Establishing a Sound Material-Cycle Society: Experience of Kitakyushu City, Japan

1. Introduction

Solid Waste Management (SWM) is one of the key challenges faced by the cities especially in developing countries. It is one of the key responsibilities of the local governments and often at the top of the most pressing problem list of the city mayors and administrators. The quality of the SWM is also a good indicator of a city's service provision and good governance. Further, proper planning of SWM can improve the public health, quality of life, environmental condition, and resource management in the city. The indiscriminate dumping of organic waste into landfills or open dump sites results in serious air pollution, soil and groundwater contamination as well as emissions of greenhouse gases (GHGs). Proper management of MSW thus can contribute to climate change mitigation.

In keeping with the global trends, many cities are now focused on the waste hierarchy as a preferred approach for management of solid waste that aims at waste reduction, re-use, recycling, energy recovery and landfill as a last option (See Figure 1). Japan displays one of the best examples in the world of formulating national and local policies for establishing a sound material-cycle society based on the 3R principles. The Basic Act for Establishing a Sound Material-Cycle Society (Act No. 110 of 2000) which was enacted in 2000 represents a shift away from traditional end-of-life disposal policies to a more integrated and circular approach within the broader context of sustainable consumption and production.

In this background this paper aims to discuss the experience of Kitakyushu City, one of the environmental model cities in Japan, in achieving efficient and closed-loop management of material resources, reduce the amount of waste produced and to be landfilled. Based on the national legislation, Kitakyushu City has developed its first Basic Plan for Municipal Solid Waste Management in 2001 aiming to achieve the target of 20% waste reduction and 25%
increase in recycling activities by 2011. This paper, therefore, presents the implementation of the basic plan, key policy and strategic measures have taken, achievements and lessons learned that may help for other local governments that are planning to modernise their municipal solid waste management (MSWM). The basic information was gathered by reviewing the literature of the City of Kitakyushu.

The paper includes four main sections. After this brief introduction, section two presents the historical development of Kitakyushu City from a Grey City to a Green City. Section three highlights the development of the basic plan for MSWM in Kitakyushu City based on the national fundamental law for establishing a sound material-cycle society and its achievements. The section gives recent figures related to municipal waste generation, recycling, treatment and final disposal. Further, it will see the financial achievement comparing revenue and expenditure for municipal solid waste management. Further, it provides key policies and regulations as well as good practices in promoting 3R (reduction, reuse, and recycling) in establishing a sound material-cycle society in the city. Some of the policy measures are introduction of separated waste collection, pre-paid designated bags for household waste collection, infrastructure development for waste recycling and treatment (eco-town, incineration and waste management centers), community-based activities for environmentally-friendly lifestyles (waste paper, composting, green waste, waste food oil, eco-life stage, my bag campaign and environmental passport and 3R education). Finally, section four concludes by discussing lessons learned and identifying some practical recommendations that give some policy recommendations for the local decision makers and city officials who wants to modernise their SWM.

2. Kitakyushu City and its Historical Development

Kitakyushu, a city with a total population of one million, is one of the leading environmental cities in Japan. Historically, it was a castle city that served as a centre of the governmental and commercial activities in Kyushu, the western part of the country (See Figure 2). Due to its strategic location as a key junction for sea and land transport, the City of Kitakyushu took a national attention during the Meiji period that was came to power in the latter half of the 19th Century. The railroads and port facilities were rapidly developed, and a castle city became an industrial city for supporting the country’s industrial revolution. In 1901, the Yawata Steel Works, a first modern steel factory in Japan, was established in Kitakyushu City. The city was further developed by merging five separate cities in 1963 and played an important role in the modernisation and rapid post-war economic growth in the country1.

Figure 2: Location of Kitakyushu City
Source: Environmental Bureau, Kitakyushu City, 2010
Population: Approx.960,000(2015)
Land area: 489.6km²
Municipal budget: Approx. US$4.3 billion (2013)

---

1 For more information about the historical development of Kitakyushu City, please refer <https://www.city.kitakyushu.lg.jp/english/file_0059.html>
However, this rapid economic growth and industrial prosperity brought serious environmental pollution including heavy air and water pollution. The Shiromiya districts of Dokai Bay area which was located in the centre of the city’s industrial zone was highly contaminated by industrial and domestic waste water that progressed to such an extent that the bay was called the Sea of Death. Despite this situation, the residents, businesses, and the local government united in the task to overcome pollution. Considering the negative effects on the health of their families, a local women’s association called the Tobata Women’s Association who came first to take action against this pollution situation. Based on the results of several years of research carried out in cooperation with the university professors, this woman’s association asked the local government to take necessary measures to address the environmental pollution and started to educate the public on the issue through the We Want Our Blue Sky Back Campaign.

As a result, the local government established necessary regulations and requested businesses to take appropriate measures. In 1971, prior to the establishment of the Environmental Agency by the national government, Kitakyushu founded the Environmental Pollution Control Bureau (currently the Environment Bureau). Kitakyushu City also established a number of regulations, including the Kitakyushu Pollution Control Ordinance which was more stringent than the national laws at that time and enforced a series of effective measures that targeted major companies in the city, including the execution of agreement to prevent pollution. Responding to the local government request, private enterprises introduced cleaner production, including energy conservation, resource recycling, and pollution reduction through technological innovation and capital investment. These collaborative efforts between citizens, businesses, and local government helped to bring significant improvement in Kitakyushu’s environment (See Figure 3). In the 1985 report of the State of the Environment, the Organisation for Economic Cooperation and Development (OECD) shared the experience of Kitakyushu as an example of a city that transformed from a Grey City to a Green City².

Figure 3: Kitakyushu’s experience in overcoming environmental pollution
Source: Environmental Bureau, Kitakyushu City, 2010

² Kitakyushu’s experience and initiatives in the Japanese Industrial Waste Experience, UNEP/IETC, 2013,
3. Municipal Solid Waste Management in Kitakyushu City

3.1. Current Municipal Solid Waste Management System in the City

According to the Waste Management and Public Cleansing Law (1970), solid waste is divided into two broad categories such as municipal waste and industrial waste\(^3\).

![Figure 4: Municipal Solid Waste Management System in Kitakyushu City](source)

A management of industrial waste that includes ashes, sludge, waste oil, waste acid and alkali, waste plastics and others stipulated by the government ordinances (total 21 items) is solely the responsibility of the respective enterprises\(^4\). The City of Kitakyushu provides regulatory and monitoring framework and guides the businesses for controlling the generation of industrial waste and proper recycling and disposal. Further, the city inspects the industrial activities such as compliance with disposal standards and thorough utilisation of the Disposal Confirmation Sheet (Manifest) to ensure traceability. In addition, city conducts field surveys periodically to understand industrial waste production and waste disposal conditions in the city\(^5\). All solid waste other than industrial waste is identified as municipal solid waste (MSW) or domestic waste.

3.1.1. Waste Separation and Collection

The City of Kitakyushu is responsible for proper collection and treatment of the MSW. Figure 4 shows the MSWM system in the city. The City of Kitakyushu applies the separated waste collection system. Currently, each household separates waste into 15 types or 21 categories and dispose of them accordingly\(^6\). Figure 5 illustrates the waste separation types in Kitakyushu City. The residents are requested to purchase the designated bags from any supermarkets and convenience stores to put their household or kitchen waste and others separately. The household waste collects twice a week while other recyclable items such as cans and bottles, plastic bottles (PET bottles) and plastic containers and packages collect once a week. The city has established waste collection stations at a ratio of one location for 10-20 households to ensure efficient operation.

---


\(^5\) Background Paper on the City of Kitakyushu, OECD Green Cities Programme (Final), City of Kitakyushu, 2012

\(^6\) For more information of the waste separation system in Kitakyushu City can access [http://www.city.kitakyushu.lg.jp/kankyou/file_0004.html](http://www.city.kitakyushu.lg.jp/kankyou/file_0004.html) (Japanese)
According to the city officials, approximately 33,000 collection points are established for household waste collection while 11,000 points are located for collection of plastic containers, cans, bottles and PET bottles throughout the city. Residents bring their household and recyclable materials to designated collection points by 8:30AM of the specified collection day. Each collection point has a blue colour net to cover the waste to prevent from animals such as dog and crows. The residents are voluntarily responsible for the cleaning, management and monitoring of the collection points. The city employed three different sizes of waste collection vehicles (large, medium and small) for waste collection and transportation based on the road conditions in the city (See Figure 6). The city also placed special collection boxes at different locations including selected supermarkets, community centres, and convenience stores to collect some recycling materials, such as cartons and trays, electric appliances, and other materials (See Figure 7). The used paper including waste newspaper, magazines, cardboards and miscellaneous paper collects through the promotion of group activities at the community level. The city provides financial incentives, approximately seven JPY per kg for the recovering group, to motivate voluntary groups for the recycling activities.

7 Introduction to the municipal solid waste administration, Resource Circulation Division, City of Kitakyushu Environment Bureau, 11 Nov 2014
3.1.2. Waste recycling

The collected recyclable materials from the collection points then transport to the two recycling facilities that are established close to the incineration facilities in Hiagari and Honjo areas. Both recycling centres are highly mechanised introduced proper measures to improve the working condition such as a bag tearing machine, steel and aluminium can separators, and sound proofing and fresh air supply (See Figure 8). The recycling centres are employed handicapped people in the city as part of their social welfare programmes integrating them into the productive society. After that, separated recyclable materials bring to the recycling businesses that are located in the Eco-Town and other areas (See Figure 9).
The City of Kitakyushu established Kitakyushu Eco-Town in 1997 aiming to combine the industry promotion and environmental conservation in order to establish a resource circulating society. Located in a 2,000 ha of reclaimed land in Wakamatsu, it was one of the first Eco-Town projects the government has approved and the largest one in Japan. In collaboration with the private businesses and universities, the Eco-Town implements a comprehensive recycle-related works covering in such fields from education, fundamental research, technology development, practical research and their commercialisation.

With about 29 environmental industries and 16 practical research institutions, the Eco-Town encourages development and testing of new environmental technologies, establishment of new industries, and educates the public about the environment. As Figure 10 shows the facilities in the Eco-Town area feature a combination of small and medium-scale business, such as plastic bottles, auto mobile and cooking oil recyclers.

Moreover capitalising on businesses amassed in the compound, a form of cooperation has taken as residual waste resulting from the recycling process at the various plants is utilised by other facilities. For example, a thermal recycling facility that collects and utilise thermal energy produced by incineration was established in 2005 (See Figure 11). This facility melts down residual materials that ultimately cannot be recycled by the various entities and provide the electricity generated by the resulting heat to Eco Town businesses.

---

Kitakyushu Eco-Town

- Approved in 1997 and started the operation in 1998
- No of business facilities: 26
- No of research facilities: 16
- Total investments: 66 billion JPY
- No of employment creation: 1,340
- Visitors observed: 1.2 million (up to 2012)

Figure 10: Basic Facts on the Kitakyushu Eco-Town.

Source: Building a resource efficient and zero waste city: experience of Kitakyushu City, UNCRD/UNDESA Side Event at the Second Meeting of the High Level Political Forum on Sustainable Development, Kitakyushu City, 7 July 2014

---

8 For more information about the Kitakyushu Eco-Town, please refer to [http://www.kitaq-ecotown.com/](http://www.kitaq-ecotown.com/) (Japanese)
3.1.3. Final treatment and disposal

The City of Kitakyushu has set up three incineration facilities along with other waste recycling and treatment facilities to treat the household waste aiming to sanitise and reduce the volume before landfill. The three facilities named Kogasaki, Hiagari and Shinmoji are located based on the effective waste collection and transportation. As shown by Figure 12, incineration facilities are integrated with the waste recycling and other treatment facilities in the city to maximise the resource utilisation. All facilities are highly automation of the operation system with computer control, including automatic weighing of waste, the automatic functioning of the crane and the incinerator. In addition, the countermeasures against pollution control such as bag filter (Shinmoji and Kogasaki) and wet scrubber (Hiagari) are also established.
Table 1 gives the basic facts and figures of incineration plants in Kitakyushu City. According to the data, three incinerators can accommodate approximately 2,130 tons of municipal waste per day. In addition to the waste generated by the residents of the city, the incineration plants accept the waste from nearby cities to operate the maximum capacity of the plants. All plants are produced electricity, and the generated power is used for the electricity requirement of the facility and nearby recycling facilities while surplus power is sold to electric power company. In addition, the refuse incineration heat is converted into the energy of steam and supplied to the facilities of neighbouring cities, such as the central wholesale market. The Shinmoji facility was equipped with ash smelting equipment that enables recycle ash. The rest of other plants use stoker method and ash will send to the Hibikinada sanitary landfill site with an area of 70 ha. Landfill is conducted in a hygienic facility that is shut off from the surrounding environment and rainwater or wastewater from the landfill facility is processed in a wastewater treatment plant and released into the sea. The status of the surrounding environment is periodically monitored⁹.

---

⁹ Background Paper on the City of Kitakyushu, OECD Green Cities Programme (Final), City of Kitakyushu, 2012
Table 1: Basic Facts and Figures of Incineration Plants in Kitakyushu City

<table>
<thead>
<tr>
<th>Description</th>
<th>Shinmoji Plant</th>
<th>Kogasaki Plant</th>
<th>Hiagari Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total construction costs</td>
<td>224 million USD</td>
<td>310 million USD</td>
<td>120 million USD</td>
</tr>
<tr>
<td>Capacity of the plant</td>
<td>720 tons/day (240 tons/day X 3 units)</td>
<td>810 tons/day (270 tons/day X 3 units)</td>
<td>600 tons/day (200 tons/day X 3 units)</td>
</tr>
<tr>
<td>Type of treatment</td>
<td>Gasification types (waste-gas-burning)</td>
<td>Stoker type (waste-burning)</td>
<td>Stoker type (waste-burning)</td>
</tr>
<tr>
<td>Ash</td>
<td>Melting and recycling</td>
<td>Landfill</td>
<td>Landfill</td>
</tr>
<tr>
<td>Electricity generation</td>
<td>550 kWh/ton</td>
<td>410 kWh/ton</td>
<td>230 kWh/ton</td>
</tr>
<tr>
<td>Steam condition</td>
<td>40 kg/cm³ and 400°C</td>
<td>24 kg/cm³ and 285°C</td>
<td>21 kg/cm³ and 260°C</td>
</tr>
<tr>
<td>Low calorific value (kcal/kg)</td>
<td>1,500 – 3,000</td>
<td>1,500 – 3,000</td>
<td>1,200 – 2,500</td>
</tr>
</tbody>
</table>


3.2. Historical Development of Municipal Solid Waste Management Policies and Strategies in Kitakyushu City

3.2.1. Disposal oriented policies

Before 1993, the MSWM system in Kitakyushu City was merely focused on improvement of sanitation aspects rather than material recovery. City established proper waste collection and environmentally friendly disposal. The MSW was collected by households then transported to the incineration facilities that operated by the city. No waste separation and recycling activities happened under the preview of the city. However, considering the rapid growth of MSW generation, increase of the budget requirements for waste collection and treatment and consideration of natural resources, the city changed its attitudes and policies towards waste recycling.
As a first step, the citizens were educated to separate cans and glass bottles in 1993 and later introduced the PET bottle collection and recycling in 1997. These policy changes however did not help to achieve its original objective of waste reduction in Kitakyushu City. In contrast, the waste generation has been increased annually, and the total figure became 480,000 tons in 1997 (See Figure 13).

3.2.2. Introduction of fee-based garbage bag collection system

In 1998, Kitakyushu City introduced a fee-based garbage bag collection system, the first attempt of its kind by the larger size city in the country. The residents are requested to purchase the designated colour bags to put their household waste and others separately. The price of the designated bag was determined based on the concept of pay for your waste and the prices for three sizes of bags were 15 JPY for 45 liters bag, 12 JPY for 30 liters bag and 8 JPY for 20 liters bag. The data reveals that quickly after the introduction of fee-based garbage bag collection system, the total amount of household waste was decreased by 6% from 325,000 in 1997 to 307,000 in 1998. However, it was experienced that initially the total amount of waste started to decline, it gradually levelled off after a while and then lingered persistently without raising or dropping (See Figure 13).

3.2.3. Basic Plan for Establishing a Resource-Circular Society in 2001

Aiming to accelerate the waste separation and recycling, the Kitakyushu Basic Plan for Establishing a Resource-Circular Society was established in 2001. The basic plan was set a target to achieve 20% waste reduction and 25% waste recycling target by 2011 based on the 1999 figures. The city introduced a number of new initiatives to motivate residents to reduce waste generation and increase waste separation and recycling activities. Considering the high value of plastic (containers and packaging) in the MSW, Kitakyushu City introduced the separated collection of plastic containers and packaging in 2006.

In addition, the city revised the fees of designated garbage bags. The prices of designated bags for kitchen garbage and others were increased and newly started to charge for recyclables, such as cans and bottles, PET bottles and plastic containers and packaging. However, to give more incentives for citizens to do more separation at source, the prices of the designated bags for recyclables were lower than the price of kitchen waste. Figure 15 shows the current prices of designated garbage bags.

---

10 Integrated solid waste management in Kitakyushu City, Environment Bureau, 22 January 2015
However, when the system went into actual implementation, the opinion voiced by some residents was that waste treatment should conduct by the city government using tax money. In efforts to win the public understanding of the necessity of the system, the city government held repeated meetings to exchange opinions with the residents and then reached consensus on the implementation. According to city officials, more than 13,200 facilitators (11,700 city volunteers and 1,550 city officials) joined the early morning meetings that ran 10 consecutive days, each day from 6:00 – 8:30 covering 100,000 persons. In addition, Kitakyushu City established a voluntary monitoring and reporting, patrolling and set-up of monitoring cameras for strictly enforce the illegal dumping. As a result, the City of Kitakyushu achieved 34% waste reduction in household waste exceeding the original target of 20% during the period of 1999 – 2011 (See Figure 13). Further, the recycling rate reached 30% during the period of 1999 to 2009 surpassing the target rate of 25% in 2011 (See Figure 16).
The waste reduction through recycling brings some financial benefits to the city. The total costs for the treatment of solid waste in Kitakyushu were 161 million USD in 2003. However, this amount has reduced to 135 million USD in 2009 and 130 million USD in 2012. As shown by Figure 17, the waste collection costs (52%) of 2003 was higher than the costs of waste treatment (41%). But, after the introduction of new MSWM system with more waste separation at source, the total percentage of waste collection was decreased and the portion of recycling and treatment were increased. This shows that introduction of recycling activities has increased the costs for recycling and treatment works.

![Figure 17: Reduction of MSWM costs in Kitakyushu City](http://www.iges.or.jp/en/archive/kuc/pdf/activity20110314/10_WS-S1B-4-Kitakyushu_Hamasaki_E.pdf)

3.2.4. Fundamental Plan for Establishing a Sound Material-Cycle Society in 2011

Even though, the implementation of the Kitakyushu Basic Plan for Establishing a resource Circular Society has achieved its original targets in waste reduction and recycling with direct financial benefits, Kitakyushu City recognised the importance of taking further action to address the remaining materials in the household waste. As a result, the Kitakyushu Fundamental Plan for Establishing a Sound Material-Cycle Society was formulated in 2011.

The plan focuses on creating optimal community recycling zones, contributing...
to low carbon society and a society that co-exists with nature and promotion of international environmental cooperation and business. Under the plan, Kitakyushu City established the historical waste reduction targets, including a reduction of per capita residential waste volume by 7% (from 506 g/person/day in 2009 to 470 g/person/day), achievement of recycling rate by 35% and reduction of CO2 emission resulting from general waste treatment by 22,000 tons by 2020 compared to the figures of 2009 (emissions below 100,000 tons). The Figure 18 shows the estimation of CO2 emissions reduction based on the life cycle assessment of the MSWM\textsuperscript{12}. The plan also identifies the role of key stakeholders, including residents, business and local government.

### 3.2.5. Environmental actions with residents as an environmental learning process

Based on the past experience in improving the environmental problems, Kitakyushu City promotes the environmental actions with residents as an environmental learning system in the city. These activities focuses on creating an interest in resource and waste management based on the 3R principles. The city implements awareness raising activities through various environmental events such as Eco Life Stage (Figure 20), an exchange opportunity for the environmental activities of residents. In addition, a simple packaging is encouraged in cooperation with manufactures and consumer organisations. For example, My Bag Campaign was established to reduce the consumption of shopping bags, encouraging residents to use their own bags. To motivate residents to use My Bag, the No Bags Points Campaign (Kanpass Project) was introduced wherein shoppers are given points each time they refuse the offer of plastic shopping bags which can be exchanged later for discount coupons at participating stores (Figure 19).

![Figure 19: Information of kanpas Campaign in Japanese. Source: Environmental Bureau, 2014](image1)

![Figure 20: View of Eco-Life Stage in 2011. Source: Environmental Bureau, 2015](image2)

A variety of measures are introduced to educate young and school kids on the environmental education and 3R activities. The city has established the Environmental Museum in 2001 as a historical place for environmental issues and learning. Environmental supporters, who are volunteers, guide the visitors displaying on diverse environmental issues and offering environmental study lessons (See Figure 21). In addition, a set of comprehensive and systematic environmental education text books (Midori Note) was published in collaboration with the Education Council targeting different age groups, from infants to junior high schools (See Figure 22).

\textsuperscript{12} Background paper on the City of Kitakyushu OECD Green Cities Programme (final), City of Kitakyushu, 2012
The city also promotes reuse of materials through providing information about flea markets and recycles shops to exchange and sales reused items at public venues such as environmental museum, eco life plaza. In addition, old or broken furniture that are not used in households are accepted by the city contingent upon payment (bulk waste collection fee) repaired as needed and sold at reasonable prices at the two recycling plazas. Further, Kitakyushu City provides training, education and subsidies to residents for purchasing composting equipment. The city provides incentive payments to the children’s associations to collect newspapers and magazines based on the amount of collection. The city also setup collection points at supermarkets to collect cartons and trays, electric appliances, fluorescent lights, used cooking oils, and small metal items.

4. Conclusions and Lessons Learned

Despite the growing challenges posed by the MSW generated in the cities, a shift from conventional end-of-life disposal processes to a more integrated and circular approach that promote the 3R of the waste hierarchy (reduce, reuse and recycle) through effective use of materials and other resources, is now globally recognised. Some cities in Japan and other developed countries have taken efforts to establish relevant policies and adequate mechanisms for their practical implementation aiming to develop a sound material-cycle society based on the 3Rs. Learning from these cities and sharing of their experiences of success and failure, and key contributing factors, among developing cities which are in an initial stage of developing local strategies to modernise their MSWM system would be very beneficial. This case study therefore documented the process of modernisation of MSWM in Kitakyushu City,
especially focusing on its policy development and practical implementation and identifies the following key lessons learned:

- The experience shows that Kitakyushu City was able to achieve about 30% municipal waste reduction and recycling targets during a period of 10 years adopting key policies and regulations as well as good practices in promoting 3R in establishing a sound material-cycle society in the city. The waste reduction and recycling also brings some financial benefits such as reduction of MSWM costs and emission reduction. Some of the key policy measures that are introduced by Kitakyushu City includes introduction of separated waste collection, pre-paid designated bags for household waste collection, infrastructure development for waste recycling and treatment (eco-town, incineration and waste management centres), and community-based activities for environmentally-friendly lifestyles (waste paper, composting, green waste, waste food oil, eco-life stage, my bag campaign and environmental passport and 3R education).

- The experience identifies that the choice of technologies for waste management is important but not enough to establish a sustainable material-cycle society. Other key factors such as relevant policies, legislations, incentives, monitoring tools, political support, partnership and citizen participation also play a fundamental role. MSWM needs much more understanding, participation and cooperation among different stakeholders in the city than many other service provisions. The fundamental plan with long-term vision and strategic approach from local government can express the political will and provides the opportunity for building consensus and agreement among different stakeholders. The traditional social systems and previous experience in building partnership with stakeholders to achieve common objectives may help for such collaborative efforts in planning and implementation of new waste management system.

- The case study analysis recognises the importance of adapting a phase-based or step-by-step approach for modernising the MSWM in the cities. While the stage of development in the cities are vary as their MSW characteristics, the technology options for waste separation, storage, collection, transport, treatment and final disposal should be developed considering the social factors (public awareness, involvement of NGOs and CBOs, and informal provide sector), availability of resources (human and financial) and capacity, cost efficiency, economic benefits and environmental impacts.

- One of the key strategies that Kitakyushu City has adopted and remarkably supported to the development of its Sound Material-Cycle Society is the Eco-Town Approach that seeks to achieve resource conservation in terms of energy, water, waste and materials. It geographically clustered the small and medium size recycling industries within the city in close proximately to other treatment facility and business to promote environmental industries. Further, it supports the environmental education, research, and commercialisation of resource recycling and recovery technologies. This helps to create a new social system in which resources are used more efficiently establishing a recycling-based society incorporating low carbon and co-existence with nature in addition to the traditional recycling activities. The improvement of MSWM system cans reduction of CO2 emission resulting from general waste treatment in the city.

- Needless to say that increasing awareness of the issue can promote a change in resident’s attitudes leading to a change in their behaviour on MSWM. Kitakyushu City has succeeded in creating environmental education and awareness through the application of a resident-cantered environmental action learning where
whole society from infants to elderly can join, think together, learn and take leadership roles in action. In contrast to traditional teaching methods, this action learning method promotes networks and peer-group activities through various events such as Eco-Life Stage.

Author

D.G.J. Premakumara, Senior Researcher, Kitakyushu Urban Center, Institute for Global Environmental Strategies (IGES)