse effects of the landfills mentioned above and facilitate the processes leading up to the completion of new landfills.

1) Criteria for landfill site selection

The following criteria for landfill site selection should preferably be met:

(i) The landfill is far from residential areas.
(ii) The landfill is far from water sources.
(iii) The landfill can provide the necessary capacity.
(iv) The landfill is available considering the aspects of the legal and financial constraints.
(v) Haulage distances are short.
(vi) Cover materials are available in the neighborhood (it would be most desirable if soil produced in the landfill construction process can be used for the cover soil).
(vii) There is little risk of flooding or landslides.
(viii) There is an impermeable layer under the landfill.
(ix) The landfill is far from any airports.
(x) The drainage basin is small.
(xi) The landfill is far from natural parks, historic sites and other areas that require conservation.

The details of the criteria, including the standard distances from residential areas and water sources, the order or priority among the criteria, and the possible addition of other criteria should be considered according to conditions of each landfill site. It is difficult in practice to find a site that meets all these criteria. A more common approach is to select several sites that meet these criteria, if not all, and narrow down the candidates based on the assessment of the environmental impact and economic and financial conditions.

It is worth considering the development of a landfill for use by two or more municipalities under certain conditions. Such conditions include: the concentration of population and economic activity, which makes it difficult to find a site within the city; and the possibility of achieving economies of scale if small neighboring municipalities group together to share a landfill.

2) Considerations for site selection

A lack of consensus with communities is the greatest obstacle to the development of a new landfill. To build such a consensus, it is necessary to ensure the transparency of the development plan by, for example, disclosing information in the early stages where the site selection method is determined [84].

The implementation of a landfill development plan while building a consensus with the communities is a long-term process. Waste planners have to work on such a plan while there are many remaining service years left in the existing landfills. Improving the existing landfills to gain public confidence in landfills and the implementing agencies is also important for the smooth implementation of a new landfill plan.

(4) Landfill closure

Landfills are short-lived compared with many other types of socioeconomic infrastructure. The service life of a landfill is determined by such factors as: the landfill capacity, waste generation, the capacities of other landfills to receive waste, and the level of local opposition. When closing a landfill, final soil covering is implemented to stabilize the surface and the slopes of the landfill.

Even after the landfill is closed, there are ongoing processes in the waste layers: volume reduction under the weight of the waste itself and the covering soil (consolidation settlement), and decomposition of the organic portion of the waste. That means that the closed landfill has an unstable ground base and continues to produce landfill gases and leachate. There is a need to continue to monitor subsidence, the temperature and components of the landfill gases, the properties of the leachate, and the quality of the groundwater

[84] For consensus building, see also Section 2-4-5.

and surface water that may be affected. Proper after-closure management is a major requirement for permanent closure or conversion to farmland, a park, or other purposes, as well as environmental impact reduction.