

Solid Waste Management Overview and Analysis

IGES KITAKYUSHU OFFICE¹

Overall situation

The objective of solid waste management is to provide a solution for a wide range of problems including the outbreak of insects and harmful pests that transmit diseases including plague, cholera, and dysentery; hygienic issues such as health issues that stem from the pollution of groundwater and soil due to wastewater discharge from garbage; issues regarding the living environment of the city, such as notable impact on scenery, odour, natural disasters such as floods due to waste obstructing rivers; and disasters such as the generation of methane gas from waste and fires. In developed countries, the main purpose of solid waste countermeasures is also the protection of resources.

Central governments of many countries carry out the management of environmental problems such as air and water pollution, with municipal governments mainly addressing solid waste issues. Cities in Asia are witnessing a rapid rise in the generation of waste in line with increases in population and rapid modernisation of consumer activities, and are considering solutions to cope with various issues. The following table classifies the cities that participated in this first thematic seminar into three groups according to economic levels (country GDP, city GDP for Macao and Chongqing) and provides a comparison of the state of solid waste treatment.

Table-1 Comparison of solid waste management in cities

	Group A	Group B	Group C
City	Dhaka, Kathmandu, Ulaanbaatar, Bhopal, Yangon	Cebu, Nonthaburi, Chongqing, Surabaya	Fukuoka, Kitakyushu, Macao
GDP (USD)	1000 to 3000	3000 to 10000	Over 10000
Waste generation (kg/person · day)	0.3 to 0.6	0.7 to 1.1	1.4 to 1.5
Collection rate (%)	Less than 70	80-90	Approximately 100
Treatment fees (USD/Person · Year)	Less than 1	1-3	38-220
Rate of expenditure in total budget (%)	15.4 to 38	6 to 23.2	1.6 to 5
Recycling	Informal (Metal, grass, plastic, composting)	Formal + Informal (Metal, grass, plastic, composting)	Formal (Metal, grass, plastic, furniture, clothing)
Incineration treatment rate (implementing cities / total cities)	0 / 5	1 / 4	3 / 3

There is a clear increase in waste generation with the advance of economic development. Waste in Group C is mostly comprised of paper, compared to the high rate of organic waste in Group A and B (over 50%). In winter, there are differences in the composition of waste, such as increases in waste ash, as a result of changes in lifestyles. Plastic bags used for wrapping and paper are on the increase in all cities; in China, this is referred to as “white pollution”.

Collection rates and treatment costs correlate to GNP and are on the rise. The scale of municipal budgets in Group A are small, however, the rate of expenditure for treatment fees in the overall budget is extremely large. In Groups A and B, informal collection is mainly carried out by scavengers; in Group C, collection is carried out by the municipal government.

Incineration is carried out by cities in Group C, as well as Chongqing in Group B. Incineration is an effective method to inoculate and reduce waste however, initial costs for the construction of facilities are high. Running costs are high when waste with high water content is generated, such as kitchen waste, and air pollution countermeasures for dioxins and soot and dust are necessary. If there are no economic

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reserves, the introduction of this type of treatment method can be difficult. However, incineration is a relatively safe and simple method of treatment for waste that should be separated and inoculated such as medical waste.

Issues and measures in collection

In Group A, a large number of people can be found who dispose of waste in streets, open yards, and drains. As a result, the employment of necessary personnel and percentage of the budget to address this issue are high, due to the use of street sweeping as a central part of collection activities. Additionally, collection rates are low due to an insufficient number of personnel and collection vehicles, as well as difficulties in entering narrow streets.

In Surabaya, door-to-door collection is carried out by the communities directly. Transfer points are well positioned and an effective collection system has been developed. In Dhaka, a private organisation has implemented door-to-door collection on a pilot basis and achievements have been obtained. However, there are difficulties in collecting fees from many residents, and obstacles remain in expanding the activity to other areas of the city.

Kathmandu has overcome this issue through the identification and implementation of ideal public participation. A solid waste management proposal submitted to Kathmandu by a foreign company was opposed by employees due to potential job losses. However, the municipal government included the participation of residents and businesses from the very first stage of the plan and made effective use of existing human resources and equipment, thereby developing a new method for waste collection through public-private cooperation.

Issues and measures in the promotion of recycling

In such cases as Ulaanbaatar and Surabaya, scavengers make a major contribution to the reduction of waste. However, scavengers who rummage in waste bins and scatter garbage expose and are exposed to environmental and hygienic problems. As pointed out by Bhopal, the problem is one that needs to be addressed, as a large number of scavengers are poor and include women and children.

In Cebu, scavengers are organised into independent groups and conduct organised fee-based collection and recycling together in collaboration with the municipal government. Advantages include lessening the impact on the health of scavengers as well as the surrounding environment, creation of new jobs, solutions for financial problems, and the first step towards the development of recycling businesses.

The most effective method to increase recycling rates is separation in households. Nonthaburi is successfully addressing this issue in a pilot activity to increase recycling rates and decrease waste by promoting separation at source.

With an overall objective of decreasing waste, recycling must address issues such as the understanding and cooperation of residents, enlarging the market for recycled materials, and the construction and development of fully equipped recycling facilities. In targeting the intermediate layer that possesses an awareness of environmental problems, various measures have been successful, such as the distribution of cash or coupons to residents that have collected recyclable materials.

Most cities carry out composting. There are a number of cases that demonstrate the use of waste from markets as materials for composting, as well as active participation and cooperation among the municipal government, NGOs, and businesses. In this issue, problems arise from difficulties in selling the compost. Compost contains high nitrogen levels and is suitable as fertilizer for cultivating vegetables. Compost is less expensive than chemical fertilizers and has less of an impact on the soil. In Cebu, there are discussions on the use of compost at the city markets. If profits rise due to high sales, it would be indispensable to endeavour to open markets and improve technology to cultivate effective and top quality compost.

The introduction of new recycling technologies is continuing. With the cooperation of universities, Cebu has commenced the conversion of biogas using animal waste from the city abattoir. Ulaanbaatar is reusing coal and ash from power plants as construction materials. Tires, which are a problem in Macao, are shredded into small rubber pieces in Japan and are used as fuel for cement firing and power generation, as well as materials for iron manufacturing, in addition to reuse as road pavement and slabs. Many cities understand the necessity of introducing appropriate recycling methods and technology, as well as promoting recycling business. There are number of cases that can act as reference.

Issues and measures regarding landfills

Cities such as Macao and Cebu are unable to secure land due to insufficient land area; Chongqing is mountainous and the investment for the development of landfill sites is higher than other cities. In Kathmandu, there is opposition from residents (NIMBY). Numerous measures have been taken to address

this issue, including the development of a technical plan by Chongqing that outlines the separation and decomposition of difficult-to-burn waste, to decrease the amount of leakage. Semi-aerobic landfills proposed by Fukuoka are “low cost, low technology, and less pollution”. This method is being implemented in other countries and the transfer of technology to other regions can be expected.

Issues and measures in financing

Cities in Group C outlay treatment expenses for household waste from the general budget and promote economic incentives to reduce waste. On the other hand, for cities in Group A and B, the rate for waste treatment fees in the general budget is high, and because there is a lack of finances, there are a number of cases where fees are levied in order to cover treatment costs.

One method to increase cost effectiveness is the creation of partnerships with residents and the private sector. Some examples of reference include Kathmandu, where a business charges fees and conducts door-to-door collection, and Macao, where the private sector carries out collection. With commissions to private businesses, collection efficiency rates increase due to competition between businesses; however, the role of the local government in management and inspection is important.

Cities such as Chongqing place expectations on private funding for solid waste treatment, in particular refuse-burning power generation. In contrast with the large amount of funding necessary for first stage investment and operation costs, there are numerous issues to be faced in the privatisation of waste treatment, such as low energy recovery and difficulties in cost recovery. In this regard, there are few cases, other than countries such as Malaysia, where privatisation is implemented. The actions by cities in China, such as Chongqing, may have an impact on future public-private partnerships and cooperation.

With regard to cost recovery, the practice of Surabaya in which fees are levied together with water supply fees is sound. Kitakyushu employs a method to collect solid waste through the sale and use of “fee-based designated bags”, where garbage is not collected unless placed in the bag. However, if the fees are too high, the chance of illegal disposal is increased. In this way, the setting of fees is a difficult issue.

Issues and measures in solid waste management administration

A number of cities have indicated that the necessary points for effective solid waste management are: (1) Systematic and organised management; (2) Understanding and cooperation of residents; and (3) Increasing administration capacity and introduction of appropriate technology.

In general, countries in Asia have strong centralised governments. The authority of local governments is weak, as the authority and budgets necessary for management are not transferred to the cities. Because solid waste management is an area in which the local authority has responsibility, regulations and systems lag behind, as compared with air and water pollution measures that are directly managed by the central government. Guidance by the central government and transfer of authority for solid waste management must be promoted.

Understanding and cooperation of residents is a most essential element in solid waste management. As indicated by Bhopal and Surabaya, waste is the “responsibility of all”, and everyone has an “equal share of responsibility”. If the number of people that dispose of waste improperly decrease, the burden for activities such as street sweeping can be lessened. If waste can be separated at source, recycling rates can increase and waste decrease. In order to enhance understanding and awareness of residents, campaigns and education on the issues, as well as concrete actions that can be taken by the individual, are necessary. At the same time, with the direct participation of residents, costs for cleanup will decrease, and support and contributions of residents to environmental sanitation will rise. Two cases that could be of reference in this regard could be dialogue carried out with residents to implement new measures (Kitakyushu) and campaigns (Nonthaburi).

Most cities in the Asian region have a deep understanding of the problems they face. However, cities are searching for ideas on the planning and implementation of concrete measures in order to minimize health and environmental impacts from solid waste; in other words, the most appropriate treatment methods to address each specific situation within financial, human resource and technological limitations. In this regard, ownership and capacity building of local governments is essential. Participation in training courses carried out by support organisations and dispatch of experts, as well as independent study groups are effective. Towards this end, active participation in intercity networks such as the Kitakyushu Initiative and international seminars, as well as use of databanks for successful practices would be of benefit.

City analyses are attached for reference.

DHAKA (BANGLADESH)

General information

Area:	360km ²
Population:	10 million
National GDP per capita:	USD 1,602
Total income:	BDT 2098 million (USD 37 million)

Solid waste generation

Total generation:	4500-5000 ton/day
Waste generation per capita:	0.60kg/person · day (residential area)
Waste source:	46.8% households, 21.8% street sweeping, 19.2% commercial, 12.9% industrial, 0.5% clinical
Waste composition:	72.5% food, 13.7% polythene, 5.6% paper/cardboard, 3.3% plastic

Solid waste management

Collection rate:	Estimated at 50-60%
Recycling:	Estimated at 26%; carried out by scavengers
Composting:	Conducted by residents together with NGO initiative
Expenditure:	BDT 53.00 (USD 0.90) per capita expenditure; 32.57% collection, 47.9% transportation, 19.37% disposal Conservancy tax of 2% is charged. Expenditure rate of the total budget is 15.4%.

Major challenges and strategies

According to the municipal corporation ordinance of 1983, the Dhaka City Corporation (DCC) is responsible for collection of solid waste from corporation's bins and transportation to the landfill area. Thus, DCC's involvement is only with secondary collection and final disposal. Although DCC has tried to work with communities and NGOs for primary collection and street sweeping, it is not yet well managed. On the institutional side, rules and regulations are not clear. The role and responsibilities of waste generators are not clearly defined and Municipal Corporation is unable to impose rules on the public, i.e. the present law does not provide penalties for illegal disposal of waste or littering. DCC has shortages of skilled human resources and finances, and lacks scientific approaches for problem solving.

Strategies for efficient solid waste management for DCC are therefore to carry out institutional strengthening, capacity building and gradual private sector participation in solid waste management. In particular, the formulation of laws and regulations, and promotion of community-based programs and local initiatives with NGO support are important.

Dhaka City hosts an innovative "waste to composting" mechanism that has reduced solid waste at source as well as created a market mechanism for sustainable business. The project is being organised by a local NGO ("Waste Concern"), with support from the United Nations Development Programme (UNDP). In this project, communities are directly involved in the waste management program. Each household contributes to the collection mechanism by paying fees. The collected waste is then separated, recycled and sent to a composting plant. The composting plant converts organic waste to fertiliser and enriches it chemically for local suitability. Local fertiliser companies buy the enriched fertiliser and sell it on a larger scale. The process has been sustainable, and no subsidies have been given for its operation except for NGO support and use of land.

The Kitakyushu Initiative could be instrumental to DCC in learning from the experiences of other cities especially in collection and disposal. Frameworks for law, rules and regulations for solid waste management and collection management systems must be established in DCC; some cities in the Kitakyushu Initiative Network have already excelled in these areas. Examples from Surabaya, which is based on community managed collection, could be useful to DCC. Such experiences would be of good reference to DCC in managing solid waste issues. Similarly, other cities can learn valuable insights from Dhaka's successful and replicable composting program.

CEBU (PHILIPPINES)

General information

Area:	326 km ²
Population:	0.72 million
National GDP per capita:	USD 3,971
Total income:	PHP 1257 million (USD 24 million)

Solid waste generation

Total generation:	511 ton/day
Waste generation per capita:	0.71kg/person · day
Waste source:	57% residential, 43% non-residential

Solid waste management

Collection rate:	80%
Recycling:	Scavengers (200-300 persons) have developed a cooperative and entered into a MoA with the city government. Cebu Department of Public Services and NGOs also carry out separation at source.
Composting:	1 ton/day is collected from market
Final treatment:	Landfill (capacity of 938,400m ³ ; lifetime of 6-7 years)
Expenditure:	In 2000, PHP 76 million (USD 1.4 million) was appropriated for SWM, approximately 6.3% of the total expenditure.

Major challenges and strategies

Based on an annual 2% and 4% growth rate for residential and non-residential waste, respectfully, Cebu city forecasts that they will have to manage 275,573 tons of waste per year by 2010, with a daily average of 399 and 356 tons for residential and non-residential waste, respectively.

Current challenges for Cebu include a weak institutional and organizational system for solid waste management, and problems in the upper waste stream (inefficient garbage collection due to lack of vehicles, lack of waste segregation and recycling at source, small revenue from solid waste collection charges), as well as problems downstream such as insufficient sanitary landfill operation and prohibition of incineration under the Clean Air Act of Philippines. Major issues can be identified as collection and disposal capacity, and institutional and regulatory arrangements. Increases in solid waste will place further pressure on collection and disposal. Institutional and regulatory arrangements are required to improve collection and disposal capacity. User charges, separation at source, and recycling, including informal waste pickers, are major challenges requiring a good regulatory framework and effective implementation.

Cebu has suggested a few steps to overcome these challenges. These include:

- (i) Institutional capacity building through various training programs
- (ii) Public information and awareness by involving NGOs
- (iii) Promotion of waste segregation at source
- (iv) Improvement in the practices of waste separation and recycling at disposal
- (v) Management of medical waste by the private sector and industrial waste management with the involvement of Chambers of Commerce
- (vi) Promotion of composting and recycling with the help of agricultural department
- (vii) Energy conservation and construction of biogas digester
- (viii) Efficient garbage collection system by acquiring new equipment and vehicles.

Successful cases to introduce recycling and composting, such as Nonthaburi (Thailand), can be of reference in reducing pressure on the final disposal site and generate revenue to provide motivation for communities and the staff to intensify activities. Additionally, the feasibility of the "Fukuoka Method" (Japan) could be studied in reference to final disposal techniques. Using the Kitakyushu Initiative Network, potential to acquire training for the implementation of this technique may be possible, as well as coordination with donors to support this method. However, the city may need to improve its financial position by adapting realistic user charges, as Nonthaburi is doing.

NONTHABURI (THAILAND)

General information:

Area:	39 km ²
Population:	0.27 million
National GDP per capita:	USD 6,402
Total income:	THB 331.3 million (USD 7.7 million)

Solid waste generation

Total generation:	320 ton/day (292 ton/day collected)
Waste generation per capita:	1.08kg/person · day

Solid waste management

Collection rate:	90% (frequency = twice a week)
Recycling:	5-10%, separation at source by community
Expenditure:	In 2001, the total expenditure was THB 70.6 million (USD 1.6 million), a rate of 23.2% in the total expenditure of all municipal departments.

Major challenges and strategies:

Challenges facing Nonthaburi Municipality include the lack of a waste disposal site coupled with the increasing amount of waste. The separation of waste at source is not in practice, and geography of the city makes it difficult to collect approximately 10% of waste. Nonthaburi has adopted the following strategies: reduction of solid waste by increasing recycling, public awareness and community based initiatives in recycling and composting, enforcement of user charges, and strengthening managerial skills through training.

To achieve these strategies, Nonthaburi is currently carrying out a one-year pilot activity under the Kitakyushu Initiative in two pilot areas in the Municipality with the following objectives:

- (1) Maximize recycling by 20% and minimize waste by 30%
- (2) Study of appropriate models for community involvement in solid waste management
- (3) Promotion of public participation and local coordination, as well as capacity building

Community participation is promoted through meetings, public relations, and door-to-door advocacy. The main objective is to improve separation at source and disposal of solid waste and recycling, respectfully, in marked bins on designated days. The Municipality provides collection trucks and staff for this purpose. In the pilot activity, households pay user fees of THB 20/month for solid waste; designated plastic bags are currently provided free-of-charge for recyclable materials. The collection staff and communities share the income generated from the sale of recycled materials.

After six months, the amount of recyclable materials has increased from 65.7 kg/day to 174.2 kg/day, to reach an average rate of 22.1% (initial rate was 5.3%). Composting activities are also being carried out in conjunction with recycling activities. The commercialisation of composting will soon bring additional revenue for collection staff and communities. The expansion of these types of activities to other communities within the Municipality is also an overall objective for Nonthaburi.

This type of pilot activity can be easily transferred to other cities with the political will to enhance community participation and introduce user charges. As in the case of Nonthaburi, the results of small-scale activities can be demonstrated to other communities to establish citywide activities.

ULAANBAATAR (MONGOLIA)

General information

Area:	1,359km ²
Population:	0.82 million
National GDP per capita:	USD 1,783

Solid waste generation

Total generation:	1,500-1,800m ³ (645-774 ton/day)
Waste generation per capita:	0.0012-0.005m ³ /person · day (0.52-2.15kg/person · day)
Waste source:	50% households, 30% industries, 20% other
Waste composition:	25.2% paper, 9.2% synthetic bags/paper boxes, 2.9% synthetic material, 2.5% cotton material, 4.4% glass, 5.5% cans, 2.5% metal, 2.6% plants, 2.6% vegetables, 4.5% bones, 21.4% ash, 3.7% coal, 8% soil/stones, 5% other (In winter, 60% is ash.)

Solid waste management

Collection rate:	71.4%, private sector carries out collection and transport
Recycling:	Scavengers, (0.0025-0.013 m ³ /person-day (1.1-5.6kg/person-day)
Final treatment:	Landfill, 2 sites
Expenditure:	User fee of MNT 50/month (USD 0.04/month)

Major challenges and strategies

The Ulaanbaatar Disposal Company carries out the collection of solid waste, street/park cleaning, maintenance of green areas and public buildings, and maintenance of private and public industrial organisations. With the amount of solid waste increasing 5-10% each year, Ulaanbaatar is facing difficulties in the collection of waste due to low user fees. Additionally, the central landfill is located in the upper water stream and causes serious water and soil pollution.

Strategies for Ulaanbaatar include upgrading regulations for solid waste management and reforming the implementation system, closing the landfills in Dari-Ekh and Ulaanchuluum and building a unified waste disposal facility in Moringiin Davaa in the KhanUul district, as well as developing a system for the reuse and recycling of industrial waste, capacity building of related departments, and public education.

In the winter, approximately 60% of household waste is composed of ash because coal and wood fuel are used for heating. The city government is also currently researching the possibility of developing construction materials for light concrete industries using ash, in cooperation with construction companies.

CHONGQING (CHINA)

General information:

Area:	82,000km ²
Population (millions):	31 million
National GDP per capita (city GDP):	USD 3,976 (USD 600)

Solid waste generation

Total generation:	7500 ton/day
Waste generation per capita:	0.24kg/person · day
Waste source:	7500 ton/day (domestic); 35,600 ton/day (industrial) (13 million ton/year); 1228 ton/day (hazardous) (448,400 ton/year)
Waste composition:	35% organic, 40% inorganic

Solid waste management:

Collection rate:	85%
Recycling:	25% (includes paper, rubber/plastic, glass, metal)
Incineration:	Central treatment of 1,700 ton/day of waste (planned)
Final treatment:	Sanitary landfill with total capacity of 3,000 ton/day (planned)
Expenditure:	User charges are CNY 3/household · month (USD 0.4)

Major challenges and strategies

Urban domestic waste in the city proper is collected and centrally disposed by a designated company operating under the Chongqing Municipal Administration Commission. Local construction management councils or the Chongqing Municipal Administration Bureau manage other districts and counties. Three landfill sites are planned for the city centre, with capacities of 1500, 1000, and 1000 ton/day, respectively. Due to the mountainous topography of Chongqing, the proposed investment of many landfill sites is higher than that of the same scale landfill sites in other parts of China because of higher engineering costs.

Challenges for Chongqing include improvements to the charge system by expanding targets and increasing standards; issuing prices for electricity produced by incinerators; and consideration of loans from foreign governments or Build-Own-Transfer (BOT) approaches due to financial difficulties in constructing waste treatment facilities.

The Chongqing Municipal Government has proposed a technical plan entitled "Screening-Landfill-Incineration Power Production" for eleven comparatively centralised districts/counties to centrally treat 1,700 ton/day of waste. Chongqing City has constructed small-scale screening and landfill sites and has disposed of hard-to-burn waste in landfills after decomposition. Because of decomposition, the amount of leakage from waste decreases which helps prevent secondary pollution. Chongqing City has also improved the technology of two to three coal-fired centralised power plants to act as waste incineration power plants (economically efficient transportation distances range from 28 to 94km.)

A designated company is responsible for business activities and technology-related research in the entire process of collection, screening, landfill and incineration. Based on a 15-year service period, this approach can reduce landfill volume by 30-50%, save 10-15% of investment, and increase the total capacity of power generators for waste incineration to 5500kw with an annual power production of 43.43 million kwh.

KATHMANDU (NEPAL)

General information

Area:	50.8km ²
Population:	0.73 million
National GDP per capita:	USD 1,312
Total income:	USD 5.2 million

Solid waste generation

Total generation:	944 m ³ /day (212 ton/day: 0.225 ton/ m ³)
Waste generation per capita:	0.29kg/person · day
Waste source:	99.5% households, 0.5% clinical
Waste composition:	69.80% organic, 8.50% paper, 0.54% rubber, 0.12% leather, 0.73% wood, 9.17% plastic, 0.23% bone, 3.20% textile, 0.87% ferrous metal, 0.05% aluminium, 2.5% glass, 4.33% other

Solid waste management

Collection rate:	70%; Private sector involvement in collection and transfer (pilot)
Expenditure:	USD 2 million, a rate of 38% in the total budget Fees are within or less than USD 0.7/household · month

Major challenges and strategies

The major challenge for the Kathmandu Municipal Corporation (KMC) is meeting the demands for solid waste collection, transfer and disposal within its financial, technical and managerial resource limitations. As a less developed country, the emphasis on collection is very natural, however, KMC is aware of safe and reliable disposal and treatment of solid waste at landfill sites. The Municipality is also affected by the NIMBY (“not in my back yard”) syndrome, which makes locating landfill sites a daunting task, as political establishments are sensitive to resulting protests by citizen groups. Other challenges in solid waste management are as follows: inefficient collection system by multiple handling of waste; creating public awareness and to improve the “*throw and forget*” attitude; less willingness to pay on part of people; excessive political interventions in planning and management; lack of appropriate technology; inflexible management systems; inappropriate collection vehicles and unskilled manpower; and lack of appropriate laws and regulation, and policy framework

Private sector participation (PSP) is a major strategy for KMC, with the Municipality playing a role as regulator and manager with the involvement of the private sector in overall waste management. The major objective of private sector participation is to relieve the financial burden on KMC, implementation of an efficient collection system, efficient transfer and scrap recovery/recycling/composting, as well as sanitary landfill. Formulation of appropriate policies and laws for private sector participation has been carried out. Because the introduction of private sector participation was experimental, the strategies adopted by KMC were to *plan the process but not to wait for the perfect plan; phase-wise implementation to build confidence; and evaluation of different approaches (such as contracting, franchise systems and management contracts)*. With these strategies, KMC introduced the participation of the private sector in two wards for door-to-door collection, street sweeping and waste transfer. In this arrangement, KMC provided no subsidies (with the exception of a vehicle for a six-month period) and household fees were equal or less than its tariff rate. After one year, it was seen that the private sector was making profits and willing to continue and expand their services. This reduced the burden on KMC, both financially and in terms of human resources. Approximately 50% of the people surveyed replied that services provided by the private sector were more effective. Although the current participation of the private sector is limited to collection, KMC polices are gearing towards the involvement of the private sector in all aspects of solid waste management. Lesson learned from this experience include the necessity of careful planning and experimentation with different approaches; building confidence among stakeholders; elimination of undue political intervention; and importance of transparent processes. KMC’s initiative may help address some of the constraints that cities are facing in private sector participation in solid waste management by disseminating know-how on various aspects of private sector participation, regulatory framework, and institutional arrangements.

BHOPAL (INDIA)

General information

Area:	285.88 km ²
Population:	1.4 million
National GDP per capita:	USD 2,358

Solid waste generation

Total generation:	600 ton/day
Waste generation per capita:	0.43kg/person · day
Waste composition:	Approximately 50% organic

Solid waste management

Collection rate:	60-70%
Recycling:	Carried out by scavengers
Composting:	Private company composts 20% (120 ton/day) adjacent to the landfill site; compost is sold commercially
Landfill:	75 acres, open dumping
Expenditure:	25% of municipal budget. Current cost recovery includes a conservancy tax as part of property tax/sanitary tax.

Major challenges and strategies

The major challenge facing the Bhopal Municipal Corporation is to increase the awareness of the public to dispose of waste in designated storage bins and containers. Residents generally prefer to dispose of waste when and where it is generated. The practice of recycling is not well organised and segregation of recyclable waste at source has not yet been adopted. As a result, recyclable waste is intermixed with garbage disposed at different places. The Municipal Corporation has not yet been able to adopt a system of door-to-door collection of waste, and street sweeping remains the main method of waste collection to date. Like other cities in developing countries, the emphasis of the municipal corporation is on the collection and transportation of solid waste; the issue of disposal is of less priority. Solid waste in Bhopal is composed of materials that can be composted (approximately 50%); therefore, composting is a technique that can greatly relieve pressure on landfill sites. Composting plants compost about 20% of the total waste.

Improvements in planning, financial and managerial capacity are major strategies for the Municipal Corporation. Additionally, the Municipal Corporation aims to increase operating revenue through user charges, service taxes, landfill taxes and tipping fees. These measures would relieve financial limitations that are currently issues for the Municipality. Well-trained human resources remain a bottleneck for effective planning and management, which are being improved by ongoing capacity building activities. Partnerships with the private sector, community groups and NGOs are also sought as major strategies. The Municipal Corporation has paid special attention to legal impediments and labour concerns for private sector participation.

FUKUOKA (JAPAN)

General information

Area:	340 km ²
Population:	1.3 million
National GDP per capita:	USD 26,755
Total income:	JPY 722,803 million (USD 5.8 billion)

Solid waste generation

Total generation:	772,916 ton/year (total) (2117 ton/day) 326,544 ton/year (domestic) (894 ton/day)
Waste generation per capita:	0.69kg/person · day (domestic), 1.6 kg/person · day
Waste sources:	42% household, 46% commercial, 2.5% industrial, 1% other, 7.8% accepted from outside city limits
Waste composition:	90% combustible, 7.2% non-combustible and bulky, 2.5% glass/PET bottles (domestic waste)

Solid waste management

Collection rate:	100%
Recycling:	84.5 ton/day, carried out by Fukuoka City
Incineration:	1,777 ton/day
Final treatment:	432 ton/day
Expenditure:	JPN 30,692 million (USD 248 million), a rate of 4% in the general account.

Major challenges and strategies:

With the shift to a society of mass production, mass consumption and mass waste, Fukuoka is conducting a range of measures to reduce waste volume and promote recycling, including rewards to children's groups, subsidizing systems for purchasing compost, provision of unused furniture and other items, simple wrapping, and collection of empty cans and other items by city offices, in addition to other public activities. To reduce business waste and promote recycling, corporations with buildings larger than 3,000m² are required to prepare a waste reduction report and appoint a promotion manager.

The acquisition of final disposal sites for landfills is a major issue for Fukuoka. In the Final Disposal Plan, Fukuoka has outlined the following goals:

- (1) Reduction of waste content and weight, and minimization of final disposal amount by introducing intermediate processing of waste
- (2) Strict monitoring and management of waste
- (3) Restrict the disposal of reusable and recyclable refuse by placing charges on reusable items, i.e. televisions, washing machines, air conditioners
- (4) Appropriate management of landfill sites and sewerage treatment facilities

A particular type of semi-aerobic landfill, known as the "**Fukuoka Method**", was developed as a joint project of Fukuoka City and Fukuoka University. This method was first tested in the construction of Shin-Kamata Landfill in 1975. This method has now been adopted through Japan, as recommended by the Ministry of Health and Welfare in guidelines for final waste disposal. This is a semi-aerobic landfill, where leachate is collected in leachate collection ponds through properly sized perforated pipes embedded in graded boulders. As the outlet of the main leachate collection pipe is always open to air, fresh air is drawn into the layers introducing an aerobic condition around the pipes. Since leachate is removed as quickly as it is formed, the internal waste layers have lower water content.

Advantages of the Fukuoka Method include:

- (1) Utilisation of the self-purifying capacity inherent in nature to stabilize waste materials. As a landfill method, it requires only commonly used machinery and equipment. Fresh air causes microorganisms to flourish inside the waste layers, thus hastening the decomposition process and reducing the emission of methane. This helps to address global warming issues.
- (2) The quality of leachate improves significantly and rapidly, helping to reduce costs for secondary

treatment. Moreover, the technology is cost-effective and simple to construct and operate. There is flexibility for selection of materials and pipes. Enhanced stabilization makes it possible to return the landfill sites for other uses in short period.

- (3) The overall effectiveness depends on the continuous monitoring of various performance parameters. This induces a better understanding of what it takes to achieve a given environmental standard in final waste management, thereby laying a sound foundation for future upgrading and improvement.

Technology has been successfully transferred to Malaysia (Seberang Perai) at Ampang Jajar landfill site in 1996, followed by Guangzhou City (China) in 1997, and Tehran Municipality (Iran) in 1998 and various training programs inside and outside Japan have also been conducted. With the help of donors and experts, this method could be applicable to other cities in the Kitakyushu Initiative Network.

KITAKYUSHU (JAPAN)

General information

Area:	470km ²
Population:	1 million
National GDP per capita:	USD 26,755

Solid waste generation

Total generation:	1,400 ton/day
Waste generation per capita:	1.40kg/person · day
Waste composition:	40% paper, 20% plastic

Solid waste management

Collection rate:	100%; 2 times per week (recycling 1 time per week)
Recycling:	Separated at source by residents (2 recycling plants)
Incineration:	3 plants (electricity sales amount to 7% of revenue)
Final treatment:	Sanitary landfill
Expenditures:	The budget of the Environment Bureau is JPN 17,600 million (USD 145 million), approximately 3.3% of the general account. Half of the budget for SWM comes from general revenue; user fees account for 12%; user charges are obtained from the sale of “designated bags” (JPN 15/bag (USD 0.12/bag)).

Major challenges and strategies

Solid waste issues require the understanding, participation, and cooperation/partnership of all members of society than any other environmental issue. Great potential for such partnerships exist in traditional and indigenous local social systems. To draw out this potential, the sharing of many experiences of success and failure, and their contribution factors, among local societies is beneficial. The selection of appropriate technology that is most appropriate or effective depends on each city's situation. Kitakyushu utilises incineration to reduce volume in order to accommodate limited landfill space and stabilizing reclaimed areas by avoiding decomposition of organic waste, as well as consideration of economic benefits from energy utilisation. The amount of solid waste generated per year has increased rapidly due to economic development. The amount of solid waste per capita per day is high, in particular the generation of paper and plastic; therefore, the volume reduction of solid waste is a high priority issue.

Residents actively participate in community activities and recycle paper products (newspapers, journals, packages, other). In addition, residents separate cans, glass, and plastic bottles, which are then collected and utilised as raw materials after pre-processing. Some glass bottles are reused using deposit-refund systems. The city government established a subsidy programme for promoting composting activities by residents. At present, 26,526 households have compost equipment.

Kitakyushu adopted a system for the use of designated bags (clear plastic bags) in 1998. Income from the sale of these designated bags is also used to assist and promote environmental activities in communities. The fundamental process of solid waste management is consensus or agreement in the local community. This decision-making process in Kitakyushu included: (1) Questionnaires to develop dialogue with residents; (2) Meetings with residents during the planning phase through cooperation with neighborhood associations to exchange ideas and information on the feasibility and objectives of fee-based system, benefits and additional responsibilities of new system; (3) Consensus between residents and the city, after which the official agreement was amended by the Kitakyushu City Local Ordinance of Solid Waste Management, and; (4) Advice and assistance for residents' activities by city government officers and volunteers.

In order to effectively and efficiently implement new policies on solid waste management based on local community consensus and common goals, an understanding of the state of solid waste generation, estimation of future need, identification of issues and problems, measures to solve issues, evaluation of the capabilities and roles of local stakeholders, and securing all necessary resources, are required.

MACAO (CHINA)

General information

Area:	25.4km ²
Population:	0.44 million
City GDP per capita:	USD 14,055
Total income:	USD 1.1 billion

Solid waste generation

Total generation:	229,444 ton/year (629 ton/day)
Waste generation per capita:	1.43kg/person · day
Waste source:	72% household, 8% commercial, 15% industrial

Solid waste management

Collection:	Private sector carries out collection and transport of waste
Recycling:	Paper, plastic bottles, aluminium cans (300 recycling points)
Incineration:	Capacity of 778 ton/day, volume reduced to 20% after incineration
Final treatment:	Sanitary landfill (incineration residue, construction waste, animal carcasses, used tires)
Expenditure:	USD 17 million/year (Collection/transportation: USD 12.7 million, MSW incineration: USD 3.9 million, Landfill: USD 625,000), with a rate of 1.5% in the total budget.

Major challenges and strategies

Management of municipal solid waste is carried out by the Civic and Municipal Affairs Bureau (Department of Environment, Hygiene and Licensing), the Office for Infrastructure Development, and the Port Authority. Due to Macao's geographic area, high cost of land, and long-term waste treatment facility, incineration was the most appropriate technology to address environmental concerns.

Because of issues associated with insufficient land resources for waste disposal, solid waste management in Macao must also focus on decreasing waste generation through reuse, reduction, and recycling. There are a number of constraints limiting the extent of waste recovery and recycling activities, i.e., low public awareness; lack of financial incentives to reduce waste because costs for collection and disposal services are not linked directly with the quantity of wastes; restrictions on source separation and storage practices; and low value of recovered materials (plastic bottles, tires). Other barriers to the waste recycling campaign include high land and labour costs and the lack of market demand, which discourages the recovery of marginal materials and investments in waste recovery technology. Macao is conducting studies on the improvement of recycling through education and public relations, and allocating land for recycling.

Since 1992, the collection and transportation of municipal solid waste (MSW) and incineration have been contracted out to two private companies

- (1) Companhia de Sistemas de Resíduos, Limitada (CSR): Carried out collection, cleaning and maintenance of public garbage containers (380 staff, with 25 refuse compacted collection truck, 4 high pressure water jet vehicles, 6 sweeping vehicles).
- (2) Additional company: Incineration of 36 tons/per hour, 283,800tons/per year and generated 12MW of power for its own consumption. Remaining work is contracted out to a concessionary electric company that is operating the local public power supply network.

The private sector's motivation for profit will lead to the efficient conduct of activities to consistently improve returns, development of innovative methods to enhance services, more investment in the quality of assets to reduce long term maintenance and operating costs, and management of risks associated with completing investment projects in time and on budget. This type of service contract helped avoid "government failure" to improve efficiency, improved the capacity of local and central governments, and improved environmental technology and management skills, as well as contributed to the promotion of environmental business.

SURABAYA (INDONESIA)

General information

Area:	290km ²
Population:	2.8 million
National GDP per capita:	USD 3,043
Total income:	IDR 980 billion (USD 110 million)

Solid waste generation

Total generation:	1,630 ton/day
Waste generation per capita:	0.58kg/person · day
Waste source:	68% household, 16% market, 11% commercial/industries, 5% street and open space
Waste composition:	56% organic, 4.4% paper, 39.6% other (dry season)

Solid waste management

Collection rate:	Collection is organised by neighbourhood units; City government is responsible for transport of waste to final disposal facilities.
Recycling:	Conducted by scavengers, estimated at 30%
Composting:	In practice
Final treatment:	Semi-sanitary landfill (2 sites, 40.5ha and 16ha), composting, mini-incinerator
Expenditure:	IDR 60 billion (USD 6.6 million) is appropriated for transportation and disposal, a rate of 6% of the total budget. Fees for collection are included in “community fees” (IDR 10,000-30,000/month (USD 1.1-3.2)). Transportation and disposal costs are paid to the city directly and vary from IDR 6,000-14,000/month (USD 0.55-1.5). Total income for the city from transportation and disposal fees is IDR 15 billion (USD 1.6 million).

Major challenges and strategies

One of the major challenges in Surabaya City is organising recycling. Recycling activities have been carried out by scavengers, which have often led to exposure of solid waste on streets and sanitation problems. Scavengers reduce solid waste volume by almost 30% in Surabaya, which greatly reduce costs for transportation and disposal downstream. A new approach is urgently required to manage an efficient recycling system involving the scavenger labour force.

The major challenge for Surabaya is the large gap between income and expenses in solid waste management. Expenses are subsidised from other sources such as tax and other city revenue.

Strategies to date have been to ensure participation and involvement of the community, which, in turn, promotes self-development of the community itself. Institutional aspects, especially law and regulations must be improved together with human resources. Participation of private investors in solid waste management is limited, especially due to a lack of institutional framework, rules and regulations.

One of the lessons other cities can learn from Surabaya is community participation in managing local issues including solid waste. Surabaya is at the centre of the well known "Kampung Improvement Programme (KIP)" and "Comprehensive Kampung Improvement Programme (C-KIP)", with the focus on empowering local communities to solve their own problems with support from the local government and professionals. Solid waste management is inside the scope of KIP. In this arrangement, local communities are responsible for solid waste management in their neighbourhood. User fees are charged to households based on collective decisions, and arrangements are made to collect and transport solid waste to transfer stations by these units. For practical reasons, household fees for solid waste management are embedded with other fees in the form of a “community fee”. Under this arrangement, households pay transport and disposal charges for solid waste management to the city government, either through water bills or at the sub-district level.

YANGON (MYANMAR)

General information

Population:	3.7 million
National GDP per capita:	USD 1,027
Total income:	USD 20 million (MMK 15 billion)

Solid waste generation

Total generation:	3,000 ton/day (1999, estimated)
Waste generation per capita:	0.52kg/person · day (2000)
Waste source:	60% household, 15% market, 10% commercial, 15% other
Waste composition:	58% organic, 1% paper, 4% plastic, 4% animal carcasses/bones, 2% ashes/dust, 11% cane/bamboo, 20% other (wet season)

Solid waste management

Collection rate:	50-60%, private sector conducts collection
Composting:	200,000 bags (25kg) produced in last 15 months
Final treatment:	Dumping, landfill
Expenditure:	Fees: MMK 30-60/month

Major challenges and strategies

Yangon faces a number of challenges in the management of municipal solid waste including the lack of sanitary and controlled dumping sites; insufficient equipment, vehicles, and technical support; inadequate segregation at source and recycling activities; and institutional deficiencies, inadequate legal provisions, and resource constraints.

Similar strategies, as outlined for Cebu (Philippines) may be helpful in addressing the above challenges. This also includes the replication of community involvement for segregation and recycling activities as being conducted in Nonthaburi (Thailand). Moreover, the “Fukuoka Method” may also be useful to improve final disposal conditions. Nevertheless, institutional and regulatory frameworks are necessary, which should be considered with its relationship to the diverse political establishment of this country in comparison to Cebu and Nonthaburi.