Chapter 4

An Overview of 3Rs in Singapore

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Chapter 4. An Overview of 3Rs in Singapore

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I. Introduction

This report provides an overview of how Singapore manages its solid wastes from both municipal and industrial sources. The management of toxic and hazardous waste is not covered in this report.

Singapore is relatively a small country. Its land area in 2007 was reported to be about 707 sq km. Its population grew from about two million in 1970 to four million in 2000. The quantity of solid wastes produced per year from 1970 to 2000 also increased in tandem with the growth in population, rapid industrialization and increase in Gross Domestic Product (GDP) (Table 1).

Table 1. The Amount of Solid Wastes Produced Per Day Compared to Singapore's Population and GDP.

Year	1970	1980	1990	2000	2007
Population ('000)	2,074.5	2,413.9	3,047.1	4,027.9	4,588.6
GDP (S$ mil)	5,804	25,117	66,778	159,840	243,168
Amount of Solid Wastes (Tonnes per day)	1,200	2,600	5,700	7,700	7,000

Source: National Environment Agency and Statistics Singapore (2007)

It was quickly realized at that time that given the scarce land resource in the country and with the rapid increase in waste generation, the landfill technology was not sustainable. Up to the 1970s, all municipal wastes were landfilled. The only landfill that continued to operate then at Lorong Halus, was also closed in 1999. Since then, several concrete actions were taken (by the National Environment Agency) to reduce the amount of solid wastes generated per day.

II. Solid Waste Management Strategies

Several strategies were implemented to address the problems on waste in the country. This resulted to a reduction in the quantity of wastes generated from 7,700 tonnes per day in 2000 to 7,000 tonnes per day in 2007. The strategies included the following:

Strategy 1: Volume Reduction
Strategy 2: Waste Recycling
Strategy 3: WasteMinimization

II-1. Volume Reduction

II-1-1. Waste Collection

The huge amount of municipal waste generated daily required a highly efficient collection and disposal system. Otherwise, in hot and humid climate of Singapore, municipal and domestic wastes would quickly putrefy resulting in smell, propagation of vectors and other public health issues.

Over the years, Singapore has developed one of the most efficient refuse collection systems in the region. To improve collection efficiency and service quality, the waste collection service was privatised in 1999. Singapore is divided into nine geographical sectors and waste collection companies have to bid for the licence to provide refuse collection services in each sector. Currently, the refuse collection services are provided by four appointed Public Waste Collectors. The system was put in place in 2001, with primary objectives to improve collection efficiency and service quality. The public waste collectors (PWCs) are awarded seven-year contracts to service a sector, including the collection of recyclable materials from households under the National Recycling Programme.

II-1-2. Incineration

Incineration was adopted as the most effective method of waste disposal. Incineration reduces the volume of wastes by as much as 90%. In the process, energy is recovered for power generation. The bottom ash is then landfilled, after ferrous metals have been removed.

The first incineration plant was commissioned in 1979. Since then, three other incineration plants were set up. With limited land available for waste disposal, Singapore's policy for solid waste management is to reduce the volume of waste that goes to the landfill by incinerating all incinerable waste at the four Waste-to-Energy Plants. In 2007, 2.57 million tonnes of waste was disposed at the refuse disposal facilities and about

2.38 million tonnes (92.7%) of the refuse was incinerated. The remaining non-incinerable waste such as sludge, silt, shipyard waste, construction and demolition waste, and the incineration ashes are disposed at the offshore Semakau Landfill.

The total effective incineration capacity of the existing incineration plants amounts up to 8,200 tonnes per day. This is sufficient to handle all incinerable wastes currently generated in Singapore, which is slightly more than 7,000 tonnes per day. A fifth incineration plant is expected to start its operation in mid 2009 to replace the another one that is nearly at the end of its operation lifespan.

II-1-3. Recovering Energy from Waste

The waste heat of the incineration process produced about 954 million kWh of electricity which is about 2 to 3% of the total electricity generated in Singapore. Scrap metal was also recovered in the plants with magnetic devices. The quantity of scrap metal recovered in 2007 amounted to 14,000 tonnes. They were sold to local steel mill which reprocess the metal into steel products.

The amount of refuse going to the landfill has gradually decreased over the last 10 years while the amount of waste disposed at waste-to-Energey Plants have gone up (Table 2).

Table 2. Amount of Refuse Disposed at the Waste-to-Energy Plants and the Landfill Over a Period of 10 Years

Year	Landfill ('000 Tonnes)	Waste-to-Energy Plants ('000 Tonnes)	Total Refuse Disposed of ('000 Tonnes)
1998	958.1	1884.1	2842.2
1999	756.2	2036.3	2792.5
2000	357.2	2440.1	2797.3
2001	251.3	2550.9	2802.2
2002	204.3	2421.3	2625.6
2003	193.8	2311.2	2505.0
2004	219.6	2263.0	2482.6
2005	270.1	2278.6	2548.7
2006	234.5	2329.1	2563.6
2007	187.3	2379.5	2566.8

Source: National Environmental Agency (2007).

II-1-4. Establishment of the Semakau Landfill

The incineration ash, as well as the non-incinerable wastes, are disposed at the Semakau Landfill. The offshore landfill started operating on April 1999 after the last

landfill on the mainland was used up. It has a capacity to contain 63 million m^3 of waste and is expected to last until 2045. The cost for the landfill is about US$915 million (please give the equivalent in US$). Every day, about 500 tonnes of non-incinerable waste and 1,500 tonnes of incineration ash is sent to the landfill.

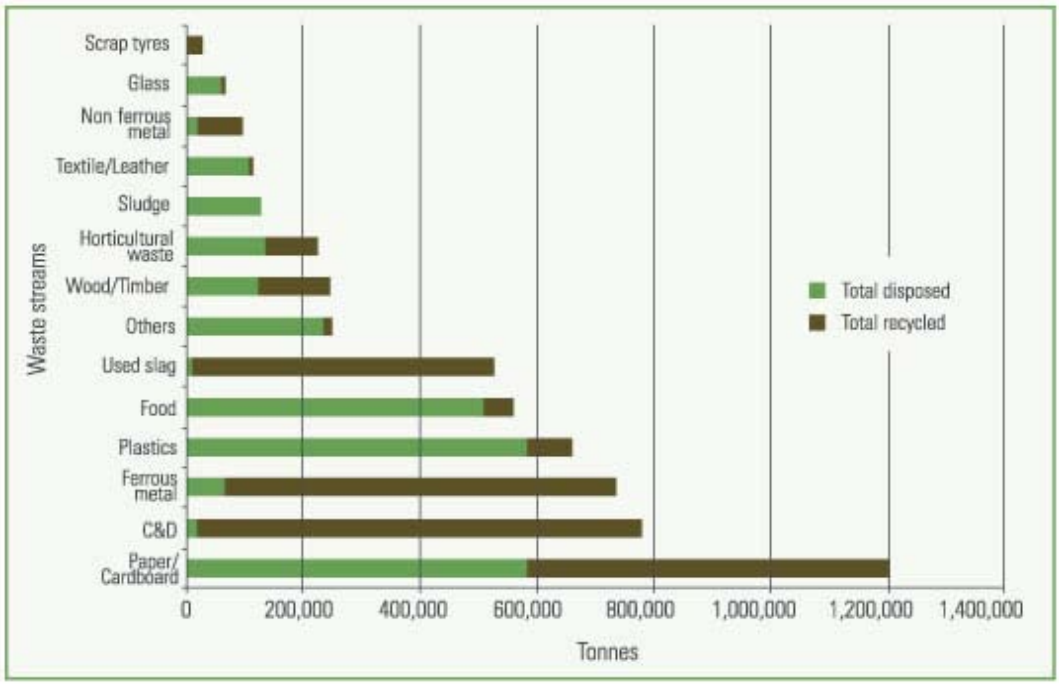
Members of the public are allowed to visit the Semakau Landfill to learn about the waste management of Singapore. The landfill is now an attractive eco-tourism site that co-exists with the vibrant marine biodiversity of the inter-tidal walk on the same island. A visitor centre was set up with an information gallery and posters to educate visitors about solid waste management. Arrangements can be made for visitor groups to do bird watching or star gazing activities.

II-2. Recycling

The second waste management strategy is recycling. The recycling programmes began in 2001 when the quantity of waste generated reached its peak at 7,700 tonnes/day. These programmes targeted the public households, condominium, private apartment estates, schools and industrial estates.

Figure 1 compares the quantity of the different types of wastes disposed of and recycled. In 2007, 54% of wastes were recycled. The quantity of used slag recycled is close to 100%. Some 91% of ferrous metal wastes, 98% of construction and demolition (C&D) waste, 41% of horticultural wastes and 51% of paper waste were recycled. The target is to recycle 60% of Singapore's wastes by 2012.

Figure 1. Waste Generation in Singapore



Source: National Environment Agency (2007)

II-2-1. National Recycling Programme

The National Recycling Programme was launched in April 2001. Under this programme, the public waste collectors licensed by the National Environmental Agency are required to work with recycling companies to implement door-to-door collection of recyclable material in both public housing estates and landed properties within their servicing sectors.

Public estates dwellers are given recycling bags and residents in landed properties are given bins to put in recyclable materials. They will put out their recycling bags or bins outside their door for collection by recycling companies on a predetermined collection date. The recyclables collected include clean paper, plastic, glass containers, metal cans and old clothing.

To encourage the public to play a pro-active role in recycling and for a more cost effective system, the fortnightly collection programme was replaced with centralized recycling bins placed strategically at some places of the residential estates. There is at least one set of centralized recycling depositories for every five blocks of flats. About 3,800 recycling bins are also placed in public areas such as outside subway stations, shopping streets and malls.

The government has also made it mandatory for all condominiums and private apartments to provide receptacles for recycling within their estate. Managing agents and management councils of these establishments are guided by the National Environment Agency to set up the structured waste recycling programmes.

II-2-2. Recycling in the Schools

In September 2002, a structured waste recycling programme was launched in the schools. The aim of this recycling programme is to educate and inculcate the recycling habits amongst students. The recycling programme involves the setting up of a Recycling Corners with recycling bins for paper, cans, plastic bottles and other educational materials. The amount of recyclables collected is measured to monitor the programme. Over 95% percent of the schools have taken part in this programme.

II-2-3. Recycling of Industrial and Commercial Waste

Non-domestic waste from industries and commercial premises accounts for about 50% of the waste disposed at the waste disposal facilities. Recycling bins are placed at convenient locations such as lift lobbies of each block of the industrial estates for factories to deposit recyclable waste. Designated areas have been set up at bin centres

within industrial estates for wooden pallets for reuse or recycling. A guide on waste minimization, published by the National Environment Agency with the assistance from a Working Group which comprised of five different corporations, was also developed to help companies reduce waste through more effective and efficient use of resources, reusing and recycling. The guide was developed to assist companies to reduce waste at source and to recover more recyclables from the industrial sector for reuse and recycling, thereby helping the industries improve productivity and profitability

II-2-4. Plastic Recycling

The amount of plastic waste generated is about 660,000 tonnes per year and about 11% is recycled. There are several companies that are engaged in this recycling activity as a business. Most would collect waste plastics for resale without further processing. One company in the Sarimbum Recycling Park is involved in the entire recycling process – from sorting, melting, shredding and granulation. The final product is plastic resins.

II-2-5. Wood Recycling

The amount wood waste generated per year is about 250,000 tonnes. About 52% is recycled through shredding the wood and carbonizing to make it into technical wood products, pallets, furniture or charcoal. Branches and trees received through tree pruning are sent to the composting plants to be processed into compost for planting and landscaping work.

II-2-6. Food Waste

The Asia's first major bio-mechanization and renewable energy plant was built in Singapore in 2007. It has the capacity of processing up to 800 tonnes of organic waste per day. At full capacity, the plant can reduce more than half of the food waste currently delivered to the incineration plants. The material will be recycled into sanitized nutrient rich compost as a soil media for organic farming and the landscaping industry. Biogas is also harnessed for the production of renewable electrical energy.

II-2-7. Recycling of construction and demolition waste

The waste generated from construction or demolition activities amounts to about 780,000 tonnes/year. These wastes cannot be incinerated and about 98% are recycled. The waste is made into fine or coarse aggregates that can be made into concrete products or used for road kerbs.

II-2-8. Copper Slag

A large volume of used copper slag is collected from the major shipyards in Singapore. A new plant that is capable of processing 360,000 tonnes of copper slag per year was opened in October 2008. The processed copper slag is then used in the process for making concrete.

II-2-9. Case study of a recycling company

Veolia Environmental Services is one of the four public waste collectors in Singapore. It provides integrated waste management services, which includes waste collection, disposal and recycling. The company collects glass bottles, plastics, metal, clothing and paper from private and government housing estates, schools, government establishments, hawker centres and shops. The company provides door-to-door collection service. In this system, households place their co-mingled recyclable wastes in plastic bags supplied by the company and leave these recyclables along with their trash. The recyclables are collected at predetermined intervals and brought to the plant for sorting.

A second method of collection is through the recycling stations. There are recycling stations at strategic locations in public housing estates. At each recycling station, there are two bulk bins. Each bin has a capacity of 660 L. The blue bin is for paper and the yellow bin is for light recyclables. There is one recycling station for every five blocks of apartments (approximately 500 households). Like the recyclables from the house-to-house collection, the co-mingled recyclable wastes from the recycling stations are brought to the Veolia's plant for sorting.

Veolia has a third programme which it claims distinguishes itself from its competitors. Veolia promotes recycling with the help of the Resident Committees in the various public housing estates. The Resident Committees organise monthly recycling day for the precinct under their charge. In this programme, the residents can exchange their recyclable wastes for food items at pre-determined recycling points. For every 5 kg of recyclables, the resident could get either a cup noodles or a canned food item such as sardines. This programme was started in 2004 and has been very successful. According to Veolia, up to 2,000 kg of recyclables can be collected in a two-hour session.

The logistics of collection and its associated cost are the main challenges facing waste collection companies. In private housing estates such as condominiums where units are spread out, one set of bins is required for every 100 households. This is five times less efficient compared to public housing estates.

At the sorting plant, the wastes are unloaded onto a conveyor belt. The waste stream is then sorted manually into five main types of wastes:

a. PET bottles
b. HDPE bottles
c. Plastic bottles of mixed composition

d. Mixed plastic
e. Paper

The workers also separate out the Tetrapack containers and glass bottles. After manual sorting, the conveyor then transports the waste to an automatic sorter. The sorter separates out ferrous metals and aluminium cans from the waste stream. The remaining wastes are consolidated and then brought to the incineration plant for final disposal.

The current economic crisis has affected the recycling industry. For example, it is difficult to get an attractive price for used plastic bottles and paper. According to Veolia, the cost of recycling is very similar to the cost of waste incineration. This does not help to make recycling an attractive option.

There is a general lack of public awareness, understanding and appreciation of recycling. Hence, the wastes collected by the company are still co-mingled. This increases the cost as sorting is necessary. Efforts in raising awareness should be stepped up. According to Veolia, this can be done in four stages and the key message at each stage is as follows:

Stage 1: Recyclable wastes and trash should be thrown into separate bins
Stage 2: Recyclable wastes should be thrown into different bins according to material type
Stage 3: Recyclable wastes should be thrown into different bins according to material type and containers should be fully emptied before throwing them into recycling bins
Stage 4: Recyclable wastes should be thrown into different bins according to material type and containers should be fully emptied and flattened before throwing them into recycling bins.

II-2-10. Recycling Park

A former landfill site at the north-western part of Singapore was redeveloped into a recycling park after it was closed in September 1992. The dumping ground, which is about 20 hectares, would need 30 to 40 years of stabilisation before it could be utilised for more permanent developments. In an effort to boost the waste recycling industry in Singapore, specifically in bulk waste streams, the National Environment Agency (NEA) obtained approval to utilise part of the closed landfill site for recycling activities.

The Sarimbun Recycling Park provides a low cost solution for entrepreneurs to operate recycling facilities in Singapore. Tenants lease the land for a 3-year tenure with the option to extend to a maximum of three terms. The breakdown of companies according to the types of wastes recycles is given in the table below.

Table 3. Breakdown of Tenants at the Sarimbun Recycling Park

Type of Waste Recycled	Recycled Products	Number of Companies
Construction& Demolition	Recycled aggregate, Road Kerb, Drain Channel and aggregates	5
Horticultural & Wood	Refurbished pallets, Compost, Charcoal, briquettes	4
Street cleansing waste	Sorted leaves, soil	1
Plastics	Plastic resins	1
Tyres	Rubber crumbs (Tyre derived fuel)	1

Source: National Environment Agency Website (2009)

II-3. Waste minimization

Waste minimization programmes were introduced after 2006. The recycling programmes that were implemented before that time might not be sufficient to sustain waste reduction due to the rapid increase in waste generation. Thus, several efforts were made to reduce waste at the source. Two of the more significant programmes are the Singapore Packaging Agreement and the Bring Your Own Bag Day.

II-3-1. Singapore Packaging Agreement

As packaging waste constitutes about 35% of the domestic waste in Singapore, there is a potential to reduce packaging waste in the municipal waste stream. Signed on 5th June 2007, the Singapore Packaging Agreement represents a landmark collaborative effort between the government, industry and non-governmental organizations to work towards reducing packaging waste.

The objective of this agreement is to reduce packaging waste arising from consumer products, raise community agreement on packaging waste minimization and introduce supply chain initiatives that foster the sustainable use of resources in packaging. The signatories include five industry associations representing more than 500 companies, 19 individual companies, two non-governmental organizations (NGOs), the Waste Management & Recycling Association of Singapore and four public waste collectors. The agreement is voluntary which aims to provide flexibility to adopt cost-effective solutions to reduce packaging waste, but they have an undertaking to fulfil the following actions:

a. Meet certain recycling targets for recovery of packaging materials and have a review of these targets within two years of signing the agreement. The targets are:

1. Glass – 50 %

2. Metals (ferrous) – 95 %
3. Metals (non-ferrous) – 90 %
4. Paper – 55 %
5. Plastic – 23 %

b. Prepare annual work plans which include actions to meet the recycling targets and improve the sustainability of packaging.

c. Follow a packing code of practice where environment considerations are incorporated in their packaging.

II-3-2. Bring Your Own Bag Day

Started in April 2007, Bring Your Own Bag Day is a campaign to encourage shoppers to bring their own reusable bags to reduce wastage and promote resource conversation. Every first Wednesday of the month, major supermarkets will encourage shoppers to either buy a reusable bag or voluntarily donate 10 cents for every plastic bag taken at the checkout counter. The proceeds will then go to a registered charity to fund other environmental campaigns. This campaign has further extended from a monthly basis to every Wednesday since June 2008.

Survey shows that on average about 60% of the people supported the campaign by bringing their own reusable bags, purchasing new reusable bags, decline taking any plastic bags or make donations for each plastic bag they take.

II-3-3. Waste Minimization Through Standardization

Wooden pallets are commonly used in the industry for the transit of goods. In Singapore, these pallets come in 13 different sizes. Oftentimes, incoming goods often had to be unloaded and repacked into new wooden pallets as those from the company's suppliers are of a different size and they did not fit into shelves of the company's own warehouses. Thus, companies end up with many wooden pallets which they need to dispose of. Many of these are still in good condition.

This problem was first noticed in 1995/96 when several companies undertook their ISO 14001 environmental management system (EMS) certification audit. These companies were among the first few in Singapore to implement the ISO 14001 EMS. Companies implementing EMS were required to identify aspects of their business which had an impact on the environment. Several of these companies reported that waste from wooden pallets was significant.

At the same time, the need for pallet standardization, from a productivity improvement perspective, was also mooted. A pallet standardization working group was

set up by the Efficient Consumer Response (ECR) Council of Singapore. ECR is a private sector initiative comprising of suppliers, manufacturers, distributors and retailers. The pallet standardization project was managed by the then Singapore Article Number Council, now known as GS1 in close collaboration with the then Singapore Productivity and Standards Board (now called SPRING Singapore which is the national standards body) which co-chaired this working group with the logistics arm of National Trade Union Congress (NTUC). NTUC owns and operates a chain of supermarkets. After several meetings attended by a number of stakeholders, the group agreed on a four-way 1 m by 1.2 m standard size as it conformed to the international standard ISO 6780, "General-purpose flat pallets for through transit of goods - Principal dimensions and tolerances".

A pilot study was undertaken to understand the implications of standardizing pallet size across the Fast Moving Consumer Goods industry. It was found out that the usage of warehouse space was optimized. Wastage was also reduced as manual transfer of goods from one pallet to another of a different size was no longer necessary. It also eliminated the use of a slave standard pallet as a base for the non-standard pallets to sit on. Previously, a slave standard pallet was used so that the non-standard pallet can be handled by the forklift without having to change the forklift blades. With an estimated of about 300,000 wooden pallets in circulation, the estimated cost savings was estimated to be S$2.6 million per year in the Fast Moving Consumer Goods industry alone.

III. Conclusion

Despite the growing population and the gross domestic product, the total waste generation grew steadily. It reached a peak of about 7,700 tonnes per day in 2001 and then fell gradually to 7,032 tonnes per day in 2007. This decrease was due to the implementation of several waste management initiatives such as volume reduction, waste recycling and waste minimisation.

The critical success factors that contributed to the improvement of waste management includes the partnership of public sectors, private sectors and the people, an integrated approach for dealing with waste management and long term planning and targets for policies. To further encourage recycling, the following programmes need to be reviewed:

- Education and awareness building programmes
  Recycling rate, especially within the domestic sector, can be further improved. Currently, it is observed that recycling especially in the public housing sector is not active as storing recyclables at home would take up precious space. In addition, recycling collection points within the public housing estate are not very conveniently located and would generally require people to walk a few hundred

metres from their homes. Therefore, education programs need to be more aggressive to educate people that recycling should be a way of life, as evidenced in the European countries where it is common for people to drive to recycling collection centres to dispose of recyclables.

- Cooperation between public waste collector and grass root organizations
  Public waste collectors could work more closely with grass root organizations to promote recycling. The "Trash-to-Cash" scheme operated by one public waste collector enjoyed some success. Other public waste collectors could explore similar initiatives to promote greater recycling amongst the community it serves.

- Pricing of waste disposal services including incineration fees
  Due to heavy subsidy from the government for incineration of waste, it is more convenient and sometimes cheaper to throw away wastes than to recycle them. For instance, food waste recycling costs the same as incineration but requires upfront waste management procedures to separate the food wastes from general wastes.

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